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Fibrinogen level on admission is a predictor for massive transfusion in patients with severe blunt trauma: Analyses of a retrospective multicentre observational study

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ABSTRACT

Introduction: In the early phase of trauma, fibrinogen (Fbg) plays an important role in clot formation. However, to the best of our knowledge, few studies have analysed methods of predicting the need for massive transfusion (MT) based on Fbg levels using multiple logistic regression. Therefore, the present study aimed to evaluate whether Fbg levels on admission can be used to predict the need for MT in patients with trauma.

Methods: We conducted a retrospective multicentre observational study. Patients with blunt trauma with ISS $\geq$16 who were admitted to 15 tertiary emergency and critical care centres in Japan participating in the J-OCTET were enrolled in the present study. MT was defined as the transfusion of packed red blood cells

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(PRBC) ≥10 units or death caused by bleeding within 24 h after admission. Patients were divided into non-MT and MT groups. Multiple logistic-regression analysis was used to assess the predictive value of the variables age, sex, vital signs, Glasgow Coma Scale (GCS) score, and Fbg levels for MT. We also evaluated the discrimination threshold of MT prediction via receiver operating characteristic curve (ROC) analysis for each variable.

Results: Higher heart rate (HR; per 10 beats per minutes [bpm]), systolic blood pressure (SBP; per 10 mm Hg), GCS, and Fbg levels (per 10 mg/dL) were independent predictors of MT (odds ratio [OR] 1.480, 95% confidence interval [CI] 1.326–1.668; OR 0.851, 95% CI 0.789–0.914; OR 0.907, 95% CI 0.855–0.962; and OR 0.931, 95% CI 0.898–0.963, respectively). The optimal cut-off values for HR, SBP, GCS, and Fbg levels were ≥100 bpm (sensitivity 62.4%, specificity 79.8%), ≤120 mm Hg (sensitivity 61.5%, specificity 70.5%), ≤12 points (sensitivity 63.3%, specificity 63.6%), and ≤190 mg/dL (sensitivity 55.1%, specificity 78.6%), respectively.

Conclusions: Our findings suggest that vital signs, GCS, and decreased Fbg levels can be regarded as predictors of MT. Therefore, future studies should consider Fbg levels when devising models for the prediction of MT.

Introduction

Despite substantial improvements in acute trauma care, uncontrolled haemorrhage is still responsible for >50% of all trauma-related deaths in both civilian and military settings [1]. Massive transfusion (MT) is used in approximately 5–12% of civilian trauma patients [2,3]. Patients experiencing severe trauma are at risk for coagulopathy [4]. Moreover, when patients with trauma experience an uncontrolled haemorrhage, delay of blood transfusion will also cause life-threatening coagulopathy [4]. Therefore, early identification of patients at risk for MT is likely to minimize the risk of death from bleeding in such patients. Several scoring systems, such as the Assessment of Blood Consumption, the Trauma Associated Severe Hemorrhage Score, and the Traumatic Bleeding Severity Score have been developed to predict the need for MT in patients with severe trauma [5–7]. These scoring systems require several specialized and/or time-consuming diagnostic procedures (e.g., focused assessment with sonography for trauma [FAST], radiographic testing to check for unstable pelvic or complicated femur fractures) and are often associated with time-consuming mathematical calculations (X-rays and FAST) [5–7].

In the early phase of trauma, fibrinogen (Fbg) plays an important role in clot formation [8,9]. It is a key coagulation factor linked to both platelet activation and formation of a fibrin network [10]. Moreover, Fbg is the coagulation factor that decreases most rapidly in patients with major blood loss [11]. Measuring Fbg to assess coagulopathy is a key treatment point for patients with severe trauma. Patients with severe blunt trauma are at risk for both dilution- and trauma-induced coagulopathy [4,12]. These patients may develop coagulopathy more easily than patients with penetrating trauma because blunt trauma stimulates the production of tissue factor and factor VII, which can activate excessive coagulation [4].

It has been suggested that Fbg levels can be evaluated within minutes using specialized Point of Care Testing [13]. However, to the best of our knowledge, only one study has evaluated the use of MT prediction based on Fbg levels using multiple logistic regression [14]. Therefore, we aimed to evaluate whether Fbg levels can be used to predict the need for MT in patients with severe blunt trauma and to identify an optimal Fbg cut-off value for MT prediction.

Methods

J-OCTET database

The Japanese Observational Study for Coagulation and Thrombolysis in Early Trauma (J-OCTET) was conducted at 15 tertiary emergency and critical care centres in Japan that investigated coagulation and thrombolysis disorders in patients with severe trauma. Each hospital's institutional review board approved the J-OCTET study. Written informed consent can be waived in retrospective studies of anonymized patient data in Japan under the Ethical Guidelines for Medical and Health Research Involving Human Subjects [15]. For the J-OCTET, consecutive patients with trauma with ISS ≥16 who were admitted to the study hospitals from January to December 2012 were included; patients were excluded if they were <18 years old or if their injuries were complicated by cardiac arrest, burns, a cervical spine injury not caused by a high-energy accident, pregnancy, or liver cirrhosis. A total of 796 patients with severe trauma were enrolled in the J-OCTET.

Patient selection and massive transfusion definition

We excluded patients with penetrating trauma or missing values for Fbg levels, body temperature (BT), and respiratory rate (RR; Fig. 1).

We divided all patients into two groups: non-MT and MT. MT criteria were defined as follows: transfusion of ≥10 units of packed red blood cells (PRBCs), as reported in previous Japanese studies, and/or death caused by bleeding within 24 h of admission [7,14,16]. The reason that death due to bleeding within 24 h of admission was used to define MT is that these patients may have received MT if they had survived >24 h.

Data collection and analysis

The J-OCTET database includes 117 clinical parameters, 24 of which were retrieved for the present study: age, sex, treatment with pre-hospital fluid resuscitation, treatment with anticoagulant/antiplatelet, Abbreviated Injury Scale (AIS) score, ISS score, Revised Trauma Score, probability of survival (Ps) based on Trauma Injury Severity Score, time from injury to blood sampling (minutes), systolic blood pressure (SBP; mm Hg), heart rate (HR; beats per minute [bpm]), RR (bpm), BT (°C), Glasgow Coma scale score (GCS) (evaluated on arrival), and Fbg (mg/dL) levels [17,18]. Blood samples were collected upon admission to the emergency department and before resuscitation. We did not retrieve parameters that were not measured on admission or for patients who had missing values for >10% of laboratory data.

Furthermore, we evaluated the rates of patients who received transcatheter arterial embolization (TAE) and surgical treatment, blood transfusions (PRBCs, fresh frozen plasma [FFP], platelet concentrate [PC]), tranexamic acid (TXA) within three hours of injury, factor VII, or Fbg as intervention variables. In addition,

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