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Acute transfusion practice during trauma resuscitation: Who, when, where and why?

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ABSTRACT

Background: Early transfusion (ET = within 24 h) has been shown to be required in approximately 5% of trauma patients. Critical care transfusion guidelines control transfusion triggers by evidence based cut-offs. Empirical guidelines influence decision making for ET in trauma.
Aim: to describe the patterns, indications and timing of ET at level 1 trauma centre.
Methods: A 12-month prospective study was performed on all trauma admissions requiring ET. Demographics, mechanism, injury severity (ISS) were collected. Timing, location, volume, the clinician initiating first unit of transfusion, reason for transfusion was recorded, with corresponding blood gas results and physiological parameters. Mortality, ICU admission, length of stay, need for emergent surgery were outcomes.
Results: From 965 trauma admissions 91 (9%) required ET (76% male, median age: 38 (10–88, IQR: 22–59), blunt mechanism: 87%, ISS: 25 (4–66, IQR: 16–34). 43% (39/91) had massive transfusion protocol (MTP) activation. ET was initiated in ED (52%), OR (38%) or ICU (10%). MTP transfusions were started at a median of 0.5 h (0.5–4, IQR: 0.5–1.5), whilst non-MTP transfusions were initiated at a median 3 h (0.5-23, IQR: 2-9). The first unit of ET was initiated by trauma surgeon (35%), anaesthetist (30%), ED (19%), ICU (13%) and general surgeon (3%). Transfusions triggers at the first unit of transfusion were 'expected or ongoing bleeding' 29%, dropping haemoglobin 26%, haemorrhagic shock 24%, hypotension 10%, tachycardia 8%. Median systolic blood pressure was 90 (45–125, IQR: 80–100), heart rate was 100 (53–163, IQR: 80–120), haemoglobin was 96 (50–166, IQR: 85–114) g/l and base excess was −4.2(−22.1 to 2.7, IQR: −7.2 to 2.4) mmol/l at the time of transfusion. Emergency surgery was required in 86% (78/91). ICU admission rate was 69% (63/91). Mortality was 14%. Low volume transfusion (1–2 units) was more likely to lead to overtransfusion (Hb > 110 g/l).
Conclusion: The prospective evaluation of acutely transfused trauma patients showed a distinct pattern of transfusion triggers as the patient passes from ED to the OT and arrives to the ICU. The conventional transfusion trigger (haemoglobin level) is not appropriate in ET as early transfusion triggers are based on vital signs, blood gas results, injury patterns and anticipated major bleeding.

Introduction

Haemorrhagic shock accounts for 30–40% of all trauma deaths[1,2] and remains the leading cause of preventable mortality. Haemorrhage in trauma largely differs from bleeding in the elective setting, as it occurs before fluid replacement. Extrapolating the indication for transfusion from elective patients to trauma scenarios is rather speculative and potentially misleading. Blunt trauma can produce multiple bleeding sites, some of which are not immediately obvious, and can be difficult to control. Blood products (packed red blood cells (PRBC), fresh frozen plasma (FFP), platelets (PLT), cryoprecipitate (CRYO)) play an essential role in the management of these patients, both during resuscitation and definitive treatment. Early transfusion (ET) defined as transfusion required within 24 h of admission, is required in approximately 5% of trauma patients, with 3% having massive transfusion.[3]

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Blood components are expensive and finite resources, and their use has been demonstrated to be an independent risk factor for infectious complications,[4–6] ICU admission, increased ICU length of stay, multiple organ failure,[7] systemic inflammatory response syndrome (SIRS)[8,9] and death. Thus a liberal transfusion policy can introduce further risk to an already compromised patient. Most studies reviewing blood component usage in trauma are retrospective and registry based and fail to identify transfusion triggers.[3,10]

Elective and critical care transfusion guidelines are controlling transfusion triggers by evidence based cut-offs.[11] Available guidelines for trauma patients are designed for haemodynamically stable patients in intensive care after initial resuscitation and haemorrhage control.[12] The ATLS (Advanced Trauma Life Support) system classifies hypovolaemic shock[13] and offers a widely used guide for stratifying the bleeding patient into one of four groups. This guide is however not exact regarding ET and is unreferenced. Moreover, the validity of physiological parameter thresholds used for classifying the bleeding patient have not been verified.[14,15] Only empirical guidelines exist for ET in trauma.

The aim of this study was to describe the ET practice in all admitted trauma patients, highlighting the patterns (timing, place, transfusion initiating doctor and reason for transfusion) and to identify relevant transfusion triggers and to investigate potential overtransfusion in the acute setting. We hypothesized that ET is indicated consistently on objective laboratory parameters.

Materials and methods

The John Hunter Hospital is a University of Newcastle affiliated, Level 1 Trauma Centre, verified by the Royal Australasian College of Surgeons. It is the busiest trauma service in New South Wales, Australia (based on number of patients with ISS $>$ 15). The trauma service has three full time fellowship trained, trauma surgeons and two trauma fellows. An institutional Massive Transfusion Protocol (MTP) was developed in conjunction with the blood bank based on the available evidence and has been in place since 2005. The MTP contains alternating packs of predetermined ratio of blood products aiming to provide a PRBC:FFP ratio of 1:1 (Table 1).

A 12-month prospective observational study was undertaken to identify consecutive trauma admissions, requiring at least one unit of PRBC within 24 h of arrival to the hospital. Late transfers ($>$24 h after injury), or patients who received blood products at the referring hospital were excluded. Patients were identified prospectively on a daily basis by the authors.

Collected variables included, demographics, mechanism of injury, injury severity score (ISS), pre-transfusion haemodynamic parameters (systolic blood pressure (SBP) and heart rate (HR)), base excess (BE) and pre-transfusion haemoglobin concentration (Hb). To examine for possible overtransfusion, Hb on admission to the ICU and at 24 h was also collected. Different Hb levels have been advocated in various patient populations,[16] in our trauma population overtransfusion was defined as an Hb of $\geq$110 g/l at 24 h after admission. Coagulation parameters were checked for evidence of acute traumatic coagulopathy (defined as prothrombin time (PT) $>$ 13 s – indicating the worst value within 24 h).

The timing (from admission to the first unit of PRBC), the location (emergency department (ED), operating room (OR) or intensive care unit (ICU)) and the person initiating the transfusion were also recorded.

The trigger was identified real-time by the trauma fellow (who was often the most senior member of the trauma team present at the arrival of the patient), by requesting and recording the reason for ordering first unit of transfusion from the initiating clinician. This process was as close to the transfusion event as technically possible (from minutes to hours), and the corresponding recorded physiological parameters were collected. The trigger was assigned to the relevant group.

Five transfusion triggers were established by the three trauma surgeons and two trauma fellows prior to the study. The identified triggers included: institutional definition of haemorrhagic shock (SBP $\leq$ 90 mmHg and BE ≤ -6 mmol/l), expected and ongoing bleeding (not meeting haemorrhagic shock criteria, but with either prehospital blood loss and/or expected further blood loss intraoperatively due to the need for multiple procedures), dropping Hb (Hb drop to below 80 g/l or below 100 g/l and 30 g/l drop within 2 h, low SBP (persistent hypotension on serial measurements $<$ 90 mmHg for at least 30 min despite fluid replacement), tachycardia (persistent elevated HR on serial measurements $>$ 110 beats/min for at least 30 min despite fluid replacement). Other triggers identified during the study which could not be classified into the five groups above included low Hb with head injury (Hb below 100 g/l and severe traumatic brain injury), low BE, coagulopathy and hypovolaemia.

The volume of different blood components was collected. The activation of the MTP was recorded. The MTP could be activated by any member of the trauma team. Early blood product use in trauma was compared to overall blood component usage in the area in all specialities.

The outcome measures were the need for emergent surgery (haemostatic procedures and all operations), ICU admission, ICU and overall length of stay (LOS) and mortality (within 24 h and overall). A haemostatic procedure was defined as an operation, with a primary goal of bleeding control (trauma laparotomy, angiography, emergent pelvic fixation, other haemorrhage control procedures).

The ethics committee of the Hunter New England Area Health Service approved this research as a minimal risk project.

The ET group was compared to the trauma admissions who did not have a transfusion within the first 24 h.

Data are presented as median (range and interquartile range (IQR)) or percentages. Statistical analysis was performed using Student's *t*-test for parametric continuous variables and Chi-squared test for categorical variables. Statistically significant difference was determined at $p < 0.05$.

Table 1
Sequence of blood products included in consecutive MTP packs.

Massive transfusion pack 1	4 units of Packed Red Blood Cells 4 units of Fresh Frozen Plasma 10 units of Cryoprecipitate
Massive transfusion pack 2	4 units of Packed Red Blood Cells 4 units of Fresh Frozen Plasma 1 unit of Pooled Platelets

MTP: massive transfusion protocol.

Results

During the 12-month study period, 91 patients required at least one unit of PRBC during the first 24 h after admission (median 4(1–34, IQR: 2–8). Of these patients, 43% (39/91) had an activated MTP.

The univariate comparisons demographics, injury severity and basic outcome measures between patients receiving ET and those who did not are depicted in Table 2. Amongst all major trauma admissions 9% (91/965) received ET.

Emergent surgery ($<$24 h) was necessary in 86% (78/91) of patients. Forty-seven per cent (37/78) of the patients had surgery primarily for bleeding control, 41 haemostatic procedures in all. Sixty-six per cent (27/41) of the haemostatic procedures were performed within 2 h of arrival. Haemostatic procedures are