Original Article

Predictors for Emergency Hemostasis in Severe Trauma Patients

Wongsakorn Chaochankit, Osaree Akaraborworn[1], Khanitta Kaewsaengrueang[1]

Department of Surgery, Faculty of Medicine, Prince of Songkla University, [1]Department of Surgery, Division of Trauma and Critical Care, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand

ORCID:

Wongsakorn Chaochankit: https://orcid.org/0000-0003-2202-7426

Osaree Akaraborworn: https://orcid.org/0000-0002-9343-9498

Khanitta Kaewsaengrueang: https://orcid.org/0000-0002-0398-6368

Abstract

Background: Exsanguination is the main cause of death in trauma patients. Early determination that a patient requires an emergency operation is crucial for saving of life. We challenge the defining predictors that guide the intervention or emergency operation for hemorrhage control in severe trauma patients. **Aims:** The aim of this study was to define the predictors that guide the intervention or emergency operation to resuscitate severe trauma patients. **Methods:** This study was a retrospective study in trauma patients from Songklanagarind hospital. Data were retrospectively collected from a prospective collection registry that included 131 trauma patients who met the trauma activation criteria at Songklanagarind Hospital from January 2014 to December 2014. Emergency operation or intervention was defined as the procedures needed to improve hemostasis within 4 h. Categorical data were compared. Logistic regression was used to measure the relationship between dependent and one or more independent variables. **Results:** The study population was 81.7% male. The age range was 31–35 years. The most frequent mechanism was blunt injury (78%). The emergency hemostasis patients had 27 patients (20.6%). The factors relate to an emergency operation or intervention to improve the hemostasis within 4 h were focused assessment with sonography for trauma (FAST)-positive ($P < 0.001$), male ($P = 0.02$), Injury Severity Score (ISS) ≥25 ($P = 0.013$), and penetrating injury ($P = 0.016$). The preventive factors to an emergency hemostasis were platelet ≥100,000 ($P = 0.039$) and age ≥50 ($P = 0.005$). **Conclusion:** The palate count, FAST, male, age, ISS, and penetrating injury are factors that relate to an emergency operation or intervention within the first 4 h.

Keywords: Emergency hemostasis, exsanguination, trauma patients

Introduction

Trauma is the most common cause of death in both developing and developed countries. The cause of death in the United States from severe trauma is in the age range of 1–34 years old. Massive bleeding was a major cause of the mortality in trauma patients.[1]

Previously, trauma deaths were characterized as having a trimodal distribution. However, more recent studies suggest a bimodal pattern with a reduction in late deaths.[2] More than 50% of all deaths still occur within minutes of the injury at the scene before arrival at the hospital.[3] These immediate deaths are the result of massive hemorrhage or severe neurological injury, and life-saving procedures were largely ineffective in preventing those deaths.[4]

Access this article online

Quick Response Code:

Website: www.archtrauma.com

DOI: 10.4103/atr.atr_19_18

In the other group of severe trauma patients who were still alive and transferred to the hospital, the physicians must have the tools to triage the patients to save a life.[5] The vital signs are the main parameters we use to guide the management in trauma patients. However, according to our basic knowledge, once a patient develops hypotension or has gone into shock, it is too late to resuscitate or transfer the patient to the operating room to save the life.[6] The mechanism and patterns of injury are the other factors that may guide the management of trauma

Address for correspondence: Dr. Osaree Akaraborworn, Department of Surgery, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.
E-mail: thegunnerpump@hotmail.com

How to cite this article: Chaochankit W, Akaraborworn O, Kaewsaengrueang K. Predictors for emergency hemostasis in severe trauma patients. Arch Trauma Res 2018;7:98-101.

patients.[6] The initial parameters at the emergency room can guide the resuscitation and management in trauma patients. However, some initial laboratory parameters at the emergency room such as hematocrit (Hct), arterial blood lactate level, or focused assessment with sonography for trauma (FAST) might help to predict the outcomes and challenge the physician to resuscitate quickly when we aggregate the vital signs and initial laboratory parameters. Conventionally, the initial Hct is not believed to be a good predictor to estimate the blood loss in trauma patients.[7] However, animal studies found that the initial Hct level decreased immediately after the hemorrhage and before intravenous resuscitation.[8-10] In addition, several parameters, including lactate level, Hct level, platelet count, coagulation level, and base deficit, might predict the emergent hemostasis in severe trauma patients.[1]

This study aims to define the predictors that guide the intervention or emergency operation to resuscitate severe trauma patients.

Methods

Study population

The trauma patients who met the trauma team activation criteria (TTAC) from January 2014 to December 2014 were retrospectively collected from a prospectively collected trauma registry. The TTAC consisted of systolic blood pressure (SBP) <90 mmHg, gunshot wound at chest or abdomen, stab wound at chest or abdomen, arrest, respiratory rate <12 or >30/min, pulse rate >120/min (postresuscitation 2 L), Glasgow Coma Scale score ≤8, evidence of pelvic fracture or long bone fracture with SBP <90 mmHg, and FAST-positive. The exclusion criteria were younger than 18 years, premedication with intravenous fluids, arrival at the emergency department (ED) at more than 4 h after the injury, those receiving operative interventions solely for neurosurgical or orthopedic interventions, pregnancy, referral patients, patients with hematologic diseases, and cardiac arrest on arrival. The ethics committee of the Prince of Songkla University approved the protocol.

Data gathering

Age, gender, mechanism of injury, underlying disease, hemodynamic status, arrest, FAST, arterial blood gas data, lactate level, and fluid data were collected initially at the ED. Emergency operations and interventions were defined as patients who needed emergency hemostasis within the first 4 h after hospital arrival. We also collected the hospital mortality.

Statistical considerations

Categorical data were compared using Fisher's exact test. Normally distributed data were compared using analysis of variance. A univariate analysis was done to evaluate the factors associated with emergent hemostatic procedure. The parameters that had $P < 0.2$ from the univariable analysis were selected for the multivariate logistic regression model with backward elimination. Logistic regression was used to measure the relationship between dependent variables and one or more than independents variables with a Mann–Whitney U-test or Kruskal–Wallis test.

Results

From January to December 2014, 183 patients met the TTAC. Fifty-two patients were excluded from the study because 38 patients were transferred from another hospital, 13 patients had cardiac arrest on arrival, and one patient was pregnant [Figure 1]. Therefore, 131 patients remained in this study. The age range was 31–35 years, and 81.7% were male. Blunt injury occurred in 78% of the patients.

Twenty-seven patients needed emergency hemostasis procedure. Almost half of the patients with penetrating injuries required emergency hemostasis that had significant differences between emergency hemostasis and nonemergency hemostasis. In patients with penetrating injury who required the operation (n = 11), the estimated blood loss was 50–10,000 mL (mean 2124.5 mL). All these cases needed the operative technique to stop the bleeding. FAST-positive and injury severity score (ISS) was significantly higher in emergency hemostasis. Age, gender, vital signs, pH, base excess, lactate level, platelet count, Hct, and mortality did not have any significant differences. There were 104 cases of nonemergency hemostasis. There were 33 patients who required the operation after the first 4 h after the injury. There were 21 cases that were operated in the first 24 h after the injury. There were 12 cases that were operated during admission. All these cases required the operation to manage the wound or wait the time for specific treatment that did not relate the hemostasis or reoperation. The demographic data are shown in Table 1.

The analysis used to evaluate the factors associated with the need of emergent hemostasis procedure was the univariate analysis which showed that odds ratio (OR) emergency was correlated with FAST-positive (OR 8.7, P = 0.008), age ≥50 (OR 0.012, P = 0.012), ISS ≥25 (OR 2.66, P = 0.027), and penetrating injury (OR 4.09, P = 0.003) [Table 2].

Multivariate analysis logistic regression was performed. The factors relate to an emergency operation or intervention to improve the hemostasis within 4 h were platelet ≤100,000 (P = 0.039), FAST-positive (P < 0.001),

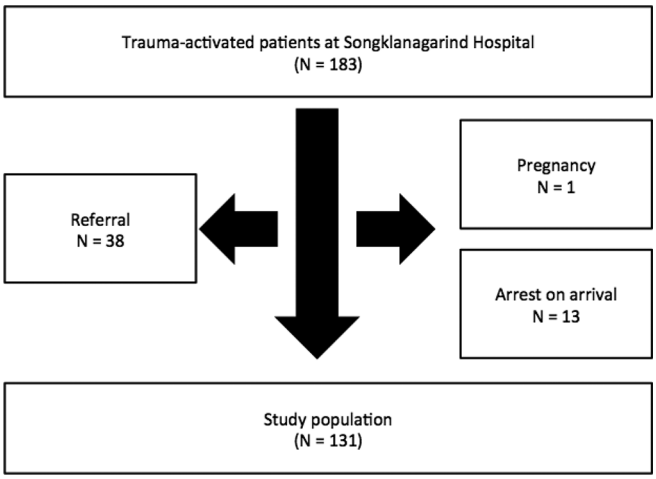

Figure 1: Flow of patients

Table 1: Demographic data divided into emergency hemostasis and non-emergency hemostasis groups (*n*=131).

Variables	Emergency hemostasis (*n*=27, 20.6%)	Non emergency hemostasis (*n*=104, 79.4%)	*P*
Age (year, median)	31 (24.5, 36.5)	35.5 (22, 47.2)	0.231
Male (*n*, %)	25 (92.6)	82 (78.8)	0.16
Mechanism (*n*, %)			0.004
- Blunt	15 (55.6)	87 (83.7)	
- Penetrating	12 (44.4)	17 (16.3)	
Vital signs			
- PR (/min, median)	118 (96, 130)	99 (80, 124)	0.107
- RR (/min, median)	28 (16, 32)	24 (20, 28)	0.242
- SBP (mmHg, median)	118 (95, 132.5)	129 (101.2, 147.2)	0.205
- SpO2 (%, median)	98 (90, 98.5)	98 (95, 100)	0.222
FAST positive (*n*, %)	5 (18.5)	3 (2.9)	0.004
pH of ABG (median)	7.3 (7.3, 7.3)	7.3 (7.3, 7.4)	0.095
BE from ABG (median)	-6.1 (-7.2, -6.1)	-6.1 (-6.4, -5.1)	0.18
Lactate (median)	3.5 (3.5, 4.8)	3.5 (3.5, 3.6)	0.548
Platelet (x10^3, mean)	249.3 (108.6)	270.5 (92.7)	0.308
INR (median)	1.1 (1, 1.1)	1.1 (1, 1.1)	0.004
Initial Hct (%, median)	41.2 (38.9, 43.1)	42 (36.7, 45.4)	0.468
ICU stay (day, median)	0 (0, 2)	0 (0, 1)	0.188
Mortality (*n*, %)	9 (33.3)	15 (14.4)	0.09
ISS (median)	27 (14, 34)	14 (5, 25.2)	0.007

Table 2: Univariable analysis between emergency operation or intervention and variables

Variables	OR (95% CI)	*P*
Hematocrit ≥30%	1.63 (0.34,7.77)	0.520
RR ≥20	1.25 (0.51,3.05)	0.624
PR ≥120	1.48 (0.62,3.54)	0.382
SBP ≥90	0.72 (0.27,1.94)	0.524
O2 saturation ≥94%	0.57 (0.23,1.43)	0.239
pH of ABG ≥7.4	0.42 (0.12,1.5)	0.148
BE from ABG > -6	0.56 (0.21,1.52)	0.242
Lactate >4	1.3 (0.49,3.48)	0.600
Platelet ≥100000	0.51 (0.04,5.84)	0.603
INR >1.5	2.69 (0.43,16.99)	0.313
Male	3.35 (0.74,15.26)	0.074
FAST-positive	8.7 (1.91,39.7)	0.008
Age ≥50	0.012 (0.02.1.05)	0.012
ISS ≥25	2.66 (1.12,6.31)	0.027
Penetrating Mechanism	4.09 (1.63,10.27)	0.003

male ($P = 0.02$), age ≤50 ($P = 0.005$), ISS ≥25 ($P = 0.013$), and penetrating injury ($P = 0.016$) [Table 3].

Discussion

This study showed the relationships between some predictors and emergency operation or intervention within 4 h after arrival at the ED. FAST-positive, male gender, ISS ≥25, and penetrating injury were related with the need for emergency hemostasis within 4 h after arrival at the ED. A platelet level ≥100,000 and age ≥50 years decreased the need of emergency hemostasis within 4 h after arrival at the ED.

Most trauma patients aged 20–30 years were reported to be the most frequent trauma patients.[11] In the current study, significantly more males than females presented with severe trauma which is consistent with the report by Lone *et al*. of a male-to-female ratio of 4.4:1 among abdominal trauma patients.[12] Blunt injuries were reported in most trauma patients which is consistent with a previous study.[13]

In this study, multiple logistic regressions were done to analyze the predictive parameters of emergency hemostasis in severe trauma patients. At present, FAST ultrasound is a useful initial diagnostic tool in trauma patients. In a report by Huang *et al*., a scoring system of five anatomical regions was described,[14] a positive FAST ultrasound is given one point at each of four regions (i.e., Morrison's pouch, Douglas's pouch, perisplenic space, and paracolic gutter) and two points for floating intestinal loops. In their report, 96% of patients with score ≥3 required an exploratory laparotomy. In this study, we did not collect the areas of positive-FAST; however, a positive-FAST was a strong predictor of emergency hemostasis. An analysis of age in 507 trauma patients in a European ED revealed that an increase in every 1w year of age resulted in a 2% increase in the risk of death. In particular, elderly patients (defined as 55 years or over) had an increased risk of dying.[15] However, in this study, age ≥50 years was a preventive factor for emergency operation. Even though elderly patients have a low physiologic reserve and might meet the TACC criteria, they may not have blood loss that requires emergency hemostasis. The mechanism of injury was a factor related to emergency hemostasis. Penetrating injury increased the need for emergency operations. The report by Gad *et al*. stated that penetrating trauma had a much higher

Table 3: Factors related to emergency hemostasis in first four hours

Variables	Adj. OR (95%CI)	*P*
Platelet ≥100000	0.02 (0,0.63)	0.039
FAST-positive	48.43 (3.35,699.89)	< 0.001
Male	10.39 (0.83, 129.45)	0.02
Age ≥50	0.03 (0, 0.79)	0.005
ISS ≥25	3.64 (1.29, 10.23)	0.013
Penetrating mechanism	3.82 (1.29,11.36)	0.016

rate of fatality overall, and the type and site of penetration injury mattered a great deal and the need for emergency hemostasis.[16] In addition, platelet count and male were the factors related to emergency hemostasis. The platelet level was associated with emergency hemostasis. A low platelet count (<100,000) was related to hemorrhage in trauma patients.[17] This study found that male gender was related to emergency hemostasis and males usually had a higher energy transfer mechanism injury than females.

This study collected only the torso trauma patients. The trauma data were collected in a high-volume trauma center. These were the merits of this study. The limitation of this study was the small population from the 1-year study. A study from prospectively collected data over several years should be performed.

Conclusion

This study can demonstrate the factors related to an emergency operation or intervention within the first 4 h after ED arrival. The platelet count, FAST, male, age, ISS, and penetrating injury are the factors related to an emergency operation or intervention within the first 4 h. These factors are reported or detected easily and quickly at the ED, and the trauma surgeons can use the data to prognosticate and plan further management in these cases quickly and properly.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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