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ORIGINAL ARTICLE

Comparison of new injury severity score and revised trauma score for mortality prediction in adult trauma patients.

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ABSTRACT… Objective: To compare the revised trauma score (RTS) and new injury severity score (NISS) in predicting mortality in adults presented with trauma. **Study Design:** Cohort Research **Setting:** Emergency Department, Ziauddin University Hospital's, Karachi. **Period:** November 12, 2022, to May 11, 2023. **Methods:** A consecutive sampling technique was used to select 384 adult patients with traumatic brain injury (TBI), aged ≥ 18 years and who visited the emergency department (ED). After obtaining vitals, Glasgow Coma Scale (GCS), RTS and NISS were measured. Each TBI patient was treated according to standard procedures and followed until discharge or death. **Results:** Of the total, 53.1% were females and 46.9% were male with an average age of 44.21 years. Predicted mortality with RTS and NISS was 13.0% and 29.7% respectively, while mortality was 22.7%. The optimal cut-off score for predicting mortality in adult TBI patients using the RTS was a score of ≤7 (sensitivity 57.5%, specificity 100.0%, positive predictive value 100.0%, negative predictive value 89.0%, diagnostic accuracy 90.4%, area under ROC curve 0.014), and similarly cut-off score under the NISS was a score of ≥16 (100.0%, 91.0%, 76.4%, 100.0%, 93.0%, 0.934). There was a significant difference (p-value <0.001) between RTS and NISS with respect to the area under the ROC curve. **Conclusion:** In adult traumatic brain injury patients, NISS was the most accurate predictor of mortality when compared to RTS.

Key words: Emergency, Morbidity, Mortality, Trauma.

INTRODUCTION

The term "traumatic brain injury" (TBI) refers to any brain damage brought on by a simple blow or a penetrating injury. TBI is considered a medical emergency, which is why emergency physicians manage TBI patients.[1,2] There is also a significant association between TBI and increased burden over hospital emergency that resulting in increased rates of morbidity, mortality, and lifelong disability.[3,4]

Globally, more than 69 million people suffer TBI each year.[5] In the United States, and in England and Wales, there are approximately 2.5 million and 1 million emergency department visits annually for TBI.[6,7] RTAs are the leading cause of TBI, with the highest incidence in Southeast Asia (56%) and the lowest in North America (25%).[5] Similarly, TBI-related mortality and lifetime disability are higher in developing countries than in developed countries.[8] Pakistan is among the developing countries with the highest burden of TBI. Despite the fact that TBI is common and severe in Pakistan, not much research has been done on the prevalence and epidemiology of TBI.[9-11] A study from Pakistan reported a TBI prevalence of 4.4% while another reported that about 33.3% of total RTAs resulted in TBI, of which 10% had severe TBI.[8,10]

Emergency physicians face many difficulties in making a quick and accurate diagnosis of TBI. Therefore, various imaging modalities and scores including GCS, Injury severity score (ISS), NISS, Trauma and injury severity scores (TRISS), Acute physiology and chronic health evaluation (APACHE) score and RTS are used to diagnose TBI, predict its severity and mortality. Brain computerized tomography (CT) is the most commonly used imaging modality to confirm TBI

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by detecting intracranial bleeding in the brain. The Glasgow Coma Scale (GCS) is a scoring system for assessing the severity of TBI. While RTS and NISS are scoring systems for predicting TBI mortality.[12-13]

One of the most important problems that emergency physicians deal with in the emergency department is traumatic brain injury in adults. The risk of traumatic brain injury is highest in the adult population worldwide, resulting in increased hospital admissions, lifelong disability and mortality. Therefore, early prediction of death in traumatic brain injury patients is important for patient management and also for reducing the risk of mortality. This study aims to compare the revised trauma score and new injury severity score in predicting mortality in adults presented with traumatic brain injury.

METHODS

A six-month cohort research was conducted at Ziauddin University Hospital's emergency department (ED) in Karachi from November 12, 2022, to May 11, 2023. A consecutive sampling technique was used to select 384 patients from ED. These patients were (1) adult, (2) diagnosed with traumatic brain injury (TBI), (3) ≥ 18 years of age and (4) who visited the emergency department (ED). Whereas TBI patients (1) with poly trauma (2) leave the ED against medical advice or (3) not willing to be a part of research were excluded.

Permission for this cohort research was obtained from the ethical review committee of Ziauddin University Hospital Karachi (Reference code: 6351222BVEM, dated April 12, 2023) and a written informed consent was also taken from patients relatives. After demographics were obtained, vitals were immediately measured and the patient was triaged to classify them according to severity. Each patient was also evaluated for details of head injury. Brain CT is performed to detect intracranial bleeding in the brain followed by evaluation of GCS score for confirmation of TBI and its severity. Presence of intracranial bleeding in the brain with a GCS score ≥3 was used to confirm TBI. A GCS score of 13–15 was used to confirm mild severity of TBI, 9–12 for moderate severity of TBI, and 3–8 for severe TBI. The optimal cut-off score for predicting mortality in adult TBI patients using the RTS was a score of ≤7 and cut-off score under the NISS was a score of ≥16. Each TBI patient was treated according to standard procedures and followed until discharge or death.

Statistical package for social sciences (SPSS; version 25) was used for calculating mean for quantitative data and frequency for qualitative data. Chi-square test was applied for stratification by using significant p value of ≤ 0.05. Sensitivity, specificity and positive predictive values and negative predictive values and diagnostic accuracy was calculated for RTS and NISS by using actual mortality as standard. Area under the receiver operating characteristic (AUROC) curve was used for predicting mortality ability of RTS and NISS in TBI patients.

RESULTS

Of the total, 53.1% were females (n=204) and 46.9% were male (n=180) with an average age of 44.21 ± 15.13 years. Most of the patients 29.9% (n=115) were in age group of 41-50 years followed by age group of 31-40 years having 25.0% (n=96) patients and 18-30 years having 20.3% (n=78) patients. Most common intent of injury was unintentional (92.7%; n=356), while mechanism of injury was falls (65.4%; n=251) followed by road traffic accidents (RTAs; 27.3%; n=105) and violence (7.3%; n=28). Mean GCS score was 12.72±3.60, whereas in most of the patients TBI severity was mild 70.3% (n=270) followed by severe TBI 22.4% (n=86) and moderate TBI 7.3% (n=28). The mean RTS was 10.79±2.14 with a predicted mortality of 13.0% (n=50). The mean NISS was 9.54±9.18 with a predicted mortality of 29.7% (n=114). 77.3% (n=297) patients recovered from TBI after treatment and 22.7% (n=87) patients died during treatment in ED (Table-I).

Among those TBI patients who were died or discharged (alive), mean GCS, RTS and NISS scores were 7.54±2.38 vs. 14.24±2.23, 7.68±2.04 vs. 11.70±1.02 and 21.72±5.38 vs. 5.97±6.64 respectively (Table-II). In this study,

mean trauma score of RTS was significantly (p-value <0.001) low in died TBI patients and NISS was significantly (p-value <0.001) high in died TBI patients as compared to alive TBI patients.

The optimal cut-off score for predicting mortality in adult TBI patients using the RTS was a score of ≤7 (sensitivity 57.5%, specificity 100.0%, positive predictive value 100.0%, negative predictive value 89.0%, diagnostic accuracy 90.4%, area under ROC curve 0.014), and similarly cut-off score under the NISS was a score of ≥16 (100.0%, 91.0%, 76.4%, 100.0%, 93.0%, 0.934). There was a significant difference (p-value <0.001) between RTS and NISS with respect to the area under the ROC curve (Table-III and Figure-1). Death in TBI patient was significantly associated with gender (p-value <0.001), age (p-value <0.001), mechanism of injury (p-value <0.001), TBI severity (p-value <0.001) and length of stay (p-value <0.001) (Table-IV).

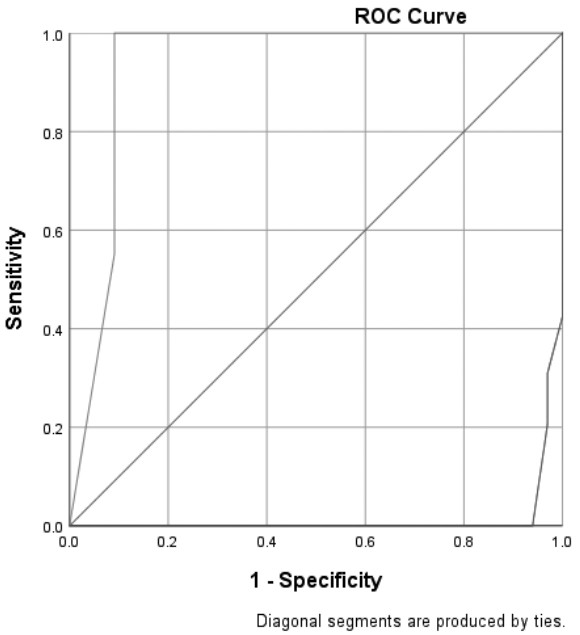

Figure-1. ROC Curve for RTS and NISS

DISCUSSION

Despite advances in medical care and technologies, traumatic brain injury remains a major global cause of morbidity and mortality and also one of the leading causes of death for adults under the age of 45. The severity and outcome of TBI are influenced by many factors, including the patient's age, extent of injury, time to emergency hospital arrival, time to triage, time to diagnosis and assessment of severity, and provision of appropriate care and treatment.[14,15]

In emergency departments, trauma scoring systems are commonly used to assess trauma severity and predict both immediate and long-term outcomes such as lifetime disability and death. These assessment scores are useful not only for predicting the severity of traumatic brain injury but also for selecting appropriate therapy by comparing treatment short and long term outcomes.[14,15]

As we discussed earlier, traumatic brain injury outcomes are affected by many factors, including the severity of the traumatic brain injury. Mortality in a TBI patient is directly related to the severity of the TBI. As the severity of TBI increases, the risk of death increases. Therefore, early and accurate prediction of death in adult TBI patients is critical for TBI therapy but also for reducing financial burden on patient and workload as well as financial burden on emergency departments.[16,17] A number of studies have evaluated different scoring systems for predicting TBI severity and mortality, but still more research is required to determine TBI severity and predict mortality in adults. Therefore, this study compares the two most commonly used scoring systems in the emergency department to predict mortality and find a more appropriate scoring system.

In this study, both genders (female 53.1% and male 46.9%) had similar TBI compared to other studies where mostly male patients presented with TBI.[18-24] The mean age of TBI patients was 44.21 ± 15.13 years, while 75% of patients were under 50 years of age. Most common mechanism of injury was falls (65.4%) followed by RTAs (27.3%). When we compare the results of this study with other studies, they report male predominance with age over 50 years and RTAs as the most common mechanism of injury followed by falls.[18-24] Differences in gender and age were reported due to patient selection and clinical presentation.

Variables		Frequency	Percentage
Gender	Male	180	46.9%
	Female	204	53.1%
Age (Years)	Mean±SD	44.21±15.13	
	18-30	78	20.3%
	31-40	96	25.0%
	41-50	115	29.9%
	51-60	39	10.2%
	61-70	28	7.3%
	> 70	28	7.3%
Vitals	Heart Rate	98.35±14.02 beats/min	
	Oxygen Saturation	93.84±8.26%	
	Systolic Blood Pressure	120.47±37.26 mmHg	
	Diastolic Blood Pressure	69.18±22.70 mmHg	
	Respiratory Rate	15.58±3.73 breaths/min	
Intent of Injury	Intentional	28	7.3%
	Unintentional	356	92.7%
Mechanism of Injury	RTAs	105	27.3%
	Falls	251	65.4%
	Violence	28	7.3%
GCS	Mean±SD	12.72±3.60	
	Mild	270	70.3%
	Moderate	28	7.3%
	Severe	86	22.4%
RTS	Mean±SD	10.79±2.14	
RTS Predicted Mortality	Yes	50	13.0%
	No	334	87.0%
NISS	Mean±SD	9.54±9.18	
NISS Predicted Mortality	Yes	114	29.7%
	No	270	70.3%
Length of Stay	Mean±SD	1.89±1.96	
	<1	291	75.8%
	>1	93	24.2%
Mortality	Yes	87	22.7%
	No	297	77.3%

Table-I. Epidemiological profile of traumatic brain injury patients (n=384)

Score	Died (n=87)	Alive (n=297)	P-Value
GCS	7.54±2.38	14.24±2.23	<0.001*
RTS	7.68±2.04	11.70±1.02	<0.001*
NISS	21.72±5.38	5.97±6.64	<0.001*

Table-II. Mean GCS, RTS and NISS in died and alive of traumatic brain injury patients (n=384)

Scores	Cutoff	Sensitivity	Specificity	PPV	NPV	DA	AUROC	P-Value
RTS	≤7	57.5%	100.0%	100.0%	89.0%	90.4%	0.014	<0.001*
NISS	≥16	100.0%	91.0%	76.4%	100.0%	93.0%	0.934	<0.001*

Table-III. Comparison of RTS and NISS in predicting mortality in traumatic brain injury patients

Variables Died (n=87)		Outcome Alive (n=297)		P-Value
Gender	Male	78 (89.7%)	102 (34.3%)	<0.001*
	Female	9 (10.3%)	195 (65.7%)	
Age	18-30	37 (42.5%)	41 (13.8%)	<0.001*
	31-40	27 (31.0%)	69 (23.2%)	
	41-50	18 (20.7%)	97 (32.7%)	
	51-60	3 (3.4%)	36 (12.1%)	
	61-70	2 (2.3%)	26 (8.8%)	
	> 70	0 (0.0%)	28 (9.4%)	
Intent of Injury	Intentional	9 (10.3%)	19 (6.4%)	0.213
	Unintentional	78 (89.7%)	278 (93.6%)	
Mechanism of Injury	RTAs	64 (73.6%)	41 (13.8%)	<0.001*
	Falls	14 (16.1%)	237 (79.8%)	
	Violence	9 (10.3%)	19 (6.4%)	
TBI Severity	Mild	5 (5.7%)	265 (89.2%)	<0.001*
	Moderate	18 (20.7%)	10 (3.4%)	
	Severe	64 (73.6%)	22 (7.4%)	
Length of Stay (Days)	< 1	41 (47.1%)	250 (84.2%)	<0.001*
	> 1	46 (52.9%)	47 (15.8%)	

Table-IV. TBI outcome with risk factors (n=143)

Adult patients were selected in this study resulting in a lower mean age while most patients presented with falls due to which female patients were slightly more likely than male patients.

In this study, 77.3% (n=297) patients recovered from TBI after treatment and 22.7% (n=87) patients died during treatment in ED. Differences in TBI-related mortality were also reported worldwide. Significantly higher TBI-related mortality was reported by Javali RH, et al.[18] 17.0%, Yousefzadeh-Chabok S, et al.[19] 13.9%, Eryilmaz M, et al.[20] 11.53% and Höke MH, et al.[21] 8.2%; while Orhon R, et al.[22] reports the lower TBI-related mortality 1.3%. In this study all patients were presented with traumatic brain injuries that results in increased rate of mortality.

In this study, among those TBI patients who were died or discharged (alive), mean RTS score was 7.68±2.04 vs. 11.70±1.02 and NISS scores was 21.72±5.38 vs. 5.97±6.64 respectively. Similar better results of NISS than RTS were also reported by other researchers. Javali RH, et al.[18] reports the lower RTS score [5.43±1.29 vs. 7.60±0.48] and higher NISS score [27.65±7.49 vs. 8.80±6.19] in non-survivors than survivors respectively. Orhon R, et al.[22] also reports the lower RTS [5.62±1.31 vs. 7.75±0.46] and higher NISS score [27.62±12.85 vs. 6.92±8.13] in non-survivors than survivors respectively. All similar results indicates that mean trauma score of RTS was significantly low in died TBI patients and NISS was significantly high in died TBI patients as compared to alive TBI patients.

In this study, TBI associated mortality was predicted by using the RTS score with cut-off score of ≤7 (sensitivity 57.5%, specificity 100.0%, diagnostic accuracy 90.4%, area under ROC curve 0.014), and similarly NISS score with cut-off score

of ≥16 (100.0%, 91.0%, 93.0%, 0.934). There was a significant difference (p-value <0.001) between RTS and NISS with respect to the area under the ROC curve.

Similarly, better diagnostic accuracy and ROC curves were reported for NISS compared to RTS by other researchers. Javali RH, et al.[18] reports the sensitivity of 97.06% vs. 91.18%, specificity of 80.12% vs. 93.37% and area under ROC curve 0.947 vs. 0.970 in RTS and NISS respectively. Eryilmaz M, et al.[20] reports the higher area under ROC curve for NISS 0.915 while RTS was reported as a non-significant score for predicting mortality. Höke MH, et al. [21] reports the sensitivity of 68.6% vs. 82.9%, specificity of 91.6% vs. 83.6% and area under ROC curve 0.81 vs. 0.88 in RTS and NISS respectively.

By comparing all these similar studies and their findings, it was concluded that NISS is superior than RTS in terms of predicting mortality in TBI. Clinicians should consider using other trauma scores, especially the NISS and RTS, in addition to GCS to determine traumatic brain injury severity and risk of death. These findings can help emergency physicians to decide which treatment plan will be best for their patients and reduce their risk of death.

CONCLUSION

In adult traumatic brain injury patients, NISS was the most accurate predictor of mortality when compared to RTS. The risk of TBI-related mortality increased significantly with male gender, age younger than 50 years, road traffic accidents, and severe traumatic brain injury.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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2	**Inayat Ali Khan:** Contribution in topic selection and data collection.
3	**Arsalan Mufti:** Contribution in topic selection.
4	**Sana Nawaz:** contribution data collection.
5	**Maaz Obaid:** Data collection.
6	**Muhammad Asad Khan:** Data collection.