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PROGNOSIS OF ICU DISCHARGE IN TRAUMATIC BRAIN INJURY PATIENTS: REGRESSION APROACH

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Abstract

Introduction: - Traumatic brain injury (TBI) is a leading cause of death and disability. A prognostic model is useful to calculate the probability of TBI outcome. It is a statistical model that includes two or more prognostic factors as independent variables and TBI outcome as the dependent variable. In present study the outcome is dichotomous, recovery or death.

Objectives: - To develop a prognostic model for the prediction of in hospital mortality in patients with traumatic brain injury (TBI) admitted to the Neurosurgery Intensive care unit (ICU).

Materials & Methods: - The demographic data of patients admitted after a diagnosis TBI in ICU were reviewed. A total of 411 patients with TBI were admitted to ICU during the study period. The endpoint of noting the outcome was ICU discharge.

Results: - The in-hospital mortality was 15.3%. On multivariate analysis the patients age, conscious level after injury, pupillary reactivity, Alcohol consumption, ENT bleed and hypertension found statistically associated with mortality. These significant variables were further considered for Logistic Regression Analysis. The overall correct prediction was 89.5% (368/411). To predict proportion of deceased & recovered equalised and high, ROC curve analysis was carried out. It revealed the new cut off probability of 0.097 with sensitivity 0.833 and specificity 0.789. The area under receiving operating characteristics (ROC) curve was 0.852.

Conclusion: - On Logistic Regression analysis patients age, conscious level after injury, pupillary reactivity, Alcohol consumption, ENT bleed and hypertension were highly associated with ICU outcome. As model is excellent for predicting in hospital mortality in patients with TBI, the probability tables for various combinations of independent variables will help clinicians and relatives in knowing the probable outcome.

Keywords: - ***Traumatic brain injury, Intensive Care Unit, Outcome Prediction***

INTRODUCTION

'No head injury is too despair of, nor too trivial to ignore'[1].

Traumatic brain injury (TBI) is a leading cause of death and disability. Now a days it represents a serious public health problem. TBI has been increasing in civilian population in a direct relationship to technological development[2], especially due to the great number of motor vehicle accidents.

It is difficult to prognoses one's outcome after admitting in hospital due to TBI. Under circumstances prognostic model helps and support clinician's judgment of the outcome. A prognostic model is a statistical model that includes two or more prognostic factors to calculate the probability of predefined outcome[3]. In medical research, the outcome is often dichotomized, for example good recovery or death[4]. Prognostic models predicting outcome on basis of initial clinical severity, demographical findings and laboratory values can provide information for patient's families & help in early clinical decision making and patient stratification[5,6]. However, such studies are carried out in different parts of the world but not in India and not to predict outcome at ICU discharge.

At hospital admission in the emergency room, besides application of demographical variables and clinical findings of the patients must be routinely evaluated. It means of an extensive and careful clinical neurological examination[7-9].

The purpose of this study is to use the combination of both admissions related demographic variables and clinical findings of the patients that predict the outcome at ICU discharge. To develop a prognostic model for the prediction of in hospital mortality the outcome at ICU discharge will be concerned with the patient's discharge status.

Materials & Methods:

Patients with Traumatic brain injury admitted in Krishna Hospital of Krishna Institute of Medical Sciences, Karad from July 2020 to April 2022 were included in this study. Close relative of total 536 patients gave consent to include their patient in the study. However, of these 125 took Leave Against Medical Advice (LAMA). Finally, total 411 patients studied till to their discharge from In Patient Department (IPD).

We considered patients clinical findings that could be determined easily within the first few hours after injury. Patients younger than 25 years of age were not included in the study. Patients with other injuries like long bone fractures, blunt or penetrating, injuries of chest or abdomen were also excluded from the study. The patient's outcome was assessed at the time of patients discharge from IPD. This study was conducted in a tertiary care centre which centres to a mixed population i.e., from urban as well as rural area. This hospital is located close to the national highway. Road traffic accident (RTA) cases form a major portion of the trauma cases load in the hospital. The demographic variables along with clinical variables such as age, sex, loss of Consciousness, vomiting, convulsion, ENT bleeding, alcohol consumption and hypertension and indicators of clinical severity such as, cause of injury, conscious level after injury and pupillary reactivity were also recorded to assess their role in prognosis of the outcome.

Statistical Analysis:

Statistical analysis was performed using SPSS computational program for windows, version 28. Descriptive analysis was done by constructing frequency tables for categorical

variables and Measures like mean & standard deviation for continuous variables. To verify the existence of association or to compare proportions between selected variables, chi-square test was employed.

The patient's age, gender and other demographic variables were compared with the use of chi-square tests. The results were considered statistically significant when $p<0.05$ otherwise it was not significant.

Logistic regression analysis used to develop the model to predict the outcome. It resulted in the form of regression coefficients and odds ratios. Backward Logistic Regression analysis was used to identify major risk factors associated with mortality.

Results:

The age range of 411 TBI patients was from 25 to 92 years with mean & SD of 47± 16 years with median age of 45 years. There were 281(68.37%) men and 130 (31.63%) women. The mean ICU stay of these patients was 8.83 ± 6.57 days with median days. The in-hospital mortality was 54(13.1%) and patients survived was 357(86.9%).

The TBI causes were road traffic accident (57.18%), fall (29.71%), Headache (9.49%) and assault (3.62%). The patients with older age, unconscious after injury, not pupillary reactivity, clinical findings like ENT bleed, alcohol consumption, non-hypertension showed significant association with ICU discharge status; mortality **(Table 1).**

Table 1. Demographic & Clinical findings wise ICU discharge status (n= 411)

Demography	**Death n= 54**	**Recovered n= 357**	**p- value**
Age			
<65years	43(10.5%)	328(79.8%)	**0.008**
≥65years	11(2.6%)	29(7.1%)	
Gender			
Female	16(3.89%)	114(27.74%)	0.734
Male	38(9.25%)	243(59.12%)	
Cause of Head Injury			
Assault	1(0.21%)	14(3.41%)	0.283
Fall	21(5.11%)	101(24.6%)	
Headache	2(0.49%)	37(9.002%)	
RTA	30(7.3%)	210(49.88%)	
Conscious level after Injury			
CON/SCON	18(4.38%)	309(75.18%)	**<0.0001**
UNCO	36(8.76%)	48(11.68%)	
Pupillary Reactivity			
Bilateral	17(4.14%)	312(75.91%)	**<0.0001**
Not reactivity	37(9.002%)	45(10.95%)	
Vomiting			
Absent	38(9.25%)	224(54.50%)	0.277
Present	16(3.89%)	133(32.36%)	
Seizure/Convulsion			
Absent	52(12.65%)	339(82.48%)	0.67
Present	2(0.48%)	18(4.38%)	
ENT bleeding			
No	32(7.79%)	308(74.94%)	**<0.0001**
Yes	22(5.35%)	49(11.92%)	
Alcohol Consumption			
No	38(9.25%)	297(72.26%)	**0.024**
Yes	16(3.89%)	60(14.60%)	
Hypertension			
No	33(8.03%)	326(79.32%)	**<0.0001**
Yes	21(5.11%)	31(7.54%)	

Multivariate logistic regression model was performed for prediction of TBI outcome as dependent variable. Age, conscious level after injury, pupillary reactivity, ENT bleed, alcohol consumption and hypertension were taken as independent variables. These socio-demographic variables found significant at 10% level of significance during Chi square analysis ($p<0.1$) and were considered for logistic regression analysis.

When compared to the older age, patients aged ≥65 years had 3.6 times higher chance of recovery at the time of ICU discharge with 95% C.I (1.355-9.366). This increasing age was significantly associated with discharge ($p<0.1$). Compared to conscious level after injury in TBI patients' unconsciousness had 2 times lower chance of recovery at the time of discharge with 95 % C.I (0.531-7.533). Patients' pupillary reactivity had 6.7 times higher chance of recovery at the time of ICU discharge with 95% C.I (1.67-26.73) as compared to pupillary non-reactivity. ENT bleed in TBI patients presenting had 1.6 times lower chance of recovery at the time of ICU discharge with 95% C. I (0.697-3.55). Compared to alcohol consumption in TBI patients presenting had 1.7 times lower chance of recovery at the time of ICU discharge with 95% C.I (0.737-3.710). Hypertensive patients in TBI presenting had 3.9 times higher chance of recovery at the time of ICU discharge with 95% C. I (1.76-8.66) in (**Table 2).**

Table 2. Multivariable Logistic regression analysis relating demographical variables with ICU outcome

Variables	B	p value	OR	95% C.I. for OR	
				Lower	Upper
Age	1.271	0.010	3.563	1.355	9.366
Conscious level after injury	.693	0.306	2.000	.531	7.533
Pupillary reactivity	1.900	0.007	6.687	1.673	26.731
ENT bleed	-.460	0.272	1.584	.697	3.599
Alcoholic consumption	-.503	0.223	1.653	.737	3.710
Hypertension	1.362	0.001	3.906	1.761	8.661
Constant	-2.637	<0.0001	.072		

Backward Logistic Regression analysis reveal that model with these all variables detected 22 deaths amongst observed total deaths correctly. While all models from step 2 to step 4 analysis detected 18 deaths correctly. Thus, in this study the model with all variables with chi- square $p<0.1$ was taken as prediction model. The model R^2 (Nagelkerke R^2) was 0.393. The prediction of this model with cut off probability 0.5 is disrobed in **(Table 3).**

Table 3. Prediction for ICU outcome with cut off probability 0.5

		Predicted ICU outcome		
		Discharge Status		%
		Death	Recovered	
Step 1	**Death**	22	32	40.7
	Recovered	11	346	96.9
Step 2	**Death**	18	36	33.3
	Recovered	9	348	97.5
Step 3	**Death**	18	36	33.3
	Recovered	9	348	97.5
Step 4	**Death**	18	36	33.3
	Recovered	9	348	97.5

Since, this table depicted very high percentage of recovered (>95%) while less proportion of death (<40%) at cut off probability 0.5. ROC curve analysis was performed to detect the cut off probability giving high and balanced percentages of recovered (specificity) and deaths (sensitivity).

The ROC curve analysis depicted the area under the curve of 0.852 (Fig. 1). Coordinates of the curve showed 0.833 sensitivity with 0.789 specificity at cut off 0.097. The prediction of the model with these cut off probability is presented in **(Table 4).** Thus, overall correct prediction of the model with cut off probability 0.097 was 80.3%.

Table 4. Prediction for ICU outcome with cut off probability 0.097

		Predicted ICU outcome		
		Discharge Status		%
		Death ($p\geq0.097$)	Recovered ($p<0.097$)	
Step 1	**Death**	45	9	83.3
	Recovered	72	285	79.8
The overall percentage = 80.3				

The simulation table derived from the model (Table 2) with all possible combinations of predictor variables is displayed in **(Table 5).**

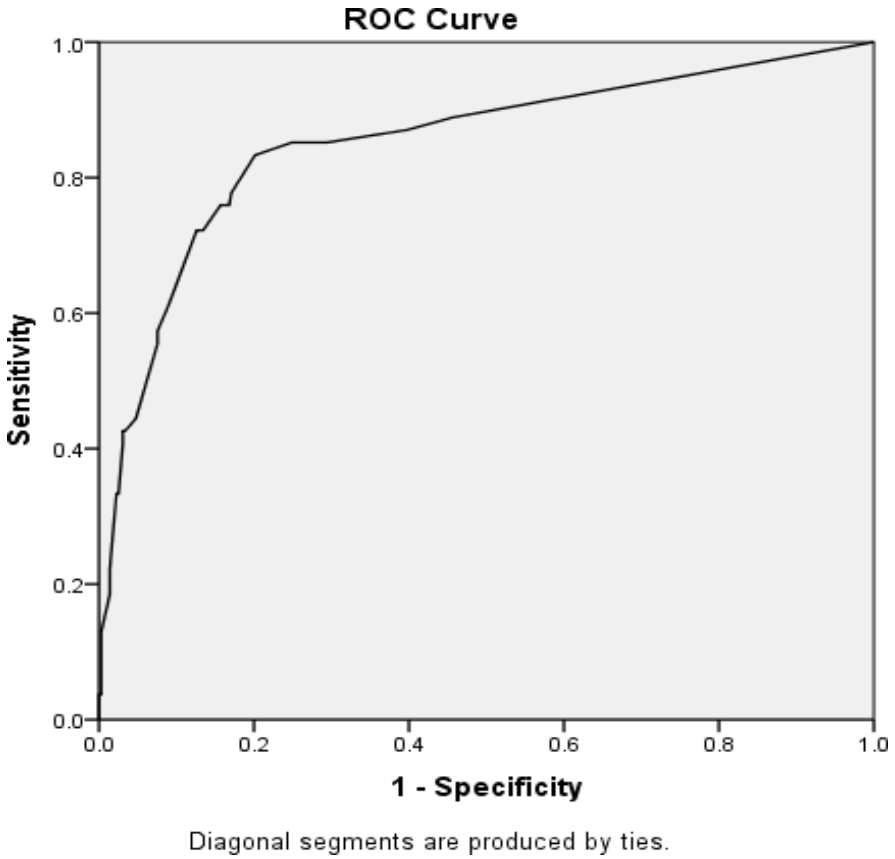

Fig. 1 The area under ROC curve for prognostic model iterations of mortality

The predictive power of the model was evaluated by using a receiver operating curve (ROC curve). The model had 0.852% predictive power to discriminate between survived and expired patients **(Fig. 1).** As model is excellent for predicting in hospital mortality in patients with TBI.

Table 5. Probability value of the customized prediction model

Age (<65=0, ≥65=1)	Conscious level after injury (Conscious=0, Unconscious=1)	Pupillary Reactivity (Bilateral=0, Not-Reactive=1)	ENT bleed (No=0, Yes=1)	Hypertension (No=0, Yes=1)	Alcohol consumption (No=0, Yes=1)	Probability (p) of Survival
0	0	0	0	0	0	**0.930**
1	0	0	0	0	0	**0.789**
0	1	0	0	0	0	**0.869**
0	0	1	0	0	0	**0.666**
0	0	0	1	0	0	**0.955**
0	0	0	0	1	0	**0.773**
0	0	0	0	0	1	**0.957**
1	1	0	0	0	0	**0.651**

1	0	1	0	0	0	**0.358**
1	0	0	1	0	0	**0.855**
1	0	0	0	1	0	**0.489**
1	0	0	0	0	1	**0.861**
0	1	1	0	0	0	**0.499**
0	1	0	1	0	0	**0.913**
0	1	0	0	1	0	**0.630**
0	1	0	0	0	1	**0.917**
0	0	1	1	0	0	**0.759**
0	0	1	0	1	0	**0.338**
0	0	1	0	0	1	**0.767**
0	0	0	1	1	0	**0.844**
0	0	0	1	0	1	**0.972**
0	0	0	0	1	1	**0.849**
1	1	1	0	0	0	**0.218**
1	0	1	1	0	0	**0.470**
1	0	0	1	1	0	**0.603**
1	0	0	0	1	1	**0.613**
0	0	0	1	1	1	**0.899**
0	1	0	0	1	1	**0.738**
0	1	1	0	0	1	**0.622**
0	1	1	1	0	0	**0.612**
1	1	0	1	0	0	**0.747**
1	1	0	0	1	0	**0.324**
1	1	0	0	0	1	**0.755**
0	0	1	0	1	1	**0.458**
0	0	1	1	0	1	**0.839**
0	0	1	1	1	0	**0.447**
1	0	0	0	1	1	**0.613**
0	1	1	1	0	0	**0.612**
1	0	1	0	1	0	**0.125**
0	1	0	1	0	0	**0.913**
0	1	1	0	1	0	**0.203**
1	0	0	1	0	1	**0.907**
1	1	1	1	0	0	**0.307**
1	1	1	0	1	0	**0.067**
1	1	0	1	1	0	**0.431**
0	1	1	1	0	1	**0.723**

0	1	1	1	1	0	**0.288**
1	0	0	1	1	1	**0.715**
1	0	1	0	1	1	**0.191**
1	0	1	1	0	1	**0.594**
1	0	1	1	1	0	**0.185**
1	1	0	0	1	1	**0.442**
1	1	0	1	0	1	**0.830**
1	1	0	1	1	0	**0.431**
1	1	1	0	0	1	**0.316**
1	1	1	0	1	0	**0.067**
1	1	1	1	0	0	**0.307**
1	1	1	1	1	0	**0.102**
1	1	1	1	0	1	**0.423**
1	1	1	0	1	1	**0.106**
1	1	0	1	1	1	**0.556**
1	0	1	1	1	1	**0.273**
0	1	1	1	1	1	**0.401**
1	1	1	1	1	1	**0.158**

The above table for various combinations of independent variables will help clinicians and relatives in knowing the probable outcome of their dear ones committed TBI.

Discussion:

All patients admitted to Krishna Hospital with a history of head trauma during the study period of May 2020 to April 2022 were included in the study. The present study was carried out on 411 patients admitted to the Neurosurgery Department at Krishna Hospital with head injuries and polytrauma in both sexes.

National and international epidemiological data have shown that TBI mainly affects young and male healthy people. Indeed, in the present investigation, accordingly to these reports, TBI was seen more frequently in young males. Navdeep Singh Saini et al[10] studied factors predicting outcome in patients with severe head injury, where the most of patient's gender was male (85.45%). They studied patients with RTA (83.64%) as the most common mode of head injury. In present study, the most of TBI patients were men 281(68.37%). The major of TBI causes was road traffic accident (57.18%) followed by fall (29.68%).

We developed a prognostic model to predict in-hospital mortality based on variables at the time of admission in ICU. Logistic regression used to construct the model. The logistic regression has advantages over the other techniques, as it does not require variables to be normally distributed and linearly related. Furthermore, logistic regression handles both categorical variables and continuous variables and gives us quickly interpretable outputs in the form of regression coefficients and odds ratios. Also used discrimination to assess the performance of the model. Prognostic model discriminated excellently between patients who died from those who survived.

Many other authors like Jennett B et al[11], Stablein DM et al[12], David F Signorini et al[13] have shown age, pupil score and GCS score to be significant predictors of long-term outcome after traumatic brain injury. In present study, demographical variables like age, conscious level after injury, pupillary reactivity, ENT bleed, alcohol consumption and hypertension were significant predictors of ICU outcome after traumatic brain injury.

Mini Jayan et al[4] in multivariate analysis found GCS at admission, hypoxia, hypotension, and obliteration of the third ventricle/basal cisterns were significantly associated with mortality. The predictive power of the model was evaluated by using a receiver operating curve (ROC) curve. The model had 91.4% predictive power to discriminate between survived and expired patients. In present study, age, conscious level after injury, pupillary reactivity, ENT bleed, alcohol consumption and hypertension were significantly associated with mortality. The predictive power of the model was evaluated by using a receiver operating curve (ROC curve). The model had 85.2% predictive power to discriminate between survived and expired patients.

Conclusion:

The performance of the model developed for patients ICU outcome was good. On Logistic Regression analysis patients age, conscious level after injury, pupillary reactivity, Alcohol consumption, ENT bleed and hypertension were highly associated with ICU outcome. As model is excellent for predicting in hospital mortality in patients with TBI, the probability tables for various combinations of independent variables will help clinicians and relatives in knowing the probable outcome and hence in taking proper actions and decisions at right time.

References:

1) Ewout W. Steyerberg, Nino Mushkudiani, Pablo Perel, Isabella Butcher, Juan Lu, Gillian S. McHugh, Gordon D. Murray, Anthony Marmarou, Ian Roberts, J. Dik F. Habbema, Andrew I. R. Maas. Predicting Outcome after Traumatic Brain Injury: Development and International Validation of Prognostic Scores Based on Admission Characteristics. PLoS Med 2008; 5(8): e165. doi:10.1371/ J pmed.0050165.

2) Chantal WP.M. Hukkelhoven, Ewout W. Steyerberg, J. Dik F. Habbema, Elana Farace, Anthony Marmarou, Gordon D. Murray, Lawrence F. Marshall and Anderew I.R. Maas. Predicting Outcome after Traumatic Brain Injury: Development and Validation of a Prognostic Score Based on Admission Characteristics. J Neurotrauma 2005; 22(10): 1025–1039.

3) Mushkudiani NA, Hukkelhoven CWPM, Hernández AV, et al. A systematic review finds methodological improvements necessary for prognostic models in determining traumatic brain injury outcomes. J Clin Epidemiol 2008;61(4):331–343.

4) Mini Jayan, Dhaval Shukla, Bhagavatula Indira Devi, Dhananjaya I. Bhat, Subhas K. Konar. Development of a Prognostic Model to Predict Mortality after Traumatic Brain Injury in Intensive Care Setting in a Developing Country. J Neurosci Rural Pract 2021; 12:368–375.

5) Maas AIR, Lingsma HF; IMPACT Study Group. New approaches to increase statistical power in TBI trials: insights from the IMPACT study. Acta Neurochir Suppl (Wien) 2008; 101:119–124

6) Roozenbeek B, Maas AIR, Lingsma HF, et al; IMPACT Study Group. Baseline characteristics and statistical power in randomized controlled trials: selection, prognostic targeting, or covariate adjustment? Crit Care Med 2009;37(10):2683–2690.

7) Chesnut MD. Implications of the guidelines for the management of severe head injury for the practicing neurosurgeon. Surg Neurol 1998; 50:187-193.

8) Finfer SR, Cohen J. Severe traumatic brain injury. Ressuscitation 2001; 48:77-90.

9) Ji-Yao Jiang, Guo-Yi Gao, Wei-Ping Li, Ming-Kun Yu, and Cheng Zhu. Early Indicators of Prognosis in 846 Cases of Severe Traumatic Brain Injury. J Neurotrauma 2002; 19(7): 869-874.

10) Navdeep Singh Saini, Vikas Rampal, Yashbir Dewan, Sarvpreet S. Grewal. Factors predicting outcome in patients with severe head injury: Multivariate analysis. J Neurotrauma June 2012; 9(1): 45-48.

11) Jennett B, Teasdale G, Braakman R, et al. Prognosis of patients with severe head injury. Neurosurgery 1979; 4:283– 9.

12) Stablein DM, Miller JD, Choi SC, et al. Statistical methods for determining prognosis in severe head injury. Neurosurgery 1980; 6:243–8.

13) David F Signorini, Peter J D Andrews, Patricia A Jones, Joanna M Wardlaw, J Douglas Miller. Predicting survival using simple clinical variables: a case study in traumatic brain injury. J Neurol Neurosurg Psychiatry 1999; 66:20–25.