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Assessing the Efficiency of Scoring System for Predicting the Probability of Massive Transfusion in Trauma Patients

Arulselvi Subramanian*, Venencia Albert, Sonika Sharma, Shyamla Kondru and Ravindra Mohan Pandey

JPNATrauma centre, AIIMS, New Delhi, India

***Corresponding author:** Arulselvi Subramanian, JPNA Trauma centre, AIIMS, New Delhi, India, Tel: 09810644033; E-mail: arulselvi.jpnatc@gmail.com

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Abstract

Background: Management of hemorrhage plays a critical role in acute trauma care, owing to its significant association with morbidity and mortality in severely injured patients. We aimed at comparing the accuracy of three prediction models Trauma Associated Severe Hemorrhage (TASH) score, Assessment of Blood Consumption (ABC) score and Emergency Transfusion Score (ETS) for early estimation of the probability of massive transfusion, and its prognostic significance following trauma.

Methods and Materials: retrospective analysis all cases of trauma, who required transfusion of >3 units of packed red blood cells (PRBC) was conducted for the duration of six months. Massive transfusion was defined as transfusion of >10 units of packed red blood cells within 24 hours. Correlation of all scoring systems with the probability of mass transfusion, severity of injury and in hospital mortality was done. Area under receiver operating characteristic (AUROC) Curve used to compare the scoring systems. Sensitivity, specificity, positive and negative predictive values were calculated for different prediction models.

Results: 13.7% of the patients included in the study received massive transfusion. The accuracy was the highest for TASH score (57.1%) followed by ETS score (22.8%) and ABC score (13.1%). Statistically significant association was observed between TASH score and PRBC units transfused (p 0.003). 87 patients died within the duration of this study, association of lower ETS score with in hospital mortality was fund to be statistically significant

Conclusion: TASH score predicts the individual's risk for massive transfusion at a very early stage following severe injury. The scoring system may indicate risk and impact trauma care management strategies to stop bleeding and stabilize coagulation.

Keywords: Massive transfusion; TASH; ABC; ETS; Trauma

Introduction

Exsanguination although preventable is the most common cause of mortality following severe injury. Around 33% of trauma deaths occur immediately after injury or before hospital arrival [1]. The mode of death of these patients is divided equally between central nervous system injury and hemorrhage [1].

Hemorrhage being a major contributor of morbidity and mortality of injury, attaining and maintaining hemostasis is a key consideration in trauma care [2]. Fluid and large volume packed red blood cell (PRBC) transfusion are used as the first-line agents during resuscitation, directed at restoring circulating volume, but also contribute to dilutional coagulopathy, which reduces the levels of hemostatic factors [3-4].

Though blood transfusion results in volume restoration and improved oxygen carrying capacity in the injured patient, it carry's adjunct various immunosuppressive and infectious consequences [5]. Defined triggers for activation of multiple transfusions (MT) protocols can ease some of these impedances, however the need for early predictions and identification of suitable patients in need for multiple transfusion has led to the to the formulation of several predictive scoring tools for the initial evaluation of the bleeding trauma patient

The primary aim of this study was to compare the accuracy of Trauma Associated Severe Hemorrhage (TASH) score, Assessment of Blood Consumption (ABC) score and Emergency Transfusion Score (ETS) for early estimation of the probability of massive transfusion in trauma patients. Secondary was to identify a scoring system that can be used as a prognostic marker among the trauma patients.

Methodology

We retrospectively analyzed all cases of trauma registered at our level I trauma center. Cases of those who required transfusion of >3 units of packed RBC during a period of six months (January to June 2011) were extracted from computerized patient record system.

Study variables

Patient demographic details namely age & gender, along with on admission clinical details including blunt or penetrating trauma, incidence of pelvic and/or femur fracture, BP, Heart rate, FAST were taken. Also details such as amount of blood & blood products transfused, length of stay in hospital, coagulopathy, mortality and cause of death were noted.

GCS (Glasgow Coma Scale), AIS (Abbreviated Injury Score), ISS (Injury Severity Score) and New Injury Severity Score (NISS) were also calculated and specified for each patient to assess the severity of injury.

Laboratory Investigation recorded were hemoglobin, platelet count, arterial blood gas analysis and routine coagulation assays (PT/aPTT/INR)

Definition

Scoring system

Utilizing the above clinical and laboratory parameters we the calculated the three scores i.e. TASH, ABC and ETS for early estimation of the probability of massive transfusion in trauma patients.

Trauma Associated Severe Hemorrhage (TASH) Score [6] predicts the probability for MT after multiple trauma. TASH uses seven independent but weighted variables to identify patients who will require a massive transfusion: systolic blood pressure, sex, hemoglobin, FAST exam (focused assessment for the sonography of trauma), heart rate, base excess (BE), and extremity or pelvic fractures. The possible range of the scores is between 0 and 28 where each point corresponds to a risk for MT in percent (Table 1).

Parameter	Finding	Points
Gender	Male	1
	Female	0
Pelvic Fracture	Absent	0
	Present	6
Femur Fracture	Absent	0
	Present	3
Free intra-abdominal fluid	Absent	0
	Present	3
Heart Rate	≤120	0
	>120	2
Systolic Blood Pressure	<100 mm Hg	4
	100-119 mm Hg	1
	≥120 mm Hg	0
Haemoglobin	<7.00 g/dL	8
	7.00-8.9 g/dL	6
	9-9.99 g/dL	4
	10-10.99 g/dL	3
	11-11.99 g/dL	2
	>12 g/dL	0
Base excess	<-10.00 mmol/L	4
	-6.01-10.00 mmol/L	3
	-2.01-6.00 mmol/L	1
	≥-2.00 mmol/L	0

Table 1: TASH Score for blood transfusion (Trauma Associated Severe Hemorrhage (TASH)-Score: Probability of Mass Transfusion as Surrogate for Life Threatening Hemorrhage after Multiple Trauma. J Trauma [6].

A TASH score ≥ 16 points (i.e.) means a probability of MT >50%.

Assessment of Blood Consumption (ABC) [7] Score consists of four dichotomous components that are available at the bedside of the acutely injured patient early in the assessment phase. The presence of any one component contributes one point to the total score, for a possible range of scores from zero to four. The parameters include: (1) Penetrating mechanism (2) ED SBP of 90 mm Hg or less (3) ED HR of 120 bpm or greater (4) Positive FAST (Table 2).

Parameter	Finding	Points
Penetrating trauma	Absent	0

	Present	1
Systolic Blood pressure	>90 mm Hg	0
	<=90 mmHg	1
Heart rate	< 120	0
	>= 120	1
FAST	Negative	0
	Positive	1

Table 2: ABC Score for blood transfusion (Early Prediction of Massive Transfusion in Trauma: Simple as ABC (Assessment of Blood Consumption) J Trauma [7]

Emergency Transfusion (ETS) [8] Score identifies patients in need for immediate red blood cell substitution, including the following variables: systolic blood pressure, FAST positive, clinically unstable pelvic ring fracture, age, admission from scene, traffic accident, fall from > 3 meters (Table 3).

Parameter	**Finding**	**Points**
Age	<40	0
	40 to 60	1
	61 to 75	2
	>75	3
Glasgow coma scale	13 to 15	0
	10 to 12	1
	6 to 9	2
	3 to 5	3
Base excess	<-1	0
	-5 to -1	1
	-10 to -5.1	2
	<-10	3
Prothrombin time	<80%	0
	80% to 50%	1
	49% to 20%	2
	>20%	3

Table 3: ETS Score for blood transfusion (The emergency room transfusion score (ETS): prediction of blood transfusion requirement in initial resuscitation after severe trauma. Transfusion medicine [8]

Patient categorization was done using different cutoff points assessed for each of the scoring system: TASH ≥10 & ≤11; ABC >2 & ≤2; ETS ≥6 & ≤7

Statistical analysis

Correlation of all scoring systems with the probability of mass transfusion, severity of injury (ISS, AIS) &severity of head injury (GCS) & mortality were done.

Rank sum test was used for the correlation of TASH score and ABC score with mortality, ISS, AIS, GCS & T-test for ETS with mortality, ISS, AIS, GCS.

Spearman's rank correlation coefficient or Spearman's rho, was calculated to determine the statistical dependence between two variables

The sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratio and accuracy were calculated for different prediction models.

The overall discriminatory capacities of models were compared using the area under the ROC curve.

Results

A total of 124 trauma patients with mean age 32.4 years, with median ISS of 9, 109 of them were males. 77 received 1-4 units, 30 received 5-9 units. 13.7% of the patients included in the study received massive transfusion with mean ± SD of 16.4 ± 5.4 units within 24 hrs of injury.

Transfusion score vs. transfusion requirements

The accuracy of different models based on the cutoff recommended by their respective authors (ETS score ≥3, ABC score ≥2 and TASH score ≥16). The accuracy was the highest in the TASH score (57.1%) when compared to the ETS score (22.8%) and ABC score (13.1%) Table 4.

Transfusion prediction models		**Massive Transfusion (yes) (n=16)**	**Massive Transfusion (no) (n=108)**
TASH (≥16)	YES(14)	8	6
	NO(110)	8	102
ABC(≥2)	YES(35)	8	27
	NO(89)	8	81
ETS(≥4)	YES(114)	15	99
	NO(10)	1	9

Table 4: The accuracy of predicting need for massive transfusion for different prediction models

Statistically significant association was observed between TASH score and PRBC units transfused (p 0.003).For measuring the relationship between TASH and RBC transfusion requirement following trauma, Spearman's ρ (rho) was calculated, as given in Table 4. Spearman correlation indicates the direction of association between the TASH score and units of PRBC, platelets and FFP required, however the ρ of 0.25 for TASH vs. RBC shows weak association (R2 0.20), strongest association of TASH was observed with FFP (ρ 0.41; R2 0.22) .

Statistically insignificant association was observed between ETS and ABC score with the units of blood and blood product transfused in Table 5.

Blood Products	TASH score				ABC score				ETS score			
	P-value	Spearman's rho	R. coef.	R2	P-value	Spearman's rho	R. coef.	R2	P-value	Spearman's rho	R. coef.	R2
RBC	0.0039	o.258	0.506	0.2044*	0.2055	0.1150	0.028	0.0169	0.818	-0.0209	- 0.0135	0.0014
FFP	0.0007	0.410	0.594	0.2295*	0.1234	0.1931	0.051	0.0545	0.796	0.0327	-0.032	0.0074
Platelets	0.0088	0.350	0.351	0.1133	0.6930	0.0545	0.009	0.0022	0.838	-0.0281	-0.042	0.0174

Table 5: Correlation of Transfusion Scores with RBC, FFP and Platelets

Transfusion score vs. severity of injury (ISS, GCS, AIS)

Injury severity score: Trauma patients with an ISS score of ≥25 had a median TASH score of 11 (4 - 23), ABC score 2 (0-3) and mean±SD ETS score of 5.17 ± 1.33. Median TASH and ABC score was higher in patients with an ISS score of ≥ 25 when compared to patients with an ISS score of <25, however mean ETS score was lower in ISS ≥ 25 in comparison to the ISS<24 group. The variations in transfusion scores based on the severity of injury were observed to be statistically significant (p value 0.005, 0.003 & 0.04 respectively).

Abbreviated Injury Score: Trauma patients were categorized into two groups i.e. AIS ≤ 5 and AIS>5. Median (min-max) TASH was 11 (2-23) (p<0.001) and ABC score was 1.5 (0-3) (p<0.001) for patients with AIS>5.

69.4% patients with an AIS>5 had a TASH of (11-20) and 16.6% with AIS>5 had an ABC score of (2-4) compared to 83.3% with an ABC score of <2.

Glasgow Coma Scale: Correlation of severity of head injury was done with TASH and ABC score; however ETS was not included for the analysis as GCS is one of the parameter for calculation of ETS.

Based on the GCS the study subjects were categorized into two group i.e. severe & moderate head injury (GCS ≤ 12) and mild head injury (GCS≥13). Median (min-max) TASH and ABC score for severe & moderate head injury was 8 (2-21) and 0 (0-3) which was lower than the TASH and ABC score for mild head injury 9 (1-23) and 1 (0-3) respectively; however this variation in scores was not statistically significant.

Transfusion score vs. Mortality

87 patients died within the duration of this study. Although all the transfusion score were lower for those who died as compared to those who survived, as depicted in Table 6, but only the association of ETS score with in hospital mortality statistically significant, patient who dies had a ETS score 5.4±1.45 compared to 6.5 ± 1.90 for those who survived (p value 0.008).

Parameter		Dead (n=36)	Alive (n=87)	P – value
Gender	Male	33 (91.67)	76 (87.36)	0.756
	Female	3 (8.33)	11 (12.64)	
Age	<40	23 (63.89)	62 ()71.26	0.310
	40 – 60	10 (27.78)	23 (26.44)	
	>60	3 (8.33)	2 (4.07)	
TASH Score		8 (2-21)	9 (1-23)	0.7110
TASH Score	1-10	30 (83.33)	75 (86.21)	0.682
	11-20	6 (16.67)	12 (13.79)	
ABC Score		0 (0-3)	1 (0-3)	0.5787
ABS Score	0-2	30 (83.33)	83 (95.40)	0.036
	2-4	6 (16.67)	4 (4.60)	
ETS Score		5.4 ± 1.45	6.5 ± 1.90	0.008
ETS Score	1-6	17 (47.22)	67 (77.01)	0.001
	7-12	19 (52.78)	20 (22.99)	

Table 6: Correlation of study parameters with in hospital mortality

Area under the receiver operating characteristic (ROC) curve for ETS was 0.686, with sensitivity of 72.2%, specificity of 55.1% and cut off of ≥6 for the prediction of Mortality in trauma patients.

Discussion

Blood transfusion is an essential component of trauma services. Severely injured trauma victims most often undergo massive blood transfusion due to extensive damage and blood loss. We compared the accuracy of three established MT predicting models in our trauma care set up.

Statistically significant correlation was observed between TASH and probability of PRBC transfusion, and ETS score was found to be significant predictor of mortality (p value = 0.008), but not in predicting probability of mass transfusion.

13.7% patients required MT in our study, which is slightly higher than those reported by Poon et al. [9] (2.6%) and Rainer et al. [10] (<5%), however similar to Mitra et al. [11] (14%).We have previously described a mortality rate of 48% following massive blood transfusion [12], comparable with the mortality rate (54%) for patients requiring MT in Poon [9] & Rainer's study [10].

Although similar to our study , M. Chico-Fernández et al. report significant differences between TASH and ABC and ETS (p<0.00001) and no significant differences between ABC and ETS, they concluded that when applied to routine clinical practice, TASH poses the difficulty of having to deal with a large number of variables in comparison with ABC and that these scores are particularly useful for discarding subjects at low risk of requiring MT, as reflected by the high negative predictive value of the different scores and for the different cutoff points [13]. Similar results were reported by Mitra et al., however they defined MT >5 units in 4 h [11], contradictory Mutschler et al. argued that TASH score does not rely on sophisticated and time-consuming laboratory diagnostics, also that prothrombin time (PT) and activated partial thromboplastin time (aPTT) which are components of other scoring systems which usually require 30-40 mins for analysis had been intentionally excluded from TASH.

Borgman et al. demonstrated that a high FFP: RBC ratio of >1:2, transfused on average <5 h from admission, is independently associated with improved survival in trauma patients that have a TASH score of ≥15, Conversely, no survival benefit and a possible association with increased organ failure and decreased ventilator-free days with the use of a high FFP: RBC ratio for patients with a TASH score <15 [14]

Poon et al. [9] compared and reported that the accuracy to predict MT was best in TASH score (97.3%), compared to ABC score (95.1%). Sensitivity was better in ABC score (33.3%) than in the TASH score (25.9%). The area under ROC curve for TASH score and ABC score were 0.911 and 0.809 respectively.

Different cutoffs for TASH score have been suggested by various authors [9,14], TASH score had the highest overall accuracy as reflected by an AUROC of 0.889. TASH score at a cut-off ≥ 8.5 showed a sensitivity of 84.4% and also a high specificity (78.4%) as reported by Brockamp et al., however they recommended prospective validations of scoring systems in the future [15].

One potential limitation of the TASH score, as stated by Maegele et al. [16] may be related to the fact that both development and validation of the score were performed on datasets from almost entirely blunt trauma patients (>95%). It may be possible that the assumptions based on datasets from those patients may not be appropriate for the penetrating trauma population; our study included both blunt as well as penetrating trauma patients, and observed TASH to have highest correlation with probability of transfusion. Another limitation of TASH as seen throughout various publications is the considerable number of variables required for its calculations, as opposed to ABC (four parameters)or ETS score(nine parameters), however all the relevant data required to calculate ETS can be acquired during the first 10 min of arrival of the trauma patients to the emergency department [17]. Recently Mutschler [18] and colleagues prospectively assessed the time to complete TASH calculation in a cohort of trauma patients. Overall, the mean time for assessment and complete calculation of TASH was published to be 7: 56(±0·06) min, providing prospective evidence that TASH is a valid tool to early risk-stratify the bleeding trauma patient, and can be calculated within <8 min upon arrival of the patient to the emergency department.

On correlating the association of severity of injury with the MT prediction scoring systems, we observed that statistically significant association of high severity of injury (ISS ≥ 25, AIS>5 and GCS ≤ 12) with a higher TASH & ABC score and lower ETS score; suggesting a relative association of severity of injury with prediction of MT by the various scoring systems scoring systems.

The diagnostic accuracy of TASH score was observed to be highest (57.1%) when compared to the other MT prediction models i.e. ETS score (22.8%) and ABC score (13.1%).

Ours was a retrospective study which limited the assessment of certain parameters i.e. time for calculating each score was not taken into account in this study.

Conclusion

TASH score is an easy to use scoring system that predicts the individual's risk for MT and thus life threatening hemorrhage at a very early stage following multiple trauma, with a higher accuracy in comparison to the other prediction models that have been previously suggested. When taken as surrogate for life threatening bleeding, the scoring system may focus attention on relevant variables indicative of risk impact strategies to stop bleeding and stabilize coagulation in acute trauma care. Also ETS can serve as an indicator of adverse outcome in trauma patients.

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