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Brief Report

Modified traumatic bleeding severity score: early determination of the need for massive transfusion☆,☆☆,★

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ABSTRACT

Background: Determination of the need for massive transfusion (MT) is essential for early activation of a MT protocol. The Traumatic Bleeding Severity Score (TBSS) predicts the need for MT accurately, but takes time to determine because systolic blood pressure after a 1000 mL of crystalloid infusion is used. The aim of this study is to determine the how well the Modified TBSS (age, sonography, pelvic fracture, serum lactate and systolic blood pressure on arrival) predicts the need for MT (accuracy).
Methods: This is a single-center retrospective study of trauma patients (Injury Severity Score ≧16) admitted between 2010 and 2014. The TBSS, the Trauma Associated Severe Hemorrhage (TASH) Score, and the Modified TBSS were calculated. *MT* is defined as ≧10 U packed red blood cell transfusion within 24 hours of injury, and the predictive value of the need for MT was compared by area under the receiver operating characteristic curve (AUC) analysis among three scores.
Results: Three hundred patients were enrolled, and MT given to 25% of patients. Although the AUC of the TBSS was higher than that of the TASH score (0.956 vs 0.912, $P = .006$) and the Modified TBSS (0.956 vs 0.915, $P = .001$), there was no difference between the AUC of the Modified TBSS and the TASH score. The Modified TBSS has high accuracy, within an AUC >0.9.
Conclusion: The predictive value of the Modified TBSS of the need for MT is still high and is equivalent to the TASH score. The Modified TBSS is calculated earlier in resuscitation than the original TBSS.

1. Background

Massive hemorrhage is a major cause of death due to traumatic injury [1–3], and early administration of blood products with higher plasma and platelet ratios in trauma resuscitation are associated with decreased mortality [4]. Many major trauma centers in the United States, have instituted massive transfusion (MT) protocols to initiate the transfusion of blood products in the appropriate ratio as early as possible [5]. Convenient, early and accurate determination of the need for MT are essential for early activation of a MT protocol, and several appropriate triggers for MT protocol initiation have been developed, such as scoring systems [6] and rotational thromboelastgraphy [7].

Scoring systems to predict the need for MT are generally easy to use and not expensive. A high accurate scoring system is ideal for this purpose. There are a number of such scoring systems in use today. Brockamp and colleagues conducted a detailed review of six such scoring systems including the Trauma-Associated Severe Hemorrhage (TASH) score, the Prince of Wales score, the Vandromme score, the Assessment of Blood Consumption score, the Schreiber score and the Larsen score [6]. They reported that the TASH score has the highest overall accuracy.

The Traumatic Bleeding Severity Score (TBSS) is a simple and highly accurate scoring systems to predict the need for MT [8] (Fig. 1), which use only five variables, including patient age, systolic blood pressure after rapid infusion of 1000 mL of crystalloid, the result of the Focused Assessment With Sonography for Trauma scan, severity of pelvic fracture, and lactate concentrate on arrival. The TBSS is considered as a very useful scoring system for use in the Japanese trauma population

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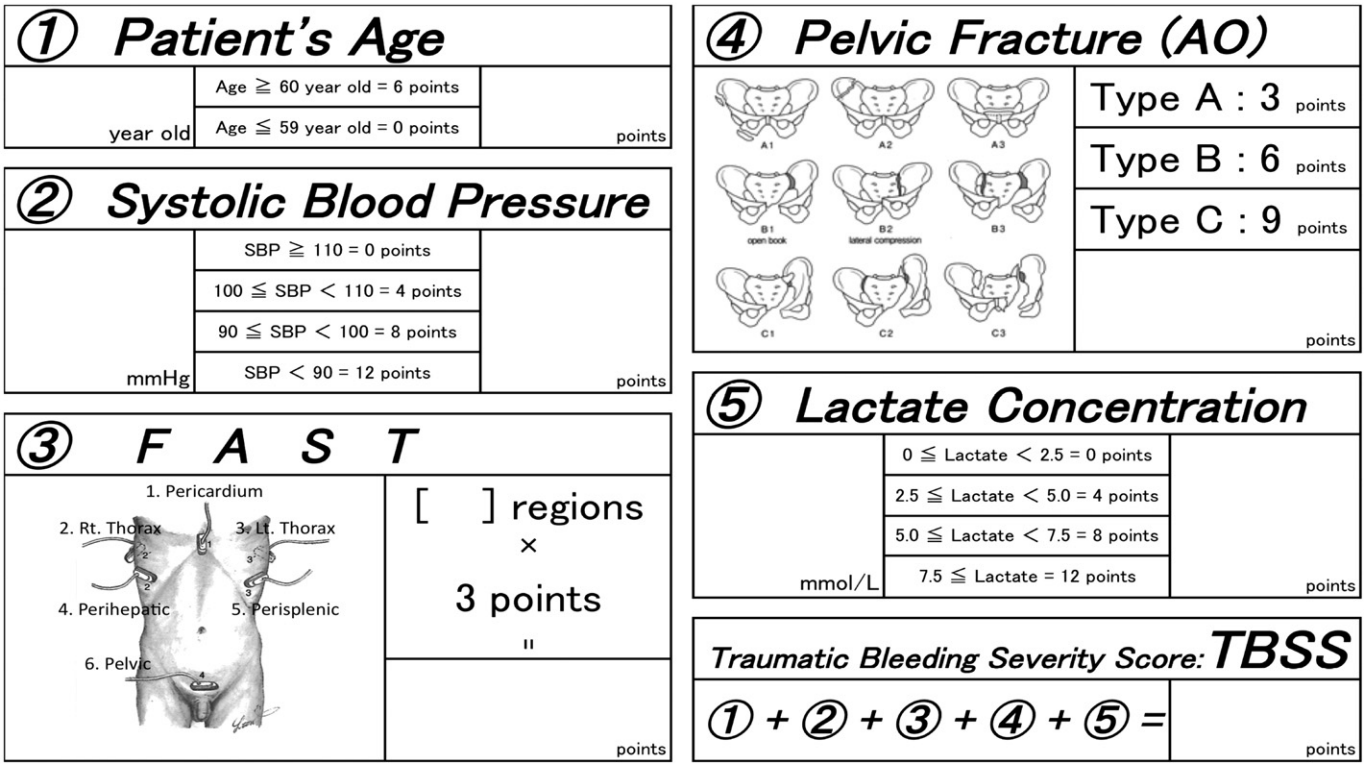

Fig. 1. The original traumatic bleeding severity score SBP: systolic blood pressure (after rapid infusion of 1000 mL crystalloid), FAST, Focused Assessment with Sonography for Trauma; AO, Arbeitsgemeinschaft für Osteosynthesefragen/Orthopedic Trauma Association classification.

[8]. The TBSS is determined using a convenient Smartphone application which is easy to use.

However, the TBSS takes time to determine because it is based on the systolic blood pressure after rapid infusion of 1000 mL of crystalloid. That is a problem for the early determination of the score and identification of the need for MT. If the systolic blood pressure on arrival can be used, instead of the systolic blood pressure after rapid infusion of 1000 mL of crystalloid, the TBSS is determined earlier, allowing the MT protocol to be instituted earlier. The aim of this study is to test the accuracy of the Modified TBSS, which use the systolic blood pressure on arrival instead of the systolic blood pressure after rapid infusion of 1000 mL crystalloid.

2. Patients and methods

This study was conducted at a single institution (Japan Red Cross Maebashi Hospital, Japan) that admits approximately 150 to 200 severely injured patients per year (Injury Severity Score >/= 16). The Institutional Review Board approved this review of patient data prior to starting the study. This is a retrospective study of severely injured patients (Injury Severity Score ≧16) admitted between January 2010 and March 2014. Due to the epidemiology of the patient population, nearly all patients in this study suffered blunt traumatic injuries. Patients who presented initially with cardiopulmonary arrest or isolated head trauma were excluded from this study, in accordance with the original TBSS study [8].

This study was conducted in the same way as the original TBSS validation study [8]. The TBSS, the TASH score [9], and the Modified TBSS at the time of arrival were retrospectively calculated. The Modified TBSS was defined as a score using the same algorithm as used to calculate the TBSS, but using the systolic blood pressure on arrival instead of the systolic blood pressure after rapid infusion of 1000 mL of crystalloid. MT is defined as a transfusion of 10 or more units of packed red blood cells, within 24 hours of the time of injury. (In Japan, one unit of packed red blood cells is approximately 120 mL.) This study was performed to determine how well the Modified TBSS can predict the need for MT, as defined. Transfusion and crystalloid infusions were administered without a specific protocol, and determined according to the clinical judgment of the physician in charge.

The predictive value of the need for MT was evaluated by area under the receiver operating characteristic curve (AUC) analysis. High accuracy *in predicting the need for MT* is defined by an area under the receiver operating characteristic curve of more than 0.9, moderate accuracy is defined as AUC less than 0.9, but greater than 0.7, and low accuracy is defined as an AUC less than 0.7 [10]. Receiver operating characteristic curve comparison was performed to compare the accuracy of predicting the need for MT comparing the TBSS, TASH score, and Modified TBSS. The method of Bonferroni correction was used to adjust the P values in multiple testing for each AUC comparison among the three groups, and a significant difference was defined as $P < .0167$ in this study. All statistical calculation in this study was performed using MedCalc® (Ostend, Belgium).

3. Result

A total of 300 patients were enrolled in this study and their clinical characteristics are summarized in Table 1. Nearly all patients (97%) suffered blunt traumatic injuries, and just 3% (10/300) suffered penetrating injuries. The median age was 60 years old (range 37-70), and 77% (230/300) were male. The median Injury Severity Score was 27 (20-36), MT (10 U or more of PRBC transfusion within 24 hours of injury) was given to 28% (84/300) of patients. The overall mortality was 14% (42/300). *Of the 42 patients who died, 30 were in the MT group (30/84) and 12 were in the Non-MT group (12/216)* (Table 2). *The mortality in the MT group was 36% (30/84) and that in Non-MT group was 6% (12/216) (P < .001.)*

The AUC of the Modified TBSS for predicting the need for MT was 0.915 (95% CI, 0.887-0.944; cutoff 14, sensitivity 80.0%, specificity 91.1%). The AUC of the TBSS was 0.956 (95% CI, 0.926-0.976; cutoff 14, sensitivity 93.3%, specificity 92.4%), and of the TASH score was 0.912