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Comparative Analysis of "Trauma and Injury Severity Scores" and "Madras Head Injury Prognostic Scale" in Assessing Head Trauma Prognosis in the Emergency Department of Shahid Beheshti Hospital, Sabzevar, Iran

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ABSTRACT

Objectives: This study aimed to compare the effectiveness of Trauma and Injury Severity Scores (TRISS) and Madras Head Injury Prognostic Scale (MHIPS) in assessing the prognosis of head trauma patients in the emergency department.
Methods: In this descriptive-analytical (predictive) study, 140 head trauma patients admitted to the emergency department of Shahid Beheshti Hospital (Sabzevar, Iran), were included from January to November 2023. Participants were selected via convenience sampling method and based on the inclusion criteria. Data were collected using a demographic questionnaire, the TRISS, and the MHIPS scale, and analyzed using Stata software (version 17).
Results: The mean age of the injured patients was 39.72±19.86 years, and 102 (73%) patients were male. For intensive care unit (ICU) hospitalization prediction, the MHIPS tool showed a sensitivity of 92%, specificity of 86%, positive predictive value (PPV) of 60%, and negative predictive value (NPV) of 98%. For mortality prediction, the MHIPS tool had a sensitivity of 89%, specificity of 86%, PPV of 27%, and NPV of 99% in predicting death. The TRISS tool demonstrated a sensitivity of 81%, a specificity of 96%, a PPV of 81%, and an NPV of 95% for ICU hospitalization, and a sensitivity of 75%, specificity of 87%, PPV of 26%, and NPV of 98% for mortality. No significant difference was observed between TRISS and MHIPS in predicting the probability of ICU admission and mortality (p=0.797).
Conclusion: Both TRISS and MHIPS demonstrated satisfactory predictive value for head trauma outcomes, with neither tool being superior to the other.

Keywords: Injuries, Prognosis, Head injuries, ICU, Mortality.

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Introduction

Traumatic head injuries represent a major public health concern [1] and are among the leading causes of death and long-term disability worldwide [2]. Globally, approximately 69 million people suffer traumatic injuries annually [3], including 5.5 million severe head injuries [4], and about 5 million people deaths each year resulting from these injuries [5]. In Iran, head trauma ranks as the second most common cause of trauma-related mortality [6], accounting for nearly 60% of these deaths [7].

Head injuries can cause diverse physical, social, emotional, cognitive, and behavioral issues, which vary depending on the severity of the injury [8]. Common complications include educational difficulties, job loss, and social isolation. These injuries frequently lead to mental health challenges, emotional disturbances, behavioral issues, and decreased academic performance. The financial burden of caring for individuals with traumatic brain injuries is substantial, placing significant strain on both family and societal resources, particularly when long-term or lifelong support is required [9].

It is critical to study and forecast mortality rates for traumatic brain injuries [10], particularly since these injuries frequently affect young individuals and active members of society [11]. Accurate prognosis of head trauma patients can significantly improve clinical decision-making, reduce hospital stays, optimize expenditures, and rehabilitation periods, and enhance patient satisfaction [12, 13]. For severe brain injury cases, the use of trauma grading systems combined with personalized treatment plans substantially improves recovery outcomes [14].

In recent years, numerous scoring systems have been developed to predict outcomes in multiple trauma patients [15]. This underscores the need for a simple, easily available, and objective scale that can reliably predict outcomes. Several mortality prediction measures have been specifically proposed for head trauma patients [16].

The Trauma and Injury Severity Score (TRISS) was developed in 1987 to evaluate trauma severity and predict survival probability. This scoring system integrates two established assessment tools: the Revised Trauma Score (RTS) and the Injury Severity Score (ISS). TRISS incorporates four key physiological parameters: patient's age, systolic blood pressure, respiratory rate, and Glasgow Coma Scale (GCS) score [17].

Ramesh and colleagues developed the Madras Head Injury Prognostic Scale (MHIPS) as an alternative grading system. This scale is based on five available clinical factors, including age, best motor response (GCS), pupillary reaction to light, oculocephalic response, and associated systemic injuries—along with computed tomography (CT) imaging findings. Similar to the GCS, the MHIPS provides an objective and quantifiable assessment with high diagnostic value. Each parameter is scored across three categories: ratings of 3, 2, and 1 represent best, intermediate, and worst prognoses, respectively. The scale yields a total score ranging from 6 (minimum) to 18 (maximum) [18].

Given the inconsistent findings in existing studies using the TRISS scale for head injury prediction, coupled with limited global research on the MHIPS scale and its relative neglect in Iranian studies despite its practical utility, this study was designed to compare the predictive performance of TRISS and MHIPS scales in head trauma patient outcomes.

Materials and Methods

This descriptive-analytical (predictive) study was conducted at Shahid Beheshti Hospital in Sabzevar, Iran from January to November 2023. Sample size determination was based on previously reported area under the receiver operating characteristic curve (AUROC) values of approximately 85% or higher for these instruments [19, 20], with an accepted margin of error of 0.15 (15%) at a 95% confidence level. These parameters yielded a required sample size of 140 participants [21]. The study included all head trauma patients aged 12 years or older who sustained injuries through road traffic accidents, falls, or other mechanisms with identifiable causes. The study included all head trauma patients aged 12 years or older who sustained injuries through road traffic accidents, falls, or other mechanisms with identifiable causes. Patients were excluded if they presented with burn injuries, asphyxiation, drowning, unknown injury mechanisms, or were declared dead on arrival at the emergency department.

The study utilized three assessment tools: 1) a demographic questionnaire, 2) TRISS, and 3) MHIPS. The demographic questionnaire collected patient information such as age, sex, history of underlying diseases, cause of injury, injury type, dates of accident, hospitalization in the intensive care unit (ICU), and final outcome (discharge or death).

The TRISS scale integrated two components: the ISS and RTS. Its calculation involved three parameters, including the patient's age (coded as 0 for <55 years or 1 for ≥55 years), ISS, and RTS scores.

First, the abbreviated injury scale (AIS) was used to calculate the ISS. The patient's body was divided into six essential areas for damage (head and neck, face, chest, abdomen, organs, and external body surface). Each of these areas was given a score from 0 (absence of lesions) to 6 (in the case of fatal lesions) based on the severity of the injury. The ISS was then determined by summing the squares of the three highest scores, resulting in a value between 1 and 75.

The RTS included systolic blood pressure, respiratory rate, and GCS, with each parameter assigned a specific score (0 to 4) based on its value, which was then multiplied by specific coefficients and summed to produce the RTS score. Finally, the ISS, RTS, and age values were multiplied by their respective regression coefficients and added together.

The survival rate was calculated by applying the TRISS-derived value to the logistic function [22]. The validity and reliability of the TRISS showed that this scale had good diagnostic ability, as reported by the area under the receiver operating characteristic curve (AUROC). The AUROC values for this scale were 0.947, 0.952 in the prediction sets, and 0.941 in the validation sets [20]. Another study demonstrated that TRISS had good discriminative power, showing AUC values of 0.98 for penetrating trauma [23]. In another study, the AUROC for TRISS was reported as 0.873 [19]. The MHIPS evaluated six factors: age, best motor response according to GCS, pupillary reaction to light, oculocephalic response, CT scan findings, and associated systemic injuries. These factors were divided into three subgroups, with scores ranging from 1 (poor prognosis) to 3 (good prognosis) yielding a total score range of 6-18. Regarding the validity and reliability of the MHIPS, Ramesh et al.'s study indicated that 87.5% of the estimates made by this tool were accurate [17].

Upon arrival at the emergency department, each head trauma patient underwent comprehensive data collection. In addition, systolic blood pressure was recorded using the researcher's sphygmomanometer, before receiving any muscle relaxant and hypnotic drugs to determine the patient's prognosis using the TRISS scale. The respiratory rate was counted for a full minute, and the patient's GCS was determined by the treating physician. Then, AIS was calculated to assess the severity of the trauma inflicted on the patient. The injured body was divided into six areas: neck, face, chest, abdomen, organs, and external surface. Then, a score of 0 (no damage) to 6 (fatal damage) was assigned to each area based on the severity of the damage using the 2008 version of the AIS book code.

Next, the ISS was calculated by summing the squares of the three most severely injured areas, yielding a value between 0 and 75. The final TRISS score was computed using the standardized calculator available at www.sfar.org. For MHIPS assessment, all six prognostic factors (age, best motor response by GCS, pupillary light reaction, oculocephalic response, CT scan findings, and associated systemic injuries) were evaluated. Patients were followed for a maximum of one month, with those requiring prolonged hospitalization beyond this period excluded from the study.

Patient outcomes were monitored throughout hospitalization until discharge, with a particular focus on mortality and ICU admission following prognostic assessment using both scales. Following data cleaning and organization, statistical analyses were performed using Stata software (version 17). Types of variables were initially used to describe the study population. For quantitative variables, means, standard deviations, medians, and interquartile ranges (IQR) were utilized, while for qualitative variables were presented as frequencies and percentages. The predictive values of the instruments were estimated using two main regression models. Logistic and Cox regression models were utilized to evaluate the accuracy of the predictions. Model discrimination was assessed using R-squared (R^2) coefficients, receiver operating characteristic (ROC) curve analysis, sensitivity, and specificity, and predictive values (both positive and negative). Comparative evaluation between models and tools was conducted employing the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). The significance level was set at $p<0.05$ for all analyses.

Results

The study population exhibited a broad age range from 12 to 83 years, with a mean age of 39.72±19.86 years. Male participants predominated, comprising 102 cases (73%), and females accounted for 38 cases (27%). Road traffic accidents represented the most frequent mechanism of injury, occurring in 95 patients (68%), followed by falls which contributed to 17% of cases (Table 1).

This study evaluated the MHIPS and TRISS scales for ICU admission and mortality outcomes. The assessment included sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) as key performance indicators. Discrimination accuracy was determined through the AUC analysis of ROC curves. The diagnostic interpretation of AUC values followed established clinical thresholds: 90-100% indicates excellent diagnostic ability, 80-90% represents good discrimination, 70-80% suggests fair performance, 60-70% shows poor accuracy, and 50-60% is considered non-informative [24].

Table 1. Frequency distribution of demographic characteristics in head trauma patients at Shahid Beheshti Hospital, Sabzevar (2023)

Variable		Number	Percentage
Sex	Female	38	27%
	Male	102	73%
Total		140	100%
Traffic Accident		95	68%
Fall		24	17%
Physical Altercation		16	12%
Other		5	3%
Total		140	100%

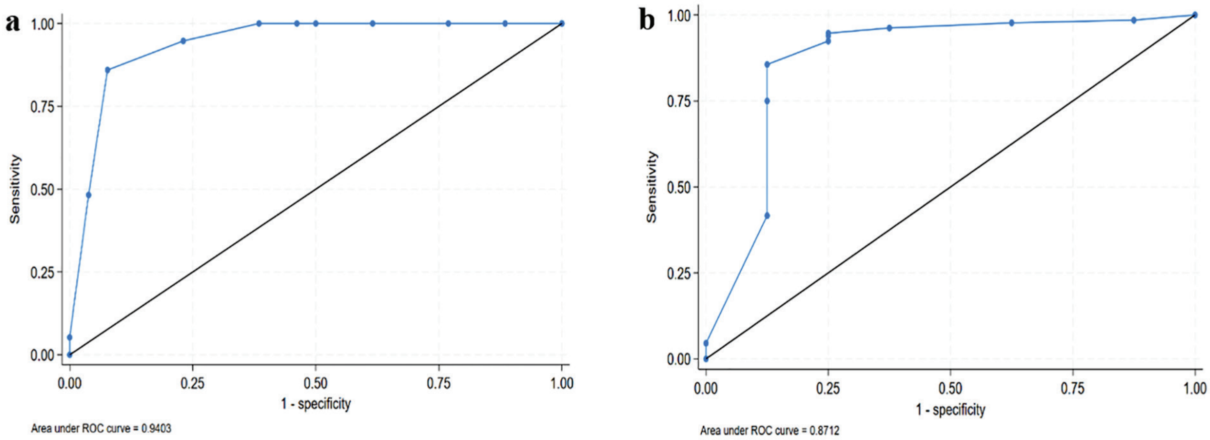

Fig. 1. The MHIPS scale predicted; a) the patient's hospitalization in the ICU and b) patient mortality.

The MHIPS scale demonstrated excellent predictive capability for ICU admission, with an AUC of 0.94 (Figure 1a). For mortality prediction, the scale showed good discriminative performance, yielding an AUC of 0.87 (Figure 1b). Table 2 presents comprehensive data on the scale's sensitivity and specificity, PPV, and NPV for both hospitalization in the ICU and mortality outcomes.

The TRISS scale demonstrated excellent predictive accuracy for hospitalization in the intensive care unit, with an AUROC of 0.94 (Figure 2a). Similarly, the scale showed excellent performance in mortality prediction, achieving an AUC of 0.93 (Figure 2b). Detailed measures of sensitivity, specificity, PPV, and NPV for both ICU admission and mortality outcomes are presented in Table 3.

Table 2. Sensitivity, specificity, predictive values of the MHIPS scale for ICU admission and mortality risk in patients

Prediction	**Cut-off Point**		**Sensitivity**		**Specificity**		**PPV**		**NPV**	
MHIPS	**Value**	**95% Confidence Interval**	**Value**	**95% Confidence Interval**	**Value**	**95% Confidence Interval**	**Value**	**95% Confidence Interval**	**Prediction**	**Value**
ICU Admission	15≥	14-16	92	75-99	86	78-92	60	43-75	98	93-100
Mortality	14≥	11-17	89	47-100	86	78-91	27	12-48	99	95-100

MHIPS: Madras Head Injury Prognostic Scale; PPV: Positive Predictive Value; NPV: Negative Predictive Value

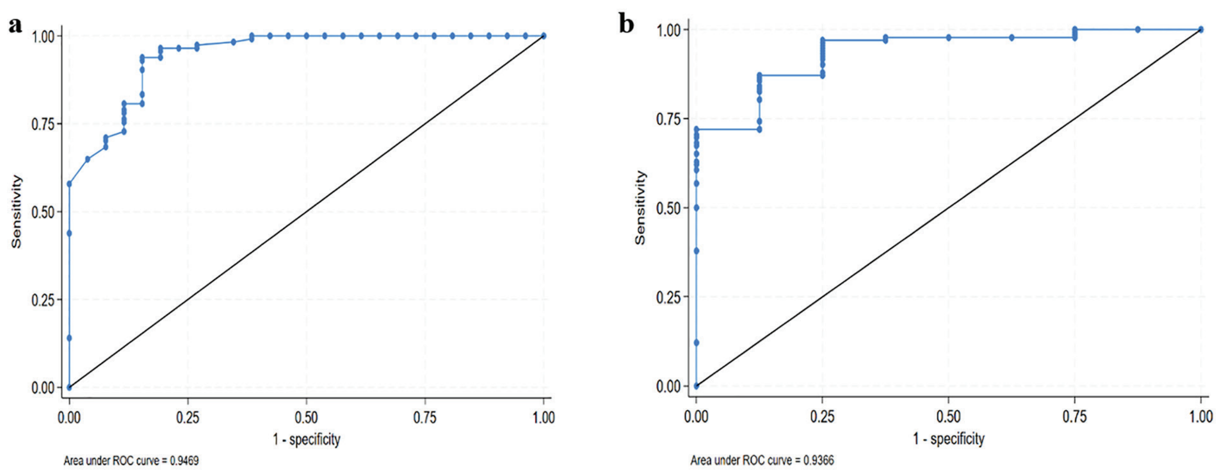

Fig. 2. TRISS scale predicted; a) the patient's hospitalization in the ICU and b) patient mortality.

Table 3. Diagnostic Accuracy of the TRISS Scale: Sensitivity, Specificity, and Predictive Values for ICU Admission and Mortality

Prediction	**Cut-off Point**		**Sensitivity**		**Specificity**		**PPV**		**NPV**	
TRISS	**Value**	**95% Confidence Interval**	**Value**	**95% Confidence Interval**	**Value**	**95% Confidence Interval**	**Value**	**95% Confidence Interval**	**Prediction**	**Value**
ICU Admission	97≥	95-98	81	61-93	96	90-99	81	61-93	95	90-99
Mortality	96≥	63-100	75	35-97	87	80-92	26	10-48	98	94-100

TRISS: Trauma and injury severity scores; PPV: Positive Predictive Value; NPV: Negative Predictive Value

Table 4. Comparative accuracy of TRISS and MHIPS scales in predicting ICU admission and mortality risk

Prediction	Instrument	The area under the rock curve	confidence interval (95%)	*p*-value
ICU Admission	TRISS	95	90-99	0.797
	MHIPS	94	88-100	
Prediction	TRISS	93	90-99	0.288
	MHIPS	87	68-100	

TRISS: Trauma and injury severity scores; MHPIS: Madras Head Injury Prognostic Scale

As demonstrated in Table 4, comparative analysis of the AUC indices revealed no statistically significant difference between the TRISS and MHIPS scales in their predictive capacity for either ICU admission or mortality outcomes.

Discussion

This study aimed to compare the prognostic effectiveness of TRISS and MHIPS for head trauma patients in emergency department settings. The TRISS scale showed excellent predictive accuracy for mortality with an AUC of 0.94. The scale showed 75% sensitivity and 87% specificity, with a PPV of about 26% and an NPV of 98%.

Raygani *et al,*. conducted a comparative study of the TRISS tool with the RTS, GCS, and FOUR scales for mortality prediction in trauma patients. They reported that the TRISS tool had a high specificity (100%) and PPV of 100%, but relatively low sensitivity (16.9%), and an NPV of 91.7% [25]. These findings were in agreement with the findings of the present study, though their investigation employed a lower cutoff threshold of ≤50%.

The TRISS scale demonstrated excellent predictive accuracy for ICU admission requirements in head trauma patients, with an AUC of 0.94. The results indicated strong discriminative ability, showing 81% sensitivity, 96% specificity, 81% PPV, and 95% NPV. Such accurate risk assessment is particularly valuable in critical care settings such as the ICU, where resource allocation decisions are crucial. Currently, TRISS serves as one of the tools used to assess the status of ICU patients [26]. Similarly, another study demonstrated the TRISS system's ability to predict mortality in trauma patients in the ICU [27]. However, no previous studies have specifically investigated TRISS for predicting the need for ICU admission. In a survey by Moradi-Lakeh and colleagues, the ISS scale was identified as the best method among four major trauma scales (ISS, RTS, TRISS, and ASCOT) for predicting hospital costs and length of stay [28].

The MHIPS scale demonstrated good predictive accuracy for mortality in head trauma patients, with an AUC of 0.87. This AUC value indicated that the MHIPS tool predicted patient mortality at a "good" level, with a sensitivity of 89%, specificity of 86%, PPV of approximately 27%, and NPV of 99%. According to a review of existing studies, no recent studies have examined the predictive value, sensitivity, and specificity of this tool. In the absence of contemporary data, our discussion primarily referenced historical studies on this scale. Notably, Ebrahimi *et al.,* found the MHIPS scale to be both precise and practical, offering advantages in speed and simplicity compared to other scoring systems such as TRISS [7].

Davis *et al.,* demonstrated that the MHIPS correctly predicted a patient's prognosis in 92.3% of cases. Their findings confirmed that MHIPS achieved high sensitivity and specificity in prognostic assessment for head trauma patients [29].

The MHIPS scale exhibited excellent predictive accuracy for ICU admission requirements in head trauma patients, as evidenced by an AUC of 0.94. This performance level was characterized by 92% sensitivity, 86% specificity, 60% PPV, and 98% NPV. As mentioned earlier, due to the limited number of studies conducted on the MHIPS scale, particularly in ICU settings, it was impossible to directly compare these findings with other studies.

The MHIPS scale incorporates five readily available clinical factors along with CT scan findings. Similar to the GCS, it provides an objective and quantifiable assessment with strong diagnostic validity. Each of the six components is scored across three prognostic categories: optimal outcomes (3 points), intermediate prognosis (2 points), and poor outcomes (1 point). The cumulative score ranges from 6 (indicating the most severe prognosis) to 18 (suggesting the most favorable outlook) [7].

As evidenced by comparable AUC indices, our analysis revealed no significant difference between the TRISS and MHIPS tools in predictive accuracy for either ICU admission or mortality. This study was the first to compare these two tools directly, while previous studies primarily focused on comparing alternative tools. For instance, Raygani et al.'s evaluation of RTS, TRISS, GCS, and FOUR scales demonstrated superior predictive performance for the FOUR scores in mortality assessment among trauma patients [25]. Another study showed that TRISS had the highest predictive accuracy among commonly used trauma scales (ISS, NISS, RTS, and TRISS) [30]. A major strength of this study was its comprehensive evaluation of both the "TRISS" and the "MHIPS" in a clinical setting. This robust comparison provided valuable evidence to inform tool selection for prognostic assessment of head trauma patients in emergency department settings.

A primary limitation of this study was the emergency condition of head trauma patients, which posed significant challenges for data collection and scale completion due to the need for rapid clinical decision-making.

Additionally, the MHIPS scale is recommended for emergency triage of head trauma patients, given its rapid calculation and minimal time requirements. Based on the findings of the present study, both the TRISS and MHIPS scales demonstrated clinically valuable predictive accuracy for head trauma outcomes, with neither scale showing clear superiority over the other. Therefore, these tools could be effectively used in hospital settings to facilitate timely prognosis and guide clinical interventions aimed at preventing or mitigating complications.

For emergency triage of head trauma patients, the MHIPS scale is recommended due to its faster and simpler calculation compared to TRISS. However, given the variable performance observed across studies, additional research is warranted to further validate these findings.

Declaration

Ethics Approval and Consent to Participate: This study was approved by the Ethics Committee of Sabzevar University of Medical Sciences, Iran (Approval No: IR.MEDSAB.REC.1401.103). All participants provided written informed consent before participation. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki, with strict maintenance of patient data confidentiality and privacy.

Consent for Publication: As the corresponding author, I hereby grant, on behalf of all co-authors, full publication rights to the journal.

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Authors' Contribution: MHN: Conceived the study design, collected data, drafted the manuscript, and manuscript editing; MA: Contributed to data collection and manuscript editing; TAS: Performed the data analysis and contributed to manuscript revisions; SF: Conceived the study design, collected data, drafted the manuscript, performed the data analysis and contributed to manuscript revisions, supervised the study, provided critical revisions to the manuscript, and approved the final version for publication. All authors read and approved the final manuscript.

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