Application of “Trauma and Injury Severity Score” and “A Severity Characterization of Trauma” Score to Trauma Patients in A Setting Different from “Major Trauma Outcome Study”

Abbas Rabbani MD*, Majid Moini MD**

To evaluate the processes of care and outcomes of injured patients, many different models have been devised and "Trauma and Injury Severity Score" and "A Severity Characterization of Trauma" score have been among the most widely used models. We conducted this study to determine the effectiveness of these systems of evaluation to our setting in Iran, which is substantially different from the North American trauma centers, where these models were developed.

Using our data registry on trauma patients, we derived new coefficients for Trauma and Injury Severity Score and A Severity Characterization of Trauma scoring systems to calculate the probability of survival of patients. Finally, we determined the calibration and discrimination of the models by calculating the Hosmer-Lemeshow statistic and the area under the receiver operating characteristic curve.

In our study, TRISS and A Severity Characterization of Trauma provided an adequate estimation of the survival probability and both models showed better discrimination in penetrating trauma. Discrimination in blunt injuries was a little lower, yet satisfactory. In pediatric patients the discrimination was also good and A Severity Characterization of Trauma had a better performance.

Both models can be used reliably to predict outcome of trauma patients in our setting.

Keywords: Injury severity scoring model • mortality prediction • outcome • trauma

Introduction

During the first four decades of life, trauma is an important cause of mortality and morbidity. Since it involves the most active group of the society, improvement of trauma care and prevention of avoidable deaths are among the main goals of health care systems of many countries. On the other hand, evaluating processes of care and outcomes of injured patients are important if improvements in the quality of care delivered to injured patients are to be accomplished. So far, many different models have been devised for prediction of outcome of trauma patients, but the ideal one has yet to be developed and validated.

The “Trauma and Injury Severity Score” (TRISS) introduced by Champion et al 1 is a combination index based on multiple anatomic and physiologic indices including age and mechanism of injury. It has become the standard tool for evaluating the performance of trauma centers and for identifying cases for critical discussion and areas for improvement. The usefulness and limitations of TRISS have been evaluated greatly by investigators who found that TRISS might have major limitations in assessment of severe trauma.

“A Severity Characterization of Trauma” (ASCOT)2 was the next system, which was developed to improve the accuracy and minimize the number of errors of TRISS.

We conducted this study to determine the efficacy of these systems of evaluation to our setting in Iran, which is substantially different from North American trauma centers, from which Major
Trauma Outcome Study (MTOS) data were obtained.

Patients and Methods

Tehran University of Medical Sciences established a data registry of trauma patients who are admitted to three hospitals in Tehran with the highest load of trauma patients. Trauma registry data fields are on demography, cause of injury, injury severity, and outcome. Data collection for this registry was performed by three different groups of physicians who had had special training courses to get familiar with the process of extracting the abbreviated injury scale (AIS) codes necessary for calculation of TRISS and ASCOT. Thirty medical practitioners covered the emergency departments (EDs) 24 hours a day and filled in the emergency questionnaire. Then, three physicians visited the admitted patients every day and filled in the ward questionnaires. A medical practitioner checked all the questionnaires, evaluated, and corrected them (if necessary) based on fixed protocols. When one patient died, additional postmortem data were collected to corroborate the injuries described. Extensive human and computer checks for data completeness, consistency, and accuracy minimized the possibility of errors in data collection.

Our study sample consisted of consecutive trauma patients admitted or died of trauma to our centers and, therefore, included only those patients with an injury severe enough to be admitted. This omitted most of the extremely mild injured cases, which in our belief makes the judgment more appropriate.

Some investigators use the MTOS coefficients for computing TRISS and ASCOT. We believe that it is important to develop a new set of TRISS and ASCOT coefficients from our own data in order to fairly determine the calibration of the two models. Furthermore, it is proposed that MTOS data and coefficients provided more than 12 years ago can no longer be considered representative of the current patient risk.

TRISS was computed with the logistic regression analysis on survival consisting of the RTS, injury severity score (ISS), patient age, and type of injury (blunt or penetrating) as dependent variables. We derived new regression coefficients for TRISS from our database to calculate the probability of survival (Ps) of patients. Like TRISS, we calculated ASCOT separately for patients with penetrating and blunt trauma. It uses anatomic and physiologic measures of injury severity and age as dependent variables. The calculations for ASCOT are, however, more complex than TRISS and described elsewhere. Ps values for ASCOT were also computed with the logistic regression analysis using new regression coefficients. Patients with a $P$ value of $\geq 0.50$ were predicted to live while those with a $P$ value of $< 0.50$ were predicted to die. The models were evaluated and compared using measures of discrimination and calibration.

Discrimination was defined as ability of an index to classify patients correctly as survivors or nonsurvivors. The measures of discrimination used were disparity, misclassification rate, and area under the receiver operating characteristic (ROC) curve. Disparity was defined as difference between the average Ps for survivors and nonsurvivors. Misclassification rate was defined as patients who died but were predicted to survive, or who survived but were predicted to die.

Calibration was defined as the level of agreement between actual and model-predicted number of survivors and deaths in various risk strata. We used the Hosmer-Lemeshow (H-L) statistic to measure the calibration. The H-L statistic measures a logistic function’s predictive calibration across the range of Ps’s. It is based on comparisons of the actual and expected numbers (i.e., based on model predictions) of survivors and deaths for all Ps deciles. The statistic has an approximate $\chi^2$ distribution with eight degrees of freedom. Values of H-L $\leq 15.5$ do not reject the hypothesis that the model provides an adequate fit of the data ($P < 0.05$).

In all analyses, confidence interval and significance level of $P$ value were chosen 95% and 0.05, respectively.

Results

During the data collection period, a total of 4,096 patients, including 1,100 pediatric and 2,996 adult patients (2,514 blunt, 482 penetrating injuries), were admitted to the three participating hospitals, which had complete data required for the evaluation of TRISS and ASCOT.

Table 1 shows the statistical summary of the patients of whom 78% ($n = 3,195$) were males and 27% ($n = 1,100$) aged $< 15$ years. The study sample had a 6% ($n = 247$) mortality rate. Eighty-seven
percent (n = 3,563) of all patients had blunt trauma. The mean ± SD age of our patients was 28 ± 19 years; the mean ± SD RTS on ED admission was 7.54 ± 1.16. The mean ISS in our blunt (7.2) and penetrating (5.7) injured patients were significantly different (P < 0.0001).

Regarding the areas under ROC curves in all groups, ASCOT and TRISS were comparable; both had areas >0.93 and except in pediatric patients, were not significantly different. The areas under ROC curves were particularly high in penetrating injuries and both models can reliably be used. The misclassification rates were lower in penetrating injuries. The H-L values for TRISS and ASCOT indicated that both models fulfill the goodness-of-fit criterion. This value was remarkably better for ASCOT. The calibration of the models was also better in penetrating than blunt injuries. In blunt trauma, the mean Ps for non-survivors was more than 0.50 while it was less in penetrating injuries. This supports the fact that the models work more accurately in penetrating injuries. Comparing different values, only in pediatric patients, ASCOT was obviously superior to TRISS.

**Discussion**

The ISS were developed to provide a quantitative measure of trauma severity and evaluation of patient care compared to with standard value. This study focused on TRISS and ASCOT, the two most widely used trauma scoring models in North America.

The main usage of injury scoring systems is for comparison of any particular trauma care system with the MTOS series; both TRISS and ASCOT models are widely used in this regard.3,4

With a glance at our results, it is obvious that our patients differ in many aspects from most studied patient groups in North America including MTOS. We had a higher portion of pediatric patients (up to 27%), lesser cases of gunshots and stab wounds and most importantly, as is evident from ISS and RTS values (Table 1), less severe injuries in our study.7 These differences along with the different characteristics of our trauma care system support the need for reevaluation of using these systems in Iran.

We had satisfactory results with both TRISS and ASCOT. The areas under ROC curves and H-L statistics, as determinants of discrimination and calibration, respectively, were both excellent. The area under ROC curve in neither group was below 0.93; in penetrating traumas with ASCOT methodology it even exceeded 0.99. As a matter of fact, these systems act as efficiently in our setting as many similar studies conducted in North America.6,8

The TRISS and ASCOT performances in our study were comparable. The areas under ROC curves in all groups were high and not significantly different except in pediatric patients in whom the area under ROC curve was significantly higher for ASCOT.

Regarding calibration, both models achieved values ≤15.5 in any individual group. This does not reject the hypothesis that the models provide a statistically good fit to patient outcomes, which is in contrary to some studies.6

Our patients with penetrating injuries had better prognoses than those with blunt trauma, which may be due to lower severity of injury (lower ISS)

### Table 1. Statistical summary of the patients.

<table>
<thead>
<tr>
<th>Mechanism of injury</th>
<th>n (%)</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road traffic accident</td>
<td>1884 (46)</td>
<td>28±19</td>
</tr>
<tr>
<td>Falls</td>
<td>778 (19)</td>
<td>8 ± 4</td>
</tr>
<tr>
<td>Strike by blunt object</td>
<td>606 (14.9)</td>
<td>30 ± 11</td>
</tr>
<tr>
<td>Cuts</td>
<td>614 (15)</td>
<td>67 ± 8</td>
</tr>
<tr>
<td>Stab wound</td>
<td>210 (5)</td>
<td>7.2 ± 7.1</td>
</tr>
<tr>
<td>Gunshots</td>
<td>4 (0.1)</td>
<td>5.7 ± 5.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patients’ age group</th>
<th>n (%): Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>4096 (100): 28±19</td>
</tr>
<tr>
<td>&lt; 15 yr</td>
<td>1100 (27): 8 ± 4</td>
</tr>
<tr>
<td>15 – 55 yr</td>
<td>2935 (62): 30 ± 11</td>
</tr>
<tr>
<td>&gt; 55 yr</td>
<td>461 (11): 67 ± 8</td>
</tr>
<tr>
<td>RTS on ED admission</td>
<td>7.54 ± 1.16</td>
</tr>
<tr>
<td>ISS</td>
<td></td>
</tr>
<tr>
<td>Blunt</td>
<td>3563 (87): 7.2 ± 7.1</td>
</tr>
<tr>
<td>Penetrating</td>
<td>533 (13): 5.7 ± 5.6</td>
</tr>
<tr>
<td>Total</td>
<td>4096 (100)</td>
</tr>
</tbody>
</table>
in the former group. This is in agreement with some demonstrations outside North America.\textsuperscript{4} Better prognosis, in turn, results in better prediction by scoring systems, since these models have limitations in severe trauma.\textsuperscript{5} On the other hand, there was higher disparity in our penetrating trauma patients, which contributed to the better prediction of models in this group.

The unfavorable results of disparity should be considered more carefully in this study. Although most studies reported high disparity for both models,\textsuperscript{6} we did not get the same results in our setting. This can be explained by overestimation of Ps among patients with head and spinal injuries by the models.\textsuperscript{7} This resulted in higher the mean Ps and consequently, lower disparity between mean Ps of survivors and nonsurvivors. It reduces the power of correctly predicting actual deaths and increases the false-negative results, leading to a higher rate of unexpected deaths.\textsuperscript{3}

The overall injury severity of our patients was lower compared with other studies, probably because the mixture of our patients differed from that of the developed countries. In Iran, like many other developing countries, care of trauma patients has not yet been regionalized. We do not have an integrated trauma system and the prehospital care offered to our patients is quite different from developed countries. Emergency Medical Service (EMS) does not triage trauma victims, so these patients are referred to the nearest hospitals where the equipment and staff may not be sufficient for the care of such patients. This matter should be considered as one of the main causes of loss of many severely-injured patients before arrival to ED and the lower mean ISS of patients who reach hospital alive. We propose that lower severity of injury in our patients, due to the above-mentioned reasons resulted, in better prediction of scoring systems and their good performance in our setting.

In conclusion, we recommend that all authorities in developing countries should consider using current survival probability models with the new coefficients derived from their own regional databases for evaluation of trauma care and prediction of outcome of their trauma patients in spite of many differences of their trauma care systems including lack of a competent EMS and triage mechanism.

\section*{References}