

Performance validation of different trauma scoring systems among polytrauma patients having predominantly blunt abdominal trauma

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ABSTRACT

Introduction: Blunt abdominal trauma substantially contributes to mortality and morbidity in patients with polytrauma. Appropriate clinical assessment is important in setups lacking facilities of advanced diagnostics (abdominal computed tomography scans and ultrasonography) to decide if the patients' needs exceed the facilities available. This study aimed to assess the utility of the commonly used trauma scores in predicting the outcome (favorable or unfavorable) in patients with predominantly blunt abdominal trauma. **Study Design and Methods:** In this prospective observational study of 12-month duration, we calculated three scores (Glasgow Coma Scale [GCS], Revised Trauma Score [RTS], and Injury Severity Score [ISS]) in patients brought to emergency department and fulfilling the inclusion criteria. These patients were categorized into two categories (favorable and unfavorable) depending on their treatment outcome. The difference in the mean scores for both outcomes in each score was calculated and further inferences were obtained by using the unpaired *t* test. A receiver-operating characteristic curve for each score was drawn to understand the trade-off between sensitivity and specificity at each cutoff value and for determining area under curve (AUC) for all three scores. **Result:** A total of 103 patients were recruited in the study (88 men and 15 women) with the mean age of 31.03 (\pm 13.40) years and 34.47 (\pm 18.04) years, respectively. The difference in the scores was maximum for ISS and minimal for RTS. The visual impression, as well as AUC values, shows that ISS performed well to discriminate between the favorable and unfavorable outcomes in each cutoff values (AUC = 0.806, lower bound 0.678 to upper bound 0.934) compared to GCS and RTS scores. The Youden's J statistic for ISS value of 42 was maximum (0.298) and corresponding sensitivity and specificity were 0.651 and 0.647. **Conclusion:** ISS is superior as compared to GCS and RTS in predicting outcome in polytrauma patients with a blunt abdominal injury. ISS value of <42 predicts a favorable outcome.

Keywords: Blunt abdominal trauma, Glasgow Coma Scale, Injury Severity Score, polytrauma, Revised Trauma Score

Introduction

Trauma is a major health problem worldwide.^[1] It is the leading cause of morbidity and mortality in the first four decades of

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life.^[2] The abdomen is the third most injured region of the body and is affected in 7%–10% of trauma victims,^[3] and about 70%–80% of abdominal trauma is blunt.^[4,5] Clinical examination alone is insufficient because patients may have altered level of consciousness or distracting injuries. A high index of suspicion for blunt abdominal trauma should be kept based on the mechanism of injury as initial clinical evaluation may not reveal any positive findings. Moreover, patients with polytrauma may

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have altered mental status or distracting injuries rendering examination alone to be inadequate in the timely identification of abdominal injuries.^[6] Ultrasonography (USG) is considered the best modality in the initial evaluation of blunt abdominal trauma patients especially in hemodynamically unstable patients as it is noninvasive, requires minimal preparation time, and can be readily performed in the emergency area by an emergency physician.^[7] It can be safely repeated for follow-up evaluation as unlike computed tomography (CT) scan it does not pose the risk of high-dose radiation. Focused assessment of trauma with sonography (FAST) has become an important adjunct in the primary survey of trauma patients and has become a “must-have” modality in modern emergency departments (EDs). Despite its substantial utility, constraints of availability and expert dependence restrict and confine its usage on the operational plane in the Indian context.

The fact should also be seen in terms of delayed diagnosis due to aforementioned constraints where timely diagnosis and management has a definitive impact on clinical outcomes. Therefore, clinical examination still seems to be of utmost importance in hospitals with resource scarcity where a judicious triage with appropriate and timely referral may be done for selective patients.

Trauma-scoring systems have been developed to provide an objective criterion for predicting the morbidity and mortality in trauma patients, which in turn helps in deciding the optimum management strategy including appropriate resource allocation. These scores either measure the alteration in patient’s physiology; Glasgow Coma Scale (GCS) and Revised Trauma Score (RTS) or anatomy; Injury Severity Score (ISS).^[8]

As the patients with blunt abdominal trauma are often presented with diverse clinical presentations and masked clinical profiles (about time to injury), the right clinical judgment is indeed a challenging task in the absence of a scan. Therefore, in this study, we chose a subgroup of polytrauma patients with predominantly blunt abdominal trauma to compare the performance of these scores for predicting favorable and unfavorable outcomes.

Thus, this prospective observational study was conducted to compare the efficacy of commonly used trauma scores in predicting the outcome (favorable or unfavorable) in the setting of a resource-limited tertiary-care government-run hospital in central India.

Materials and Methods

This prospective observational study (12-month duration) was conducted in a tertiary care teaching hospital of central India and included all polytrauma patients with predominantly blunt trauma more than 10 years of age presenting in the ED within 24 h of injury. The study was approved by the institute’s human ethics committee and an informed consent was obtained from all the patients enrolled in the study. The initial management

in ED was as per the Advanced Trauma Life Support (ATLS) protocol (primary survey followed by detailed secondary survey). Necessary radiological investigations (radiographs, USG, and CT scan) were done as per the discretion of the treating doctor and the findings were recorded. Depending on the injury characteristic, the further course of action was decided (intensive care unit or ward admission and operative or nonoperative management).

Details of every emergency procedure (operative/nonoperative) were recorded. The patients needing orthopedics and neurosurgical operative procedures were excluded in the study.

In every case, the following three trauma-scoring systems were calculated at the time of initial assessment: GCS, RTS, and ISS.

The clinical outcome was dichotomized as favorable and unfavorable. All patients who discharged and advised (D/A) after having a good prognosis and Discharged on Request (DOR) were counted as a favorable outcome, whereas the clinical outcome as death and transferred were considered unfavorable.

Data analysis

All three scores (CGS/RTS/ISS) were first descriptively analyzed in reference to gender and favorable and unfavorable outcomes. The difference in the mean scores for both outcomes in each score was calculated and further inferences were obtained by using unpaired *t* test. For this purpose, the type-1 error was set on 0.05. A receiver-operating characteristic (ROC) curve for each score was drawn to understand the trade-off between sensitivity and specificity at each cutoff value and for determining area under curve (AUC) for all three scores. We did a reverse scoring for ISS to assign the same inferential direction to the ISS scale construct. The event was considered as an unfavorable outcome for the analysis purpose. We also attempted to develop a composite algorithm (age and sex-specific) for all three scores using the “r-part” package in R software. This analysis aimed to obtain the pure leaves (observations of one particular class) and determining the cutoffs thereof.

Results

There were 88 male patients and 15 female patients in the study. The mean age of the participants was 31.03 (\pm 13.40) years for men and 34.47 (\pm 18.04) years for women.

Table 1 shows the descriptive statistics for all three scores in reference to men and women.

Table 2 shows the difference in mean scores among the patients having a favorable and unfavorable outcome in reference to scores under inquiry with their confidence intervals. The unpaired *t* test in all three scores showed that even if the null hypothesis were true (no difference in the scores in favorable and unfavorable outcome), the probability of getting these differences were <0.05 in all three scores. The difference in the

scores was maximum for ISS and minimal for RTS. The ROC curve [Figure 1] and corresponding Table 3 show the AUC values with 95% confidence interval. The visual impression, as well as AUC values, shows that ISS performed well to discriminate between the favorable and unfavorable outcome in each cutoff values (AUC –0.806, lower bound 0.678 to upper bound 0.934) compared to GCS and RTS scores. We further tried to develop the “clinical prediction rule” for individual patients using the age, sex, and three scores under inquiry using the machine learning techniques [Figure 2]. The tree took only ISS score for information gain and showed the ISS <42 as a critical value for discrimination. The Youden’s J statistic for this cutoff value was maximum (0.298) and corresponding sensitivity and specificity were 0.651 and 0.647.

Discussion

In this study, we analyzed 103 cases of polytrauma with a predominantly blunt abdominal injury with the primary aim to compare the efficacy of three trauma scoring systems (GCS, RTS, and ISS) in predicting treatment outcome. The maximum number of patients sustaining blunt trauma abdomen and polytrauma belong to the younger age group, that is, 10–29 years which is quite understandable, as this category is most active in career pursuing leading to a major portion of their time spent outdoors, exposing them to risk of trauma. The commonest mode of injury in our study was road traffic accidents (69.9%) which is in agreement with the literature.^[5,9,10]

Trauma-scoring systems are designed to quantify the severity of an injury which helps in estimating the probability of survival and thereby provides objective guidance to treatment decision making. Several studies have compared the efficacy of trauma scores in predicting outcomes in patients with polytrauma.^[10-16] and the results are conflicting. As the scoring systems are used

in the ED apart from being optimally accurate in predicting the outcome, they should be uncomplicated and easy to use. These scores can be categorized based on predictor variables they include, that is, physiological, anatomical, or both. GST and RTS consider the change in patients’ physiological parameters, whereas ISS is an anatomic-based model. Over the years researchers have developed newer scores that are more or less modification or combination of above scores.^[16-19] Currently, there is no ideal injury scoring system. RTS, GCS, and ISS are in clinical use for a long time and are familiar to doctors of every age group working in ED, thereby having wider acceptability. Therefore, in this study, we decided to compare the efficacy of scores most commonly used in ED.

The ISS considers the sum of squares of the highest abbreviated injury scale codes in the three most severely ISS body regions. This square transformation assigns an exponential weight to the more injured anatomical region without compromising the extensiveness of the injury which is taken care of by the additions of scores, whereas these features are absent in CGS and RTS. This score seems to be more tailored and adapted to prognosis prediction as the highest order of injury (critical/maximum) assigns the dis-proportionally highest score (75) which is clinically more meaningful. ISS seems to be more extensive (inclusive of diverse traumatic events) and comprehensive (inclusive of lacerations, contusions, abrasions, and burns) than its physiological trauma score counterparts.

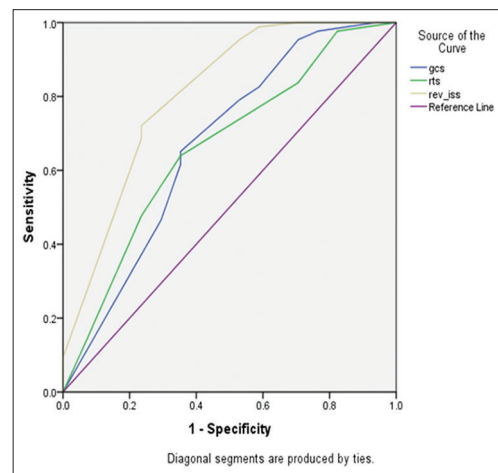


Figure 1: ROC Curve

Table 1: Descriptive statistics for three scores under inquiry				
Variables	Sex	n	Mean	Std. deviation
GCS	M	88	12.97	2.361
	F	15	13.13	2.167
RTS	M	88	9.93	1.453
	F	15	9.73	1.100
ISS	M	88	28.64	7.816
	F	15	31.47	6.791

Table 2: Mean difference of scores among participants with blunt abdominal trauma having favorable and unfavorable outcomes						
Outcome		Mean	Std. deviation	Mean difference	95% Confidence interval of the difference	t (P)
GCS	Favorable (86)	13.28	2.090	1.750	0.197 to 3.302	2.356 (0.029)
	Unfavorable (17)	11.53	2.918			
RTS	Favorable (86)	10.05	1.345	.870	0.147 to 1.593	2.388 (0.019)
	Unfavorable (17)	9.18	1.510			
iss	Favorable (86)	27.27	5.816	-10.791	-15.947 to -5.635	4.392 (0.00)
	Unfavorable (17)	38.06	9.795			

Table 3: Confidence interval for area under curve (AUC) for the 3 competitive scores

Scores	Area (std. error)	P	Asymptotic 95% confidence interval	
			Lower bound	Upper bound
GCS	.670 (.080)	.028	.512	.827
RTS	.663 (.074)	.034	.519	.807
rev_iss	.806 (.065)	.000	.678	.934

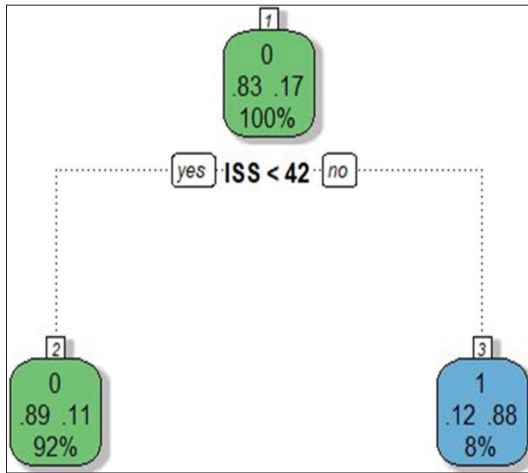


Figure 2: Classification tree showing the branches and nodes

Our study suggests that ISS has a superior ability to distinguish between favorable and unfavorable outcomes. The lower bounds of the other two scores are near to null with larger standard errors showing the less discriminatory power. The best-case scenario (upper bound of 95%CI) grants a near-ideal AUC to ISS indicating near-ideal discrimination.

In Jawali *et al.* study, the mean ISS was significantly higher in elderly trauma patients with unfavorable outcome (area under ROC 0.963).^[20] In a more recent study, Agbroko *et al.* in their study showed that the high ISS score along with a delayed intervention is a predictor of increased mortality in blunt abdominal trauma patients.^[21]

As the injuries in blunt abdominal trauma are concealed, it needs some degree of clinical expertise and the use of adjunct diagnostic modalities (USG or CT scan) to confirm the presence and extent of the injury. In the absence of appropriate expertise and diagnostic adjuncts such as in a primary health-care setup, trauma scores that measure the degree of assault of normal physiology and anatomical structures give a useful objective assessment of the severity of the injury. The institution of trauma scores in such health-care centers may allow a nonspecialist physician to look more accurately, systematically, and holistically to the patients presenting with blunt abdominal trauma. Simultaneously the severity grading on an ordinal scale may offer a hint for appropriate triage and judicious referral to higher center. A prospective study to assess the efficacy of these trauma scores in reducing over/under triaging at a primary health center level is recommended though.

The results of this study should be seen with some caveats—first, the participants are recruited from the single center with limited sample size which may induce measurement bias (if any) and outcome assessment bias (if any). Second, all the absconded and leave against medical advice (LAMA) patients were categorized under unfavorable outcome which may not be always true. The resultant overestimation may skew the performance of a score in one direction. However, from the human behavioral perspective, absconding is the phenomenon that may be seen on both the ends of the self-appreciation spectrum. Either the patient may perceive himself as too healthy to obviate the need of care or too sick to be benefited by these modalities of treatment. The resultant vectors thus move to the null effect. Finally, ISS < 42 has only been shown to be associated with a favorable outcome. Its utility in optimizing referral strategy at the primary health-care setup would have to be tested in a large-scale prospective study.

Conclusion

This study supports the superiority of ISS over RTS and GCS in predicting the outcome in polytrauma patients with predominantly blunt abdominal trauma. These scores could be a valuable adjunct to decision-making for appropriate resource allocation in the hospital with disproportionate patient load. They can also be used as an objective tool in guiding a primary care physician regarding urgency and selecting the suitable referral center.

Key points

1. Trauma scores provide the assessment of the severity of injury in patients with polytrauma.
2. The ISS is superior to RTS and GCS in predicting outcome in polytrauma patients with blunt abdominal trauma
3. ISS value of <42 predicts a favorable outcome in polytrauma patients with predominantly blunt abdominal trauma

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Conflicts of interest

There are no conflicts of interest.

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