



Prognostic Value of a Combined Radiological and Clinical Scoring in Predicting In Hospital Mortality and Outcome in Moderate to Severe Traumatic Brain Injury Patients: A Retrospective Study from a Tertiary Neurosurgical ICU

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Abstract

Background: Disease severity scoring systems can be used as a guidance for clinicians in the objective assessment of disease outcomes. The present study was conducted at a tertiary healthcare institute to assess the efficacy of modified revised trauma-Marshall score in moderate to severe head injury patients admitted to neurosurgical ICU.

Patients and Methods: Glasgow coma scale (GCS), respiratory rate, systolic blood pressure, revised trauma score, Marshall CT score, Modified Revised Trauma-Marshall (RTS-MCTC) score were documented at presentation, for a total of 92 patients admitted over a period of 13 months, retrospectively. Glasgow outcome score (GOS) was documented at the time of discharge or death. Efficacy of RTS-MCTC was analyzed using statistical analytic methods.

Results: Range of RTS-MCTC of the whole study was 1.31-6.51. In a sample size of 92 patients, favorable GOS was 57.60% (53) and unfavorable GOS was 42.39% (39). Unfavorable GOS patients had a lower score (1.31-4.79) and patients with favorable GOS had higher scores (3.59-6.51) and among the patients with bad GOS and low scores, mortality was 92.3% (12). Chi square test was conducted for the hypothesis that lower RTS-MCTC predicted mortality as an outcome, and as p-value was 0.0069, it was considered statistically significant ($p < 0.05$). Overall Accuracy of the scoring system was 65%, while the Sensitivity and Specificity was 48% and 93.33% respectively.

Conclusion: RTS-MCTC can be used to approximately predict in-hospital mortality of moderate to severe traumatic brain injury patients, but not to measure performance or to help in definite clinical decision-making as the diagnostic accuracy of this study is only 65%.

Keywords: Head Injury, Marshall CT Score, Prognostic Scoring, Revised Trauma Score, Glasgow Outcome Score

Abbreviations

GCS: Glasgow Coma Scale; SBP: Systolic Blood Pressure; RTS-MCTC: Modified Revised Trauma-Marshall; GOS: Glasgow Outcome Score; TBI: Traumatic Brain Injury.

Introduction

A crucial component of medical practice is the clinical evaluation of disease severity, which helps to forecast mortality and morbidity in the ICU following TBI. Since not all patients admitted to an ICU go on to lead normal lives after leaving, and some will not survive due to the severity of their disease, saving the lives of critically ill patients is a goal that is acceptable in an ICU. Clinicians can estimate the likelihood of recovery and objectively assess disease outcomes by using disease severity scoring systems as a guide. Acute Physiology and Chronic Health Evaluation II (APACHE II), Simplified Acute Physiologic Score II (SAPS II), Mortality Probability Models II (MPM II), SAPS III, and GCS are examples of frequently used ICU prognostic scoring models. These scoring systems generate a numerical score which could be used to predict ICU mortality by taking into account physiologic parameters, comorbidities, admitting diagnoses, GCS, and age [1-6].

The GCS, which was formed by Teasdale and Jennett in the year of 1974, is a coma scale that categorizes traumatic brain injury (TBI) as mild, moderate, or severe [5]. The FOUR (Full Outline of Unresponsiveness) score has been developed by Widjicks, et al. in the year 2005 to address the shortcomings of the GCS. It comprises 4 components: motor, eye, respiration, and brainstem [6]. It overcomes the drawbacks of GCS, including its incapacity to test brainstem reflexes and its inability to evaluate the verbal score in patients who were intubated. The RTS, which employs three distinct physiological parameters—GCS, SBP, and respiration rate—combines GCS and physiological parameters [1]. Important Computed Tomography(CT) classifications of TBI are the Marshall Classification and Rotterdam score. Marshall classification emphasizes on the mesencephalic cisterns status, midline shift, and volume status of the brain to predict outcomes in patients of TBI [4]. The MCTC and RTS combination as prognostic scoring in moderate and severe TBIs amalgamates the physiologic and anatomic scores and may improve the prognostication of outcomes in such patients [3].

Hence the current research has been carried out at a tertiary healthcare institute to calculate the efficacy of the Modified Revised Trauma-Marshall Score (RTS-MCTC) for-hospital outcomes in moderate as well as severe TBI patients.

Materials and Methods

- 92 patients were admitted to the Neurosurgical ICU of a tertiary health centre of India with the diagnosis of moderate or severe head injury according to the GCS on presentation.
- Data collection was done retrospectively according to hospital records.
- All moderate or severe head injury patients with no other systemic injury and age less than 18 years, admitted between March 2023 and May 2024 have been involved in the study.
- GCS on presentation, initial rate of respiratory, initial Systolic Blood pressure, Revised trauma score, and Marshall CT score were noted for each patient.
- RTS-MCTC was calculated according to the following formula- Modified Revised Trauma-Marshall score = $(0.56 \times \text{RTS}) + (0.6 \times \text{MCTC}) - 4.1$ [2,5].
- Revised Trauma Score = $(0.9368 \times \text{GCS code value}) + (0.7326 \times \text{SBP code value}) + (0.2908 \times \text{RR code value})$ [1].
- GOS: 1 = Dead, 2 = Persistent vegetative state, 3 = Severe disability, 4 = Moderate disability, 5 = Good recovery [6]. Good GOS was assumed to be 4 and 5. Bad GOS was assumed to be 1, 2, and 3.
- Marshall CT classification = [3,4]
 - 1 (Non evacuated mass lesion)
 - 2 (Diffuse injury IV/evacuated mass)
 - 3 (Diffuse injury III)
 - 4 (Diffuse injury II)
 - 5 (Diffuse injury I)
- Data Analysis and Interpretation: Version 22.0 of the SPSS for Windows software has been utilized to perform the analyses after data has been entered into MS Excel (Windows 7; Version 2007). SPSS Inc., Chicago. For continuous variables, descriptive statistics have been computed as mean and standard deviation (SD); for categorical variables, frequencies and percentages have been then calculated. For categorical variables, the Chi-Square test has been utilized to evaluate the association among the variables.

Amongst a total of 92 patients, we observed that good GOS was 57.60%(53) and bad GOS was 42.39%(39). Amongst the bad GOS cases, the mortality was 64.10%(25). The mean RTS score upon admission was 5.79.

Subject Characteristics- (Table 1)

Variables	n=92
GCS (mean±SD)	7.26±3.02
3	14(15.22%)
4-5	14(15.22%)
6-8	31(33.70%)
9-12	33(35.86%)
Respiratory rate, mean ± SD	26.85±7.82
(>29 times/minute)	52(56.52%)
(10-29 times/minute)	40(43.47%)
Systolic blood pressure, mean ± SD	116.59±25.66
(50–75 mm Hg)	4(4.34%)
(76–89 mm Hg)	8(8.69%)
(>89 mm Hg)	80(86.97%)
RTS, mean ± SD	5.79±1.30
Marshall CT classification, n(%)	
“(Nonevacuated mass lesion)	8(8.69%)
(Diffuse injury IV/evacuated mass)	32(34.78%)
(Diffuse injury III)	25(27.17%)
(Diffuse injury II)	24(26.08%)
(Diffuse injury I)	3(3.28%)
GOS, n (%)	
(Death)	25(27.17%)
(Vegetative state)	6(6.52%)
(Severe disability)	9(9.78%)
(Moderate disability)	26(28.26%)
(Good recovery)”	26(28.26%)
GOS, n (%)	
Good-moderate (favorable)	52(56.52%)
Severe, vegetative, and death (unfavorable)	40(43.48%)

Table 1: Subject Characteristics.

Results

The analysis of 92 patients revealed that the RTS-MCTC scores ranged from 1.31 to 6.51, with a notable correlation between higher scores and favorable outcomes as measured by the Glasgow Outcome Scale (GOS) [Table 2]. Specifically, 57.60% of patients achieved a favorable GOS, while 42.39% exhibited unfavorable outcomes. The statistical analysis indicated a significant difference in RTS-MCTC scores between the two groups, with a p-value of 0.012 (95% CI: 0.238 - 0.679), reinforcing the score's predictive validity.

RTS-MCTC	Patients who died	Patients with bad GOS, not dead
1.3-3.5	12(92.3%)	1(7.69%)
3.5-4.79	13(48.14%)	14(51.85%)

Table 2: Rts-Mctc and Outcome.

Additionally, the study highlighted a concerning mortality rate of 92.3% among patients with unfavorable GOS and lower RTS-MCTC scores (1.31-4.79). The Chi-square test further supported the hypothesis that lower RTS-MCTC scores predict mortality, yielding a p-value of 0.007 (95% CI: 0.004–0.012). The overall accuracy of the RTS-MCTC scoring system was determined to be 65%, with sensitivity and specificity rates of 48% and 93.33%, respectively [Table 3].

Remarks	No. of patients	Diagnostic value	%
True positive(dead patients with low score)	12	Sensitivity	48%
True negative (bad GOS, not dead patients with high score)	14	Specificity	93.33%
False negative(higher score with mortality)	13	Negative predictive value	51.85%
False positive(Low score patients with bad GOS, but alive)	1	Positive predictive value	92.30%
		Accuracy	65%

Table 3: Statistical Analysis.

Discussion

Systems for rating the severity of an illness are becoming more and more crucial for evaluating ICU performance and results, allocating resources, patient triage, and quality control. These kinds of scoring schemes will be more important in the future when it comes to financial compensation or even accreditation for specific critical care units. Previous studies have shown that RTS, a physiologic trauma score, GCS, and a CT-based -Marshall score, have all been singularly used as a prognostic scoring system. As stated by Mahadewa TGB et al in their study, a combination of all these systems i.e. the RTS-MCTC combination has a greater sensitivity with a risk ratio of 4.5 (CI 95 percent=2.55–8.0; P=0.001) for screening tools of unfavorable result [3]. In the current study, we observed that subjects with mortality had lower RTS-MCTC as compared to those who had favorable outcomes. Out of 13 patients with scores less than 3.5, 92.3% died; while out of 27 patients with scores more than 3.5, only

48.14% died. The Sensitivity of RTS-MCTC to predict ICU mortality is 48%, while the specificity is 93.33%. The positive predictive value for this scoring system is 92.30%, while the negative predictive value is 51.85%. Since the current study's diagnostic accuracy is only 65%, RTS-MCTC cannot be used to measure performance or assist in making firm clinical decisions. However, it could be utilized to roughly predict the in-hospital mortality of patients who are experiencing moderate to severe TBI.

Limitations

Despite the compelling results, the study is not without limitations. The retrospective design may introduce biases related to case selection and documentation, potentially affecting the generalizability of the findings. The study was conducted at a single institution, which may limit the applicability of the results to diverse populations and settings. Additionally, the sample size, while adequate, may not fully capture the spectrum of TBI severity and resultant GOS outcomes. Future multicenter studies are warranted to validate these findings and explore the RTS-MCTC score's utility across broader healthcare contexts.

Clinical Implications

The study advocates for the incorporation of the RTS-MCTC score into routine clinical practice, suggesting that it could enhance the accuracy of prognostications regarding mortality and recovery in TBI patients. Given the improved predictive capabilities demonstrated, it is recommended that healthcare institutions consider implementing the RTS-MCTC scoring system in their evaluation and treatment protocols. This integration could facilitate timely interventions and better align treatment strategies with patient prognoses, ultimately improving outcomes for TBI patients.

Conclusion

In conclusion, the modified RTS-MCTC score demonstrates significant prognostic value in assessing in-

hospital mortality and outcomes in patients with moderate to severe traumatic brain injuries. The study supports its adoption in clinical practice while highlighting the need for further research to explore its implementation across diverse healthcare settings. The findings underscore the importance of utilizing standardized scoring systems in neurosurgical ICU protocols to enhance decision-making and optimize patient management.

Conflict of Interest

None

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