Comparative validation of effectiveness of predictive scores among the trauma patients in a tertiary care hospital, Chennai, India

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Comparative validation of effectiveness of predictive scores among the trauma patients in a tertiary care hospital, Chennai, India

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ABSTRACT

Aims. To compare the effective predictiveness of predictive scores BIG, TRISS, NISS, and APACHE II in traumatic patients in a tertiary care hospital in South India.

Materials and Methods. 699 traumatic patients were selected for this present study and observational and comparative methods were used. The study was conducted at the Department of Emergency Medicine, Sri Ramachandra Institute of Higher Education and Research, Ramachandra University- Chennai, South India, from July 2021 to January 2024.

The collected data from the study were initially entered into Microsoft Excel, the data was exported and analyzed using IBM SPSS statistics software version 25.0. Descriptive analysis techniques were employed to present the results, including the use of frequency and percentage distributions. This allowed for a comprehensive description of the data and its characteristics.

The predictive score's AUCs were compared, and an Independent t-test was done to present the F value and p-value. The ROCs for predictive scores were also done and expressed. The mean and SD were calculated for the predictive scores among the survivors, and non-survivors, and analyzed to check the statistical significance among the survivors, and non-survivors.

Results. 699 patients admitted for trauma care were selected for this study. In the present study, the AUC of the BIG score at the time of admission was 0.869; 95%CI- 0.839-0.898, **0.0005.** The AUC of the NISS score was (day-1-0.899; 95%CI-0.873-0.925; **0.0005**), (day-3-0.888; 95%CI-0.861-0.915;**0.0005)**, (day-5-0.882; 95%CI-0.0.853-0.910; **0.005**), and ROC of comparing BIG and NISS scores were also reported. The AUC of the APACHE II compared with the BIG score was (day-1-0.880; 95%CI-0.852-0.908; **0.0005**), (day-3-0.872; 95%CI-0.842-0.902;**0.0005),** and (day-5-0.889; 95% CI-0.0.860-0.912; **0.0005**), and ROC of comparing BIG and APACHE II scores were also reported. The AUC of the TRISS compared with the BIG score was (day-1-0.512; 95%CI-0.460-0.564), (day-3-0.510; 95%CI-0.458-0.562)**,** and (day-5-0.498; 95%CI-0.446-0.551), and ROC of comparing BIG and TRISS scores were also reported.

In the current study the BIG score's mean ± SD value in survivors was 22 ± 8, and in non-survivors was 38 ± 12.5 **(F value-54.39, p value-0.000).** The APACHE II score's day-1 mean ± SD value in survivors was 22 ± 9, and in non-survivors was 52 ± 20 **(F value-202.858, p value-0.000).** The APACHE II score's day-3 mean ± SD value in survivors was 22 ± 9.5, and in non-survivors was 51 ± 21 **(F value-184.419, p-value-0.000),** and day-5 mean ± SD value in survivors was 18 ± 9.2, and in non-survivors was 48 ± 20 **(F value-159.719, p-value-0.000),**

The NISS score's day 1 mean ± SD value in survivors was 4 ± 9, and in non-survivors was 45 ± 11 **(F value-20.643, p value-0.000).** The NISS score's day 3 mean ± SD value in survivors was 22 ± 8, and in non-survivors was 44 ± 13 **(F value-38.774, p value-0.000).** The NISS score's day 5 mean ± SD value in survivors was 19 ± 90, and in non-survivors was 41 ± 13 **(F value-40.608, p value-0.000).** The TRISS score's day 1 mean ± SD value in survivors was 64 ± 23, and in non-survivors was 76 ± 21 **(F value-0.031, p value-0.000).** The TRISS score's day 3 mean ± SD value in survivors was 60 ± 22, and in non-survivors was 73 ± 22 **(F value-1.394, p value-0.000).** The TRISS score's day 5 mean ± SD value in survivors was 61 ± 22, and in non-survivors was 74 ± 21 **(F value-0.757, p value-0.000).**

Conclusions. NISS, APACHE II, and TRISS predictive scores were calculated for day 1, day 3, and day 5. NISS and APACHE II were the most effective at predicting mortality in trauma patients, and as a result, BIG, NISS, and APACHE II can be used to predict prognosis in traumatic patients. The current study found that the BIG score showed strong predictivity with NISS and APACHE II for predicting prognosis. While some researchers considered TRISS to be a good predictive score, the current study found it less helpful.

Keywords: trauma, predictive scores, BIG, NISS, APACHE II, TRISS, GCS

INTRODUCTION

Traumatic patients initially exhibit symptoms such as exhaustion, disorientation, depression, anxiety, agitation, numbness, dissociation, bewilderment, bodily arousal, and muted emotions. Trauma is an emotional response to a horrific event, such as an accident, rape, or natural disaster [1]. Trauma affects young people disproportionately affected by injury, and the greatest cause of mortality for those between the ages of 15 and 29 worldwide is traffic accidents [2]. For those between the ages of one and forty-five, trauma remains the primary cause of death [3].

Among children and young people (5–29 years old), trauma is the leading cause of morbidity and mortality in Africa and the leading cause of death globally [4]. According to predictions from the Centers for Disease Control and Prevention, traumatic injuries in the US would have cost $4.2 trillion in total in 2020. Medical expenses missed productivity at work, and expenses related to mortality and quality of life are all included in the total expenditures [5].

The degree of trauma can vary, posing little to life-threatening risks to one's life (mortality) or ability to function (morbidity) [6]. Hence trauma requires immediate forceful prompt, convenient, and accurate intervention, and to assess the prognosis and outcome of the traumatized patients, several predictive scores were identified and practiced [7].

Among the predictive scores for traumatic patients, in a study conducted on 426 patients, the TRISS score was the best in predicting mortality with an AUC of 0.93, sensitivity of 97.1%, and specificity [8]. In pediatric traumatic patients, for massive transfusion, the BIG score was

precise, simple to use, and adaptable enough to be included in a basic bedside screening tool, and mainly useful in predicting death [9].

Research data describes that the ISS scoring system has limits, though, as it only assigns a single score to various injuries within the same body region, which may understate the severity of trauma patients' injuries, and in comparison, between predictive scores, whether ISS or NISS is a stronger predictor of death is unclear [10]. In a study conducted in both traumatic and non-traumatic patients, APACHE 4 was good in predicting mortality, whereas SOFA was good in traumatic patients, hence APACHE 4 predictability in traumatic patients is unclear [11].
In regards to CRP, data shows that CRP is associated with trauma exposure [12]. However other research shows that CRP is not significantly associated with trauma, especially in sexual or physical abuse trauma [13]. One of the research studies found that traumatic patients with sepsis showed considerable association with CRP in traumatic patients [14].

All the above-discussed studies indicate that different predictive scores predict different diseases in different traumatic situations, and none of the studies published the gender-based predictive validity of predictive scores in traumatic patients, hence considering the essentiality of gender-based significant management of traumatic patients and usage of precise, fastest, simple, cheap, adequate, and bed-sided predictive scores essentiality, this present study is aimed to evaluate the BIG, TRISS, NISS, and APACHE II in the effective prediction for morbidity and mortality in gender-based traumatic population.

MATERIALS AND METHODS

Methodology

This research study design was a comparative, and observational study conducted at the Department of Emergency Medicine, Sri Ramachandra Institute of Higher Education and Research, Ramachandra University-Chennai, India between July 2021 to January 2024. 699 traumatic patients were selected with a population Infinite Sample Size;

SS = $[Z^2p\ (1 - p)]/ C^2$; Calculate the sample size for an infinite population given that the population percentage is 5, the confidence level is 95%, and the Margin of error ± 3.12 population proportion is 23%, and the Sample Size for this study is 699.

The ethical clearance certificate reference number is IEC-NI-/21/JUN/699/703. The informed consent form was received from every patient's caregiver.

Inclusion Criteria

The inclusion criteria for this study were patients >18 years of age with clinically diagnosed trauma.

Exclusion Criteria

The exclusion criteria for this study were patients of <18 years and HIV patients were excluded from the study.

Investigations

The patient's demographics, age, and clinical details such as INR level, GCS, Respiratory Rate (RR), Systolic Blood Pressure (SBP), Mean Arterial Pressure (MAP), Heart Rate (HR), temperature, WBC count, platelet count, sodium, potassium, bilirubin, and creatinine were recorded.

GCS

The GCS scoring system measures three functional components: eye-opening (E), verbal response (V), and motor response (M). By summing an individual's scores as E + V + M, the person can be classified as mild when the GCS score was 13 to 15, moderate when the GCS score was 9 to 12, and severe when the GCS score was 3 to 8), [15].

BIG score

A BIG score is calculated using the formula (Base Deficit + [2.5 × INR] + [15-GCS], and the BIG score is a highly reliable indicator of both morbidity and death in trauma cases with high energy [16].

Trauma and injury severity score (TRISS)

The probability of survival (PS) of a patient from the ISS and RTS is calculated by TRISS [17].

Acute Physiology and Chronic Health Evaluation (APACHE II)

The sum of acute physiology score, age points, and chronic health points measures the APACHE II score. A minimum score is 0, and a maximum score is 71, [18]. The APACHE II score measures illness severity obtained within the first twenty-four hours of admission.

Analysis

The study patient's GCS, BIG, TRISS, and APACHE II were calculated from collected clinical markers, and further average, mean, median, and SD values were analyzed and recorded. Further analysis was done statistically to find the positive correlation, effective predictivity, and accuracy with the ROC curve.

Statistical Analysis

After being first imported into Microsoft Excel, the study's collected data were exported and examined using IBM SPSS statistics software version 25.0. The results were presented using descriptive-analytic approaches, such as AUC as a binary classifier in comparing the predictive scores.

An Independent t-test was done to find the F value and p-value for the predictive scores and compared the accuracy between each other, further, the accuracy, and predictivity were confirmed statistically by the ROC also. To determine the statistical significance between survivors and non-survivors, the mean and SD for the prediction scores among survivors and non-survivors were computed and examined.

RESULTS

A total of 699 traumatic patients were selected for this present study, and predictive scores such as BIG (at the time of admission), NISS (mortality regardless of region of the body), APACHE II (prognostic), and TRISS (survival probability) were calculated and plotted as figures, and tabulated as tables.

Table 1 presents the comparison of AUC of predictive score BIG, and NISS in traumatic study patients. The AUC of the BIG score was 0.869 with a 95% CI of (0.839-0.898) and was

statistically significant (**0.0005**). The AUC of the NISS score on day 1 was 0.899 with a 95% CI of (0.873-0.925), and found significant (**0.0005**). The AUC of the NISS score on day 3 was 0.888 with a 95% CI of (0.861-0.915) and was statistically significant (**0.0005**). The AUC of the NISS score on day 5 was 0.882 with a 95% CI of (0.853-0.910) and was found significant (**0.0005**). **Figure 1** compares ROC of predictive score BIG, and NISS in traumatic study patients.

Table 1 Comparison of AUC of Predictive Score BIG, and NISS in Traumatic Study Patients

Predictive Scores (N=699)	Area Under the Curve	Std. Error	95% Confidence Interval of AUC		P value (Independent t-test)
			Lower bound	Upper bound	
BIG Score (Day of Admission)	0.869	0.015	0.839	0.898	0.0005*
NISS (Day 1)	0.899	0.013	0.873	0.925	0.0005*
NISS (Day 3)	0.888	0.014	0.861	0.915	0.0005*
NISS (Day 5)	0.882	0.015	0.853	0.910	0.0005*

***Statistically Significant**

Figure 1 Comparison of ROC of Predictive Score BIG, and NISS in Traumatic Study Patients

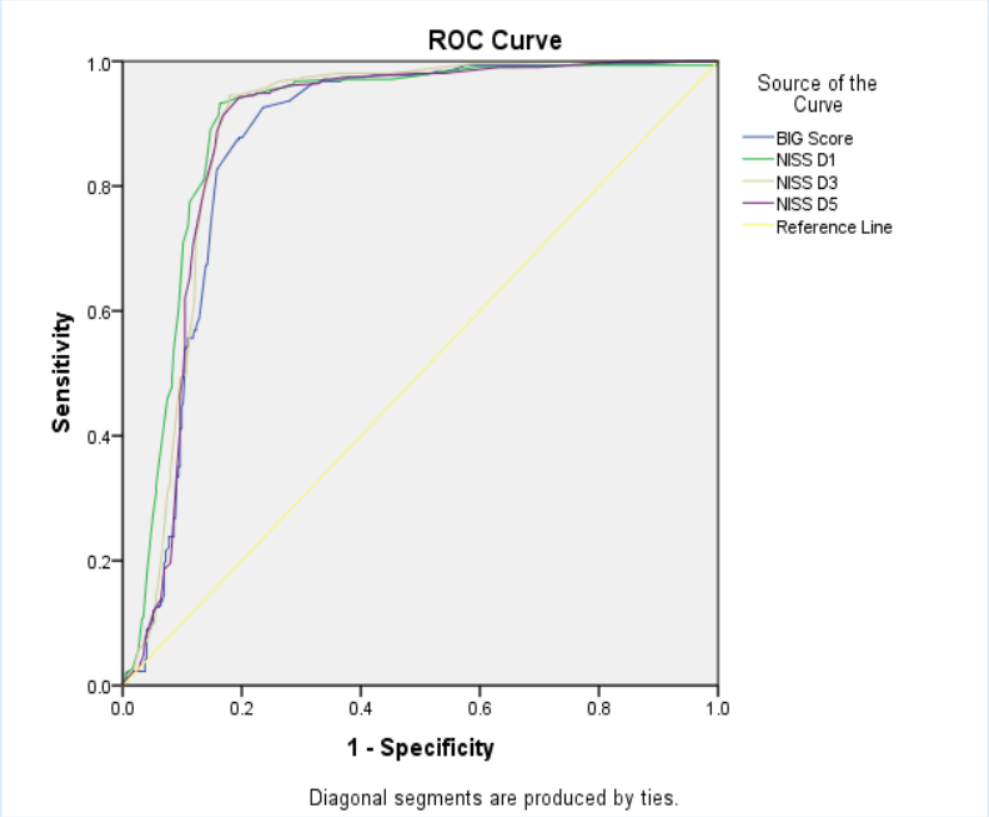

Table 2 Comparison of AUC of Predictive Score BIG, and APACHE II in Traumatic Study Patients

Table 2 Comparison of AUC of Predictive Score BIG, and APACHE II in Traumatic Study Patients

Predictive Scores (N=699)	Area Under the Curve	Std. Error	95% Confidence Interval of AUC		P value (Independent t-test)
			Lower bound	Upper bound	
BIG Score (Day of Admission)	0.869	0.015	0.840	0.898	0.0005*
APACHE II (Day 1)	0.880	0.014	0.852	0.908	0.0005*
APACHE II (Day 3)	0.872	0.015	0.842	0.902	0.0005*
APACHE II (Day 5)	0.889	0.015	0.860	0.912	0.0005*

*Statistically Significant

Figure 2 Comparison of ROC of Predictive Score BIG, and APACHE II in Traumatic Study Patients

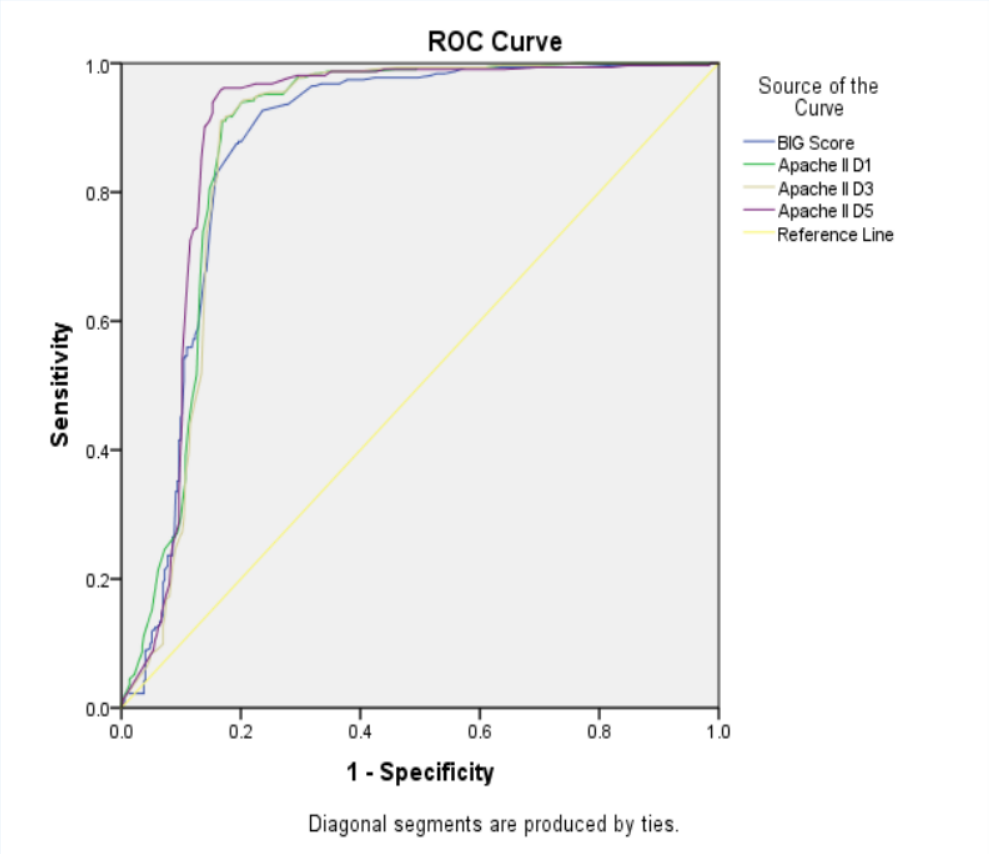

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Table 3 Comparison of AUC of Predictive Score BIG, and TRISS in Traumatic Study Patients

Predictive Scores (N=699)	Area Under the Curve	Std. Error	95% Confidence Interval of AUC		P value (Independent t-test)
			Lower bound	Upper bound	
BIG Score (Day of Admission)	0.132	0.016	0.102	0.163	0.0005*
TRISS (Day 1)	0.512	0.026	0.460	0.564	0.610
TRISS (Day 3)	0.510	0.026	0.458	0.562	0.674
TRISS (Day 5)	0.498	0.027	0.446	0.551	0.945

*Statistically Significant

Figure 3 Comparison of ROC of Predictive Score BIG, and TRISS in Traumatic Study Patients

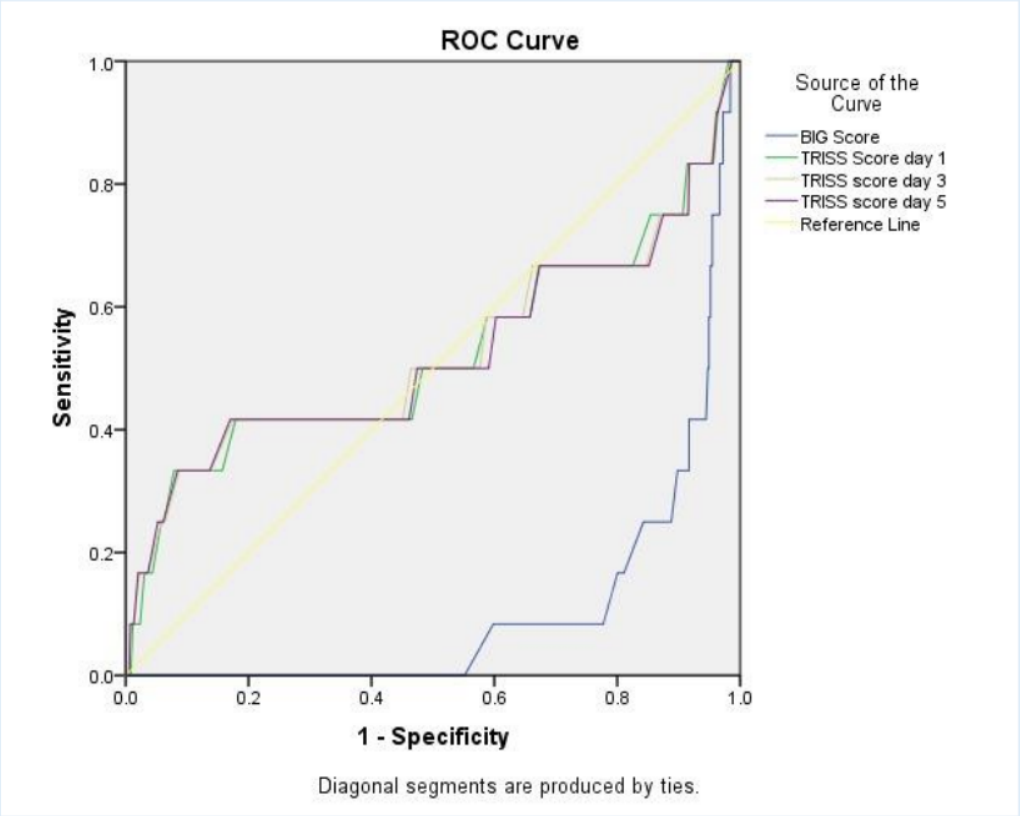

Table 2 presents the comparison of AUC of predictive score BIG, and APACHE II in traumatic study patients. The AUC of the BIG score was 0.869 with a 95% CI of (0.840-0.898) and was statistically significant (**0.0005**). The AUC of the APACHE II score on day 1 was 0.880 with a 95% CI of (0.852-0.908) and was found significant (**0.0005**). The AUC of the APACHE II score on day 3 was 0.872 with a 95% CI of (0.842-0.902) and was statistically significant (**0.0005**). The AUC of the APACHE II score on day 5 was 0.889 with a 95% CI of (0.860-0.912) and was found significant (**0.0005**). **Figure 2** compares ROC of predictive score BIG, and APACHE II in traumatic study patients.

Table 3 describes the comparison of AUC of predictive score BIG, and TRISS in traumatic study patients. The AUC of the BIG score was 0.132 with a 95% CI of (0.102-0.163) and was statistically significant (**0.0005**). The AUC of the TRISS score on day 1 was 0.512 with a 95% CI of (0.460-0.564), the AUC of the TRISS score on day 3 was 0.510 with a 95% CI of (0.458-0.562), and the AUC of the TRISS score on day 5 was 0.498 with a 95% CI of (0.446-0.551). **Figure 3** expresses the comparison of ROC of predictive score BIG, and APACHE II in traumatic study patients.

Table 4 reports the profile of predictive scores BIG, NISS, TRISS, and APACHE II among traumatic survivors and non-survivors study patients. The mean ± SD value of the BIG score in survivors was 22 ± 8, and in non-survivors was 38 ± 12.5 with an F value of 54.395 and was statistically significant (**0.000**). The mean ± SD value of the NISS score on day 1 in survivors was 4 ± 9, and in non-survivors was 45 ± 11 with an F value of 20.643 and was statistically significant (**0.000**). The mean ± SD value of the NISS score on day 3 in survivors was 22 ± 8, and in non-survivors was 44 ± 13 with an F value of 38.774 and was statistically significant (**0.000**). The mean ± SD value of the NISS score on day 5 in survivors was 19 ± 90, and in non-survivors was 41 ± 13 with an F value of 40.608 and was statistically significant (**0.000**).

Table 4 Profile of Predictive Scores BIG, NISS, TRISS, and APACHE II among Traumatic Survivors and Non-Survivors Study Patients

Variables	Mean ± SD		F value (Independent t-test)	P value (Independent t-test)
	Survivors	Non- Survivors		
BIG score	22 ± 8	38 ± 12.5	54.395	0.000*
NISS (Day 1)	4 ± 9	45 ± 11	20.643	0.000*
NISS (Day 3)	22 ± 8	44 ± 13	38.774	0.000*

NISS (Day 5)	**19 ± 90**	**41 ± 13**	**40.608**	**0.000***
APACHE II (Day 1)	**22 ± 9**	**52 ± 20**	**202.858**	**0.000***
APACHE II (Day 3)	**22 ± 9.5**	**51 ± 21**	**184.419**	**0.000***
APACHE II (Day 5)	**18 ± 9.2**	**48 ± 20**	**159.719**	**0.000***
TRISS (Day 1)	**64 ± 23**	**76 ± 21**	**0.031**	**0.000***
TRISS (Day 3)	**60 ± 22**	**73 ± 22**	**1.394**	**0.000***
TRISS (Day 5)	**61 ± 22**	**74 ± 21**	**0.757**	**0.000***

***Statistically Significant**

The mean ± SD value of the TRISS score on day 1 in survivors was 64 ±23, and in non-survivors was 76 ± 21 with an F value of 0.031 and was statistically significant (**0.000**). The mean ± SD value of the TRISS score on day 3 in survivors was 60 ± 22, and in non-survivors was 73 ± 22 with an F value of 1.394 and was statistically significant (**0.000**). The mean ± SD value of the TRISS score on day 5 in survivors was 61 ± 22, and in non-survivors was 74 ± 21 with an F value of 0.757 and was statistically significant (**0.000**) (**Table 4**).

The mean ± SD value of the APACHE II score on day 1 in survivors was 22 ± 9, and in non-survivors was 52 ± 20 with an F value of 202.858 and was statistically significant (**0.000**). The mean ± SD value of the APACHE II score on day 3 in survivors was 22 ± 9.5, and in non-survivors was 51 ± 21 with an F value of 184.419 and was statistically significant (**0.000**). The mean ± SD value of the APACHE II score on day 5 in survivors was 18 ± 9.2, and in non-survivors was 48 ± 20 with an F value of 159.719 and was statistically significant (**0.000**) (**Table 4**).

DISCUSSION

In the present study, the AUC of the NISS score was (day 1-0.899, day 3-0.888, day 5-0.882, **0.0005**), TRISS score was (day 1-0.512, day 3-0.510, day 5-0.498) whereas Javali RH et al reported in geriatric trauma cases, NISS and TRISS were used to predict death; the corresponding AUCs were 0.970, and 0.972, respectively, but not reported in respective of days of admission, [19].

The current study reports NISS (day 1-0.899, day 3-0.888, day 5-0.882, **0.0005**) and APACHE II (day 1-0.880, day 3-0.872, day 5-0.889, **0.0005**) were with good predictivity than TRISS (day 1-0.512, day 3-0.510, day 5-0.498), this present study was not compatible with Jiang L et

al study where TRISS has reported a good predictive score with AUC of 0.828, and notably, the AUCs of NISS and TRISS were substantially higher than those of APACHE II (P < 0.01), [20]. Whereas the present was compatible with the study of Li H et al, who reported that with an improved calibration (H-L: 79.10 vs. 85.92), NISS outperformed in predicting ICU admission (AUC: 0.727 vs. 0.713, p ¼ 0.0003), [21].

In the present study, the AUC of the NISS score was (day 1-0.899, day 3-0.888, day 5-0.882, **0.0005**), which was compatible with the study by Acharjee A. et al who have reported that the NISS scored highest accuracy with the AUROC of 0.69, [22]. The current study showed APACHE II had a good predictivity in prognosis in traumatic patients with AUC in day 1-.880, day 3-.872, day 5-.889, (**0.0005**), whereas Pujiastuti D et al study found that the APACHE-II rating system can accurately distinguish between patients' survival rates and has strong predictive accuracy for death rates, particularly for non-surgical patients, [23].

In this present study, the APACHE II score's day 1 mean ± SD value in survivors was 22 ± 9, and in non-survivors was 52 ± 20 **(F value-202.858, p value-0.000).** The APACHE II score's day 3 mean ± SD value in survivors was 22 ± 9.5, and in non-survivors was 51 ± 21 **(F value-184.419, p value-0.000).** The APACHE II score's day 5 mean ± SD value in survivors was 18 ± 9.2, and in non-survivors was 48 ± 20 **(F value-159.719, p value-0.000),** research by Jennings et al reported non-survivors had lower GCS than survivors (9 vs 15), and non-survivors also had higher APACHE-II scores (13 vs 11) than survivors, but not reported the days of prognosis, [24]. Researcher Oh Y et al study expressed that the APACHE II score was higher in non-survivors (survivors-18 (3–38), non-survivors-21 (6–44) (<0.001), [25].

In the current study the BIG score's mean ± SD value in survivors was 22 ± 8, and in non-survivors was 38 ± 12.5 **(F value-54.39, p value-0.000).** Bai X et al reported that the BIG score of individuals who did not survive was notably greater than that of those who did (p < 0.001), [26]. In the present study, the NISS score's day 1 mean ± SD value in survivors was 4 ± 9, and in non-survivors was 45 ± 11 **(F value-20.643, p value-0.000).** The NISS score's day 3 mean ± SD value in survivors was 22 ± 8, and in non-survivors was 44 ± 13 **(F value-38.774, p value-0.000).** The NISS score's day 5 mean ± SD value in survivors was 19 ± 90, and in non-survivors was 41 ± 13 **(F value-40.608, p value-0.000).** The TRISS score's day 1 mean ± SD value in survivors was 64 ± 23, and in non-survivors was 76 ± 21 **(F value-0.031, p value-0.000).** The TRISS score's day 3 mean ± SD value in survivors was 60 ± 22, and in non-survivors was 73 ± 22 **(F value-1.394, p value-0.000).** The TRISS score's day 5 mean ± SD

value in survivors was 61 ± 22, and in non-survivors was 74 ± 21 **(F value-0.757, p value-0.000)**, whereas Orhon R et al reported NISS mean ±SD was 27.62 ± 12.85 in the survivors and 6.92 ± 8.13 in the non-survivors, and they also reported TRISS mean ±SD in the survivors 72.80 ± 19.35 in, and in the non-survivors 98.34 ± 6.58, [27].

Predictive scores were used globally to predict the prognosis and mortality in traumatic patients, the present study was conducted in the Asian content's South Indian population, and reported BIG, NISS, and APACHE II were used to predict prognosis in traumatic patients, and based on the geographically, in Australia, the ISS and TRISS predictive scores are accepted, [28]. Taiwan's trauma care units mostly use GCS, ISS, and AIS predictive scores, [29].

LIMITATIONS

This present study's limitation was, that only 4 predictive scores were analyzed, other predictive scores would have given new insights.

CONCLUSIONS

In conclusion, various trauma predictive scores are applied globally (across continents, nations, or areas) to gauge the degree of trauma suffered by patients based on anatomical, physiological, or a combination of factors.

The present study identified that the BIG score showed strong predictivity with NISS and APACHE II for predicting prognosis and NISS, APACHE II, and TRISS predictive scores were calculated for day 1, day 3, and day 5, and NISS, and APACHE II were most effective at predicting mortality in trauma patients, and hence, BIG, NISS, and APACHE II can be used to predict prognosis in traumatic patients. Even though TRISS was reported as a good predictive score by a few researchers, the current study found it less effective.

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Conflict of Interest: None

Author's Contribution

First Author and Corresponding author- Nirmhalaa, T.N - *Study Design, Data Collection*

Second Author- T V Ramakrishnan- A*pproval*

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Third Author- Ramya Ramakrishnan-*Critical revision*

Fourth Author- Aruna Ramakrishnan - *Proofreading*

Fifth Author –Krishna Kumar Dharuman- Statistical analysis

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