ORIGINAL

Massive transfusion predictive scores in trauma. Experience of a transfusion registry


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KEYWORDS
Massive transfusion; Trauma; Injury; Scores; Intensive Care Unit

Abstract

Objectives: Our purpose is to validate previously described massive transfusion (MT) scoring in our Transfusion Trauma Registry.

Design: A retrospective cohort of adult trauma patients.

Setting: Trauma and Emergency Intensive Care Unit of a tertiary hospital.

Patients: Patients with severe trauma (injury severity score > 15) admitted from October 2006 to July 2009.

Interventions: None.

Variables: The following MT scoring and cutoff points (CP) were evaluated: Trauma-Associated Severe Hemorrhage (TASH) CP: ≥16 and ≥18; Assessment Blood Consumption (ABC) CP: ≥2 and Emergency Transfusion Score (ETS) CP: ≥3, ≥4, ≥6. MT was defined as the transfusion of 10 units or more of packed red blood cells in the first 24 h. We studied the sensitivity (S), specificity (SP), and positive and negative predictive values (PPV, NPV), the positive and negative likelihood ratios (LHR+, LHR−) and area under the receiver operating characteristic curve (ROC).

Results: A total of 568 patients were available for analysis; 77.6% were men, with a mean age of 41.16 ± 18 years and an ISS of 30 ± 13. 93.8% with blunt trauma. The overall MT rate was 18.8%. The best S was obtained with ETS ≥ 3 and best SP was obtained with TASH ≥ 18. ROC for different scores was: ABC: 0.779, ETS: 0.784, TASH: 0.889.

Conclusion: These scales can be useful for characterizing the TM population, for excluding low-risk populations, and for attempting to be objective in hematological damage control and in supporting clinical decisions, based on feasible and easily obtainable data.

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of the possibility of applying them in other settings:

Introduction

The following predictive scores were chosen in view of their predictive power, their ability to be applied in the hospital setting, and their being validated in different settings (clinical, military).

The trauma commission and hospital management of the trauma service of the tertiary care center (ICTU) have developed a protocol in resuscitation and emergency care that include the determination of patients' vital signs and their medical history and the application of the scores of trauma severity. These scores have been developed and validated in a research setting, aiming to improve the care of patients.

This protocol has been developed by the hospital emergency service (EMS) and the trauma registry (MTP). The protocol has been developed in collaboration with the hospital emergency service and the trauma registry.

The protocol includes the development of predictive scores that are used in the hospital setting. These scores are used to determine the severity of trauma and to guide the treatment of the patient.

Patients and methods

Results:

- Lesión;<br> 14% of the patients were studied. The main cause of death was severe injury (76%).<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.<br> - De asociación:Grupo con la población y la población las horas de la población. Los resultados de la población son similares a los de la población global.
Table 1  Values for the different selected scores and cutoff points.

<table>
<thead>
<tr>
<th></th>
<th>ABC ≥ 2</th>
<th>TASH ≥ 16</th>
<th>TASH ≥ 18</th>
<th>ETS ≥ 6</th>
<th>ETS ≥ 4</th>
<th>ETS ≥ 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>43%</td>
<td>43%</td>
<td>28%</td>
<td>66%</td>
<td>81%</td>
<td>89%</td>
</tr>
<tr>
<td>Sp</td>
<td>90%</td>
<td>96%</td>
<td>98%</td>
<td>94%</td>
<td>71%</td>
<td>36%</td>
</tr>
<tr>
<td>PPV</td>
<td>56%</td>
<td>78%</td>
<td>85%</td>
<td>66%</td>
<td>30%</td>
<td>26%</td>
</tr>
<tr>
<td>NPV</td>
<td>84%</td>
<td>86%</td>
<td>84%</td>
<td>86%</td>
<td>91%</td>
<td>92%</td>
</tr>
<tr>
<td>PLR</td>
<td>4.3</td>
<td>13.43</td>
<td>14</td>
<td>11</td>
<td>2.7</td>
<td>1.3</td>
</tr>
<tr>
<td>NLR</td>
<td>0.63</td>
<td>0.58</td>
<td>0.73</td>
<td>0.36</td>
<td>0.26</td>
<td>0.30</td>
</tr>
</tbody>
</table>

ABC: Assessment Blood Consumption; ETS: Emergency Transfusion Score; CP: cutoff point; NLR: negative likelihood ratio; PLR: positive likelihood ratio; S: sensitivity; Sp: specificity; TASH: Trauma Associated Severe Hemorrhage; NPV: negative predictive value; PPV: positive predictive value.

(1) The Assessment of Blood Consumption (ABC) score\textsuperscript{16, 17} assigns a value of 0 or 1 to the presence of penetrating trauma, positive focused abdominal sonography in trauma (FAST), systolic blood pressure (SBP) < 90 mmHg, and heart rate (HR) > 120 bpm (the latter 2 parameters upon arrival).

(2) The Emergency Transfusion Score (ETS)\textsuperscript{18, 19} contemplates SBP < 90 mmHg, positive FAST, clinical pelvic instability, age, admission from the scene of trauma, and mechanism of injury (traffic accident or fall from a height of over 3 m).

(3) The Trauma Associated Severe Hemorrhage (TASH) score assesses 7 independent variables correlated to an increased probability of MT and with different relative impacts: SBP, hemoglobin (Hb), presence of intraabdominal fluid, long bone fractures or complicated pelvic fractures, HR, base excess < 10, and male gender.\textsuperscript{20-23}

Different cutoff points (CPs) were assessed for each concrete score:

ABC (≥ 2).  TASH (≥ 16, ≥ 18).  ETS (≥ 6, ≥ 4, ≥ 3).

Figure 1  ROC curves and AUROC for the different scores. ABC: Assessment Blood Consumption; ETS: Emergency Transfusion Score; TASH: Trauma Associated Severe Hemorrhage.
MT was defined as the administration of ≥10 red cell concentrate units (RCs) in the first 24 h after trauma, in accordance with usual practice as reflected in the literature comparing these scores.16-23

For each score and different CP, we calculated the sensitivity (S), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (PLR) and negative likelihood ratio (NLR). Based on the combination of pre-test probability and PLR, the use of tools such as the Fagan nomogram allows us to calculate the post-test probability of requiring MT, for a given cutoff point.

Use was made of the pre-test probability (incidence in the series) and PLR for calculating the post-test probability in the Fagan nomogram for the scores and CPs that could prove most useful, with the aim of potentially applying them to a concrete patient – examining the possible combinations in search of the lowest cutoff point capable of predicting the need for MT.24

We likewise plotted the receiver operating characteristic (ROC) curves as graphic representations of the discriminative capacity of a given score based on all its CPs, and calculated the areas under the ROC curves (AUROC) for the scores and CPs that could prove most useful, with 95% confidence intervals.25,26

Comparative inferential statistical analysis was carried out of these areas using the Chi-squared test, with a level of significance of p < 0.05. The SPSS version 15.0 statistical package was used throughout.

Figure 2  Fagan nomogram for TASH CP ≥ 18, TASH ≥ 16, ETS ≥ 6. ETS: Emergency Transfusion Score; TASH: Trauma Associated Severe Hemorrhage.
Results

We studied 568 patients with a mean age of 41 ± 18 years. There was a clear predominance of males (77.6%) and of closed trauma (93.8%). The mean ISS was high: 30 ± 13. Some type of blood product was required by 52.9% of the patients, while 18.8% required MT. The mean transfused RC volume was 2.692 ± 2.793 ml in the global series and 4.925 ± 3.055 ml in the patients with MT.

The values corresponding to S, Sp, PPV, NPV, PLR and NLR for each scale and cutoff point are summarized in Table 1. The ROC curves and AUROC in turn are summarized in Fig. 1. Comparison based on the Chi-squared test was made between the ABC and ETS scores – no significant differences being found. In contrast, very significant differences were found between the TASH and the other two scores (ABC and ETS) (p < 0.00001).

For calculation of the post-test probabilities and obtaining a graphic representation of the latter, use was made of the Fagan nomogram27 for the most useful scales and CPs (TASH ≥ 18, TASH ≥ 16 and ETS ≥ 6)—post-test probabilities of about 70–78% being recorded after application of these scores (Fig. 2).

Discussion

Massive transfusion is applied in a very small percentage of patients, though high mortality is involved (40–60%), and the technique consumes up to 70% of all blood products in this type of patient population.28

Early prediction of the need for MT is very difficult to establish, but probably could contribute to improve the development of MT protocols (MTPs) – particularly in relation to early preparation of the corresponding logistics and the availability of frozen fresh plasma, and the definition of adequate blood product ratios.11 The percentage of patients requiring MT in our series was much higher than in other published series (18% versus 3–5% in the civilian population and 8–10% in the military setting).19,29 These differences are explained by the fact that ours was a selected patient sample with high ISS scores, in which many patients meeting the requirements for MT but with traumasms affecting fewer anatomical regions (e.g., severe orthopedic trauma requiring surgery) were excluded.

On the other hand, there are a number of MT predictive scores that have not been considered in the present study.31,32 Some of these instruments are specific to certain types of trauma such as penetrating chest injuries.11 Some scores have assessed blood loss based on visual estimates,33,34 ionic calcium values upon admission,35 and derived secondary hemodynamic parameters.36

The decision to apply the predictive scores considered in our study was based on their calculating options, on the recommendations of different international scientific societies,14 and on their suitability to the type of population involved (civilian in our case).

TASH with high CPs (values of 16–18) has been found to be a better predictor of the need for MT, probably due to the similarity between the studied population and our series – though when applied to routine clinical practice, TASH poses the difficulty of having to deal with a large number of variables in comparison with ABC. The scores are particularly useful for discarding subjects at low risk of requiring MT, as reflected by the high NPV of the different scores and for the different CPs.

Our study has some limitations, some of which are inherent to its design, such as the definition of MT using an a posteriori rather than an a priori time concept (with the capacity to determine massive bleeding),37 and the institutional policy with respect to the management of severe trauma and transfusion therapy.

On the other hand, this is a study in which predictive scores are applied retrospectively—though to the best of our knowledge, no prospective studies are found in the literature. Furthermore, some techniques (FAST) imply inter-operator variability, and there is some ambiguity in the definition of certain score variables—these factors being able to affect reproducibility when applying the scores.

Lastly, it should be mentioned that the findings have been useful in upgrading our institutional MT protocol.

Conclusions

Massive transfusion predictive scores can be useful for characterizing patients requiring MT and for excluding low risk populations, and help us to be objective in applying resuscitation measures with damage control, and to design and audit MT protocols—though at present these instruments are probably not able to replace clinical judgment and continuous re-evaluation within the dynamic process of initial trauma management. The choice of a given score must be based not only on its predictive capacity but also on its simplicity and rapidity, and even on the possibility of application the score in the pre-hospital setting. The clinical validation of these instruments requires prospective and multicenter studies38 adapted to the settings in which they are to be used, with the application of appropriate statistical tools and even assessments of the contributions made by each individual component.39

Conflicts of interest

The authors have no conflicts of interest to declare.

Acknowledgements

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References

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