



## Early predictors for massive transfusion in older adult severe trauma patients



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### ABSTRACT

**Background:** Many scoring systems for the early prediction of the need for massive transfusion (MT) have been reported; in most of these, vital signs are regarded as important. However, the validity of these scoring systems in older patients remains unclear because older trauma patients often present with normal vital signs. In this study, we investigated the effectiveness of previously described scoring systems, as well as risk factors that can provide early prediction of the need for MT in older severe trauma patients.

**Methods:** We prospectively collected data from a cohort of severe trauma patients (ISS  $\geq 16$  and age  $\geq 16$  years) admitted from January 2007 to March 2015. Trauma Associated Severe Hemorrhage (TASH), Assessment of Blood Consumption (ABC), and Prince of Wales Hospital (PWH) scores were compared between a younger and an older group. Furthermore, the predictors associated with MT in older severe trauma patients were assessed using multivariable logistic regression analyses.

**Results:** The area under the curve (AUC) was significantly smaller for older group than for younger group for all three scoring systems ( $p < 0.05$ ). The most important risk factors to predict the need for MT were related to anatomical factors including FAST results (odds ratio (OR): 5.58, 95% confidence interval (CI): 2.10–14.99), unstable pelvic fracture (OR: 21.56, 95% CI: 6.05–90.78), and long bone open fracture of the lower limbs (OR: 12.21, 95% CI: 4.04–39.09), along with pre-injury anticoagulant agent use (OR: 5.22, 95% CI: 1.30–19.61), antiplatelet agent use (OR: 3.81, 95% CI: 1.57–9.04), lactate levels (OR: 1.20, 95% CI: 1.04–1.39) and shock index (OR: 2.67, 95% CI: 1.05–6.84). Traditional vital signs were not early risk factors.

**Conclusion:** We suggest that MT in older trauma patients should be considered on the basis of anatomical factors, pre-injury anticoagulant or antiplatelet agent use, lactate level and SI even if traditional vital signs are normal.

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### Introduction

In recent years, the size of the older adult population and life expectancy have both increased in most developed countries [1]. In Japan, 33.1% of the population was over 60 years of age in 2015, and the percentage is projected to reach 42.5% by 2050 [2]. The percentage of older persons assessed in trauma fatalities has also been increasing annually. From 2009 to 2013, 50.1% of fatalities resulting from trauma occurred among individuals  $\geq 65$  years of

age [3]. As a result of these changes, the number of older severe trauma patients is increasing in emergency departments.

Older patients are reported to have higher mortality resulting from trauma than younger patients because of physiological differences related to declining baseline functions [4–7].

Therefore, early aggressive resuscitation and careful monitoring may be warranted in older severe trauma patients [8–10].

Several scoring systems for the early prediction of the need for massive transfusion (MT) have been reported [11–13], with most systems scoring vital signs or blood test results. However, older severe trauma patients often present with normal vital signs because of physiological differences compared with younger patients [14], and are frequently under-triaged [15–17]. Therefore, the validity of these scoring systems in older patients remains

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unclear. In this study, we investigated the effectiveness of previously described scoring systems, as well as risk factors that can provide early prediction of the need for MT in older severe trauma patients.

## Material and methods

### Study design and patient selection

We prospectively collected data from a cohort of severe trauma patients (ISS  $\geq 16$  and age  $\geq 16$  years) admitted to the Kochi Health Sciences Center from January 2007 to March 2015. The objective of this study was to validate previously described scoring systems and to determine the early risk factors for MT in older severe trauma patients. Exclusion criteria were isolated head injury, which has minimal influence on massive haemorrhage; dead on arrival; and missing data.

### Setting

Kochi Health Sciences Center in Kochi, Japan, is a 649-bed acute care hospital that treats more than 3000 trauma patients annually, most of whom are blunt trauma cases. The hospital has 20 intensive care unit beds, and approximately 200 trauma patients are admitted to the intensive care unit annually. The emergency medical system is primarily ground-based, although air transportation via helicopter is available; approximately 32% of trauma patients (ISS  $\geq 9$ ) receive helicopter transportation. Older trauma patients ( $\geq 65$  years of age) account for approximately 61% of total admissions. A trauma registry (ISS  $\geq 9$ ) has been maintained since 2007 that is managed prospectively.

The management of trauma patients follows the Advanced Trauma Life Support guidelines [18]. If a trauma patient with major blood loss has a poor response to initial fluid resuscitation or has suspected ongoing haemorrhage, group O red cell concentrate and group AB fresh frozen plasma are administered until the patient's blood type can be determined. Once the patient's blood type is determined, transfusion is performed with a 1:1:1 target ratio of red cell concentrate: fresh frozen plasma: platelet concentrate. We also attempt to maintain the patient's haemoglobin concentration between 7.0–9.0 g/dL [19]. Patients receiving pre-injury warfarin

also receive reversal agents, such as vitamin K or fresh frozen plasma.

### Data collection and definitions

Patient demographics and characteristics were documented in the hospital's electronic patient database or in the patient charts at the time of admission. MT was defined as transfusion of  $\geq 10$  red cell concentrate units within 24 h of admission or early death resulting from massive bleeding [11–13]. Survival or death was assessed during a 28-day follow-up period. Blood samples were collected within 10 min of arrival in the emergency department.

### Scoring systems

We assessed three scoring systems to predict MT; a summary of the three systems is presented in Table 1.

The Trauma Associated Severe Haemorrhage (TASH) score uses seven independent variables: SBP, haemoglobin concentration, focused assessment with sonography in trauma (FAST) results, the presence or absence of complex long bone and/or pelvic fractures, HR, base deficit, and sex. Scores  $\geq 16$  points indicate  $>50\%$  probability of MT. The reported area under the receiver operating characteristic curve (AUC) for TASH is 0.892 [11,19].

The Assessment of Blood Consumption (ABC) score uses only non-laboratory and non-weighted parameters: penetrating mechanism, SBP, HR, and positive FAST examination. Scores  $\geq 2$  have a sensitivity of 75% and specificity of 86%, and the reported AUC is 0.852 [12].

The Prince of Wales Hospital (PWH) score uses seven independent variables: SBP, Glasgow Coma Scale score, HR, displaced pelvic fracture, positive FAST on CT, base deficit, and haemoglobin. With a cut-off of  $\geq 6$ , the overall correct classification for predicting the need for MT is 96.9%, with a sensitivity of 31.5% and specificity of 99.7%. The reported AUC is 0.889 [13].

### Statistical analysis

Patients were divided into a younger (16–64 years of age) and an older ( $\geq 65$  years of age) group, based on their age at presentation. All data are presented as medians (interquartile

**Table 1**  
Comparison of parameters used in scoring systems to predict massive transfusion.

	TASH score [11]	point	ABC score [12]	point	PWH score [13]	point
Physiology	SBP < 100 mmHg	4	SBP < 90 mmHg	1	SBP $\leq$ 90 mmHg	3
	<120	1				
	HR >120 b/min	2	HR >120 b/min	1	HR $\leq$ 120 b/min GCS $\leq$ 8	1 1
Laboratory	Hb < 7 g/dl	8			Hb < 7 g/dl	10
	<9 g/dl	6			Hb 7–10 g/dl	1
	<10 g/dl	4				
	<11 g/dl	3				
	<12 g/dl	2				
	BD > 10 mmol/L	4			BD > 5 mmol/L	1
	>6	3				
>2	1					
Anatomic	Free abdominal fluid	3	Positive FAST	1	CT scan or FAST positive	2
	Clinically unstable pelvic fx	6	Penetrating mechanism	1	Displaced pelvic fx	1
	Open or dislocated femur fx	3				
	Male gender	1				
Maximum		29		4		10

TASH; Trauma Associated Severe Hemorrhage, ABC; Assessment of Blood Consumption, PWH; Prince of Wales Hospital, SBP; systolic blood pressure, HR; heart rate, GCS; Glasgow Coma Scale, Hb; haemoglobin, BD; base deficit, FAST; focused assessment with sonography for trauma, CT; computerized tomography.

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