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Clinical Investigation

CLINICAL INVESTIGATION

Blood lactate concentration and shock index associated with massive transfusion in emergency department patients with primary postpartum haemorrhage

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Background: We hypothesised that lactate concentrations are independently associated with massive transfusion in patients with primary postpartum haemorrhage. Moreover, combining lactate concentrations with the shock index, defined as the ratio of heart rate to systolic arterial blood pressure, can improve the predictive performance for massive transfusion.

Methods: We retrospectively analysed patients with primary postpartum haemorrhage in the emergency department of a tertiary referral centre in Korea between January 1, 2004 and December 31, 2015.

Results: Of the 302 patients, 101 (33.4%) patients required massive transfusion. Lactate concentration was independently associated with the requirement for massive transfusion [odds ratio, 1.56; 95% confidence interval (CI), 1.31–1.87; $P<0.01$]. The area under the receiver operating characteristic curve of lactate concentration and shock index for massive transfusion was 0.788 (95% CI: 0.736–0.840; $P<0.01$) and 0.776 (95% CI: 0.717–0.836; $P<0.01$), respectively. Lactate elevation (>4.0 mM L^{-1}) was associated with 86.1% specificity and 67.8% positive predictive value for massive transfusion. When combining elevated lactate concentrations (>4.0 mM L^{-1}) with a shock index >1.0, the specificity and positive predictive value increased to 95.5% and 82.4%, respectively.

Conclusions: Point-of-care testing of lactate concentrations in the emergency department may be useful to predict massive transfusion requirements in primary postpartum haemorrhage. Combining initial lactate concentrations with the shock index improves the predictive performance for massive transfusion requirements and may contribute to rapid risk stratification of patients with primary postpartum haemorrhage in need of transfusion and further focus on early interventions to control bleeding.

Keywords: blood transfusion; lactic acid; postpartum haemorrhage; shock

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Editor's key points

- Early prediction of transfusion in primary postpartum haemorrhage may contribute to reduced complication rates.
- Lactate concentrations show a moderate predictive value for massive transfusion in postpartum haemorrhage.
- A combination of lactate concentrations and the shock index, a ratio of heart rate with systolic blood pressure, increases the predictive value for massive transfusion from moderate to good.
- This study shows that point-of-care lactate measurements in the emergency setting may facilitate early treatment of haemorrhagic shock after labour.

Postpartum haemorrhage (PPH) is a major cause of maternal morbidity and remains one of the top five causes of maternal mortality in both developed and developing countries.[1] To optimise patient outcomes, prompt and objective recognition of PPH patients with severe haemorrhage (i.e. those who require massive transfusion during the immediate phase of resuscitation, including fluid and blood transfusion) is important.[2] However, previous studies showed that blood loss estimation by obstetricians or emergency physicians was neither precise nor accurate, and such estimates could potentially be misleading if used in clinical decision making.[3–7] Therefore, instead of blood loss estimation, objective parameters are needed to predict the severity of haemorrhage and thus the need of massive transfusion. Recent studies reported that shock index, defined as the ratio of heart rate (HR) to systolic arterial blood pressure (BP), better predicts massive transfusion compared with traditional vital signs in trauma patients.[8–12] To address such issues, we previously confirmed that an increased initial shock index is associated with the need for massive transfusion in patients with primary PPH.[2] Additionally, lactate is a better predictor than systolic BP for blood requirements in trauma patients and is a robust predictor of the requirement for massive transfusion in haemodynamically stable shock patients.[13–15] However, it is unknown whether initial blood lactate concentrations at the time of admission to the emergency department are associated with the need of massive transfusion in patients with primary PPH. Herein, we aimed to determine whether initial lactate concentrations were independently associated with the need for massive transfusion in patients with primary PPH and whether combining initial lactate concentrations with the initial shock index improved the predictive performance for the required massive transfusion.

Methods

Study design and study populations

The study was approved by the institutional review board of our institution and the requirement for written informed consent was waived by the institutional review board because of the retrospective nature of the study.

This retrospective observational study was conducted in the emergency department of a 2800-bed, university-affiliated, tertiary referral centre in South Korea. All patients with primary PPH who were referred to the emergency department and had blood lactate concentration test between January 1, 2004 and December 31, 2015 were included. The study patients were initially identified via a hospital computer database system using a hospital discharge diagnosis of 'PPH'. Primary PPH was defined as haemorrhage requiring transfusion or fluid resuscitation within the first 24 h of delivery. All patients included in this study did not deliver at our hospital but were referred to our emergency department for the evaluation and management of PPH from other hospitals or obstetric clinics after delivery. Patients were excluded if their lactate concentrations were not assessed at presentation in the emergency department or had incomplete data.

When patients with primary PPH visited our emergency department, blood lactate concentration test was performed within minutes of arriving at the emergency department. Blood lactate concentrations were measured in arterial whole blood by using a point-of-care blood gas analyser [GEM Premier 3500 with Iqm (Bedford, MA, USA), which can detect a lactate range of 0.3–15.0 mM L^{-1} and could be assessed within 1 min.

The primary outcome of this study was the requirement of massive transfusion. Massive transfusion was defined as transfusion of 10 units or more of packed red blood cells within the initial 24 h after the onset of PPH.[2] We calculated both the amount of blood that was transfused before arrival at the emergency department and the amount of blood that was transfused after arrival at the emergency department (in the emergency department and in the ICU or general ward) to determine the massive transfusion.

Patients were classified into two groups: the massive transfusion group was defined as patients who required massive transfusion and the non-massive transfusion group was defined as patients who did not. And the baseline, clinical characteristics, and initial laboratory findings were compared between two groups.

Data collection

Baseline and clinical characteristics of all patients, including age, parity, type of delivery, initial mental status, initial vital signs, initial laboratory findings, and amount of blood transfusion, and clinical outcome including embolisation, hysterectomy, length of hospital stay, ICU admission, and in-hospital death, were retrieved from electronic medical records. Initial mental status was assessed by the Alert/Verbal/Painful/Unresponsive scale at the triage stage as soon as the patient arrived at the emergency department. Initial vital signs, including systolic BP, diastolic BP, HR, and body temperature, were also measured at the triage stage. Initial shock index was calculated from initial vital signs. Because there were no transfusion guidelines for patients with primary PPH or guidelines for massive transfusion in other conditions in our institution during the study period, the decision about whether blood transfusion was performed, the type, and amount of blood in patients with primary PPH was made entirely at the discretion of emergency physicians or obstetricians treating the patient. Data collection was performed by two emergency physicians using a pre-drafted data abstraction form. The completion and accuracy of each data abstraction form was verified by one of the two emergency physicians.

Statistical analyses

The data are presented as medians and interquartile ranges for continuous variables and as absolute or relative frequencies for categorical variables. For comparisons of