Haemostatic resuscitation in practice: a descriptive analysis of blood products administered during Operation HERRICK, Afghanistan

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ABSTRACT

Introduction Life-threatening haemorrhage is the leading cause of potentially survivable injury in battlefield casualties. During Operation HERRICK (Afghanistan), mortality rates improved year on year due to a number of advances in trauma care, including haemostatic resuscitation. Blood transfusion practice has not previously been reported in detail during this period.

Methods A retrospective analysis of blood transfusion at the UK role 3 medical treatment facility (MTF) at Camp Bastion between March 2006 and September 2014 was performed. Data were extracted from two sources: the UK Joint Theatre Trauma Registry (JTTR) and the newly established Deployed Blood Transfusion Database (DBTD).

Results 3840 casualties were transfused 72 138 units of blood and blood products. 2709 adult casualties (71%) were fully linked with JTTR data and were transfused a total of 59 842 units. Casualties received between 1 unit and 264 units of blood product with a median of 13 units per patient. Casualties wounded by explosion required almost twice the volume of blood product transfusion as those wounded by small arms fire or in a motor vehicle collision (18 units, 9 units, and 10 units, respectively). More than half of blood products were transfused within the first 2 hours following arrival at the MTF. There was a trend towards balanced resuscitation with more equal ratios of blood and blood products being used over time.

Conclusion This study has defined the epidemiology of blood transfusion practice during Operation HERRICK. The DBTD is the largest combined trauma database of its kind. It will ensure that lessons learnt during this period are defined and not forgotten; it should also allow further research questions to be answered in this important area of resuscitation practice.

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Life-threatening haemorrhage is the leading cause of potentially survivable injury in battlefield casualties. Haemostatic resuscitation forms the cornerstone of the treatment, yet blood transfusion practice has not previously been reported in detail in these casualties.

WHAT THIS STUDY ADDS

- ⇒ This study has defined the epidemiology of blood transfusion practice during Operation HERRICK.
- ⇒ It found that 2709 adult casualties received 59 842 units of blood and blood products, a median of 13 units per patient.
- ⇒ Fifty per cent of the blood transfused was received in the first 2 hours following arrival at a medical treatment facility, and casualties wounded by explosion received almost twice the volume of blood transfusion as those wounded by small arms fire or motor vehicle collision.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ This study has formed the largest combined trauma database of its kind. It ensures the lessons learnt during this period are defined and not forgotten and allows for further research questions to be answered in this important area of resuscitation practice.

INTRODUCTION

Haemostatic resuscitation is the cornerstone of management of patients with life-threatening haemorrhage. The timely and balanced transfusion of blood products has been cited as one of the main reasons for improvement in survival during the conflict in Afghanistan.[1] The evolution in transfusion practice involved the increased use of blood products closer to the point of wounding, high plasma to red cell ratios, higher and earlier use of platelets (PLTS) and the use of whole blood.[2–4]

Bespoke and individualised blood transfusion should minimise wastage and ensure patients only receive what they need. There have been many attempts to develop scoring systems to predict transfusion requirements, and in particular the need for massive transfusion in individual casualties.[5–7] Algorithms have been developed to determine what clinical pathway a particular patient might follow, but there is little evidence to suggest they are superior to the gestalt of senior clinical decision makers.

On contemporary military operations and in logistically constrained environments, blood products are often limited and difficult to resupply. It is therefore important to plan appropriately for the expected number of casualties that might present to a medical treatment facility (MTF), and the blood products they require.[5]

UK legislation requires full traceability of all blood and blood components from donor to patient and vice versa, or final fate if not transfused; it also stipulates that evidence of the fate of every blood component be retained and accessible for 30 years.[8]

The record includes the details of the patient and the blood product along with the time the unit was transfused.

By using data available from deployed blood transfusion records, we aimed to match individual patient transfusion records to the UK Joint Theatre Trauma Registry (JTTR) and, in doing so, describe the epidemiology of transfusion practice at the MTF in Camp Bastion, Afghanistan, during Operation HERRICK.

METHODS

Study design

This is a retrospective analysis of blood transfusion in a single deployed MTF between March 2006 and September 2014, during which time a UK MTF was deployed in Camp Bastion, Afghanistan.

Source data

This paper analyses information from two sources: the UK JTTR and a new resource, the Deployed Blood Transfusion Database (DBTD). Data on all seriously injured patients (including UK military, coalition military and local nationals) treated by UK Defence Medical Services in deployed hospitals are collected by the in-country clinical team and recorded in the JTTR. Data were collected from clinical notes, trauma charts and, in the case of death, postmortem findings, postmortem reports were only available for UK Military personnel. Returns are electronic (where deployed information technology systems allow), with hard copy accompanying UK military patients evacuated to the UK for definitive care. The JTTR was formerly maintained by the Academic Department of Military Emergency Medicine at the Royal Centre for Defence Medicine, Birmingham, and latterly by Defence Statistics Health.

Blood products used in Afghanistan were issued along with an FMed 962 (figure 1)—known colloquially as a 'pink slip'—which documented the product type, date and time of usage and the hospital number of the recipient. These FMed 962 forms, which were retained for audit purposes, were retrieved, and the information was transferred from paper to an electronic record

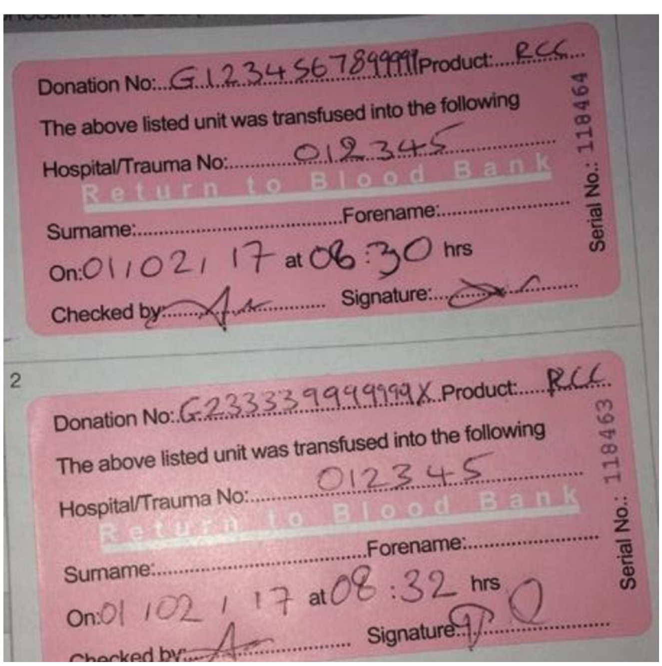

Figure 1 FMed 962, known colloquially as a 'pink slip'.

using an external data management company (Fletcher Data Services). Only blood products that were transfused at Camp Bastion or by the medical emergency response team (MERT) were included in this analysis. No data from blood product use at role 2 facilities or other settings were available for analysis.

Data merging

The hospital number was the only patient identifier included on the FMed 962. This number was linked to the hospital number of casualties captured in the JTTR. Where any hospital numbers could not be linked to a record in JTTR, further avenues of identification were pursued. Once the blood product usage data were linked to the JTTR via the hospital number, both the link and the timings were validated. Each linked record was manually validated, ensuring that the date of injury and the date of product usage could be corroborated. If it could not be corroborated, the records were unlinked. The DBTD contains details of the blood products received by casualties at the MTF between June 2006 and September 2014. A total of 111 502 individual records were contained within the dataset. Of these, 39 364 were removed as they designated a product as either returned to stock or disposed of without being transfused.

The remaining 72 138 records, including where the type of blood product transfused was unknown, were associated with approximately 3840 separate casualties (including paediatric casualties) as denoted by the individual hospital numbers. From this, 79% (3023 of 3840) were linked to a record in JTTR. There could be a number of potential reasons why the remaining casualties could not be linked to a JTTR record: blood products were required for non-trauma-related reasons; the casualty did not reach the threshold (either due to severity or treatment pathway) for inclusion on JTTR; and transfer of a patient to another medical facility and transcription error.

Injury burden was quantified by the injury severity score (ISS), stratified into mild/moderate (ISS 1–15), severe (ISS 16–25) and very severe (ISS 26–75); by maximum Abbreviated Injury Score (AIS); and by body region. The decision was made to use ISS as the determinant since this is widely used and was assumed to be a better indicator of the injury spread over multiple body regions (and overall spread of injury) as opposed to New Injury Severity Score, which may originate a combined score from one body region.

RESULTS

During the study period, 3840 adult patients were transfused with 72 138 units of blood products. Of these, 2709 adult patients (71%) could be linked to entries in the JTTR and were transfused a total of 59 842 units. This accounted for 83% of the total units transfused (including 92% of whole blood, 88% of cryoprecipitate (CRYO) and 86% of platelet units). Casualties received between 1 unit and 264 units of blood product with a median of 13 units. Ninety per cent (2445 of 2709) received less than 53 units of blood product. Two per cent (53 of 2709) of casualties received greater than 100 units of blood product. Of these, 77% (41 of 53) survived and 23% (12 of 53) died. Of the linked adult patients, 539 were UK military patients receiving 15 442 units; 1020 were coalition military patients receiving 23 816 units; and there were 1150 'others' (including local security forces, contractors and civilians) who received 20 584 units.

Injury Severity Score

Of patients undergoing transfusion, 52.7% had an ISS of <15. Patients with an ISS of 1–15 were transfused with a median of 8

Table 1 Median number of units of blood and blood products transfused by ISS band during Operation HERRICK, from 2006 to 2014

ISS band	N	RBC	FFP	PLTS	CRYO	WB	Total
1–15	1421	5	5	2	1	2.5	8
16–25	852	10	9	3	1	3	20
26–75	425	12	11	3	1	3	23

CRYO, cryoprecipitate; FFP, fresh frozen plasma; ISS, Injury Severity Score; PLTS, platelets; RBC, red blood cells; WB, whole blood.

units of blood product; those with an ISS of 16–25 were transfused with a median of 20 units and the most severely injured casualties with ISS of >25 were transfused with a median of 23 units. The most severely injured cohort accounted for 56% (87 of 156) of whole blood use but comprised 16% of patients (table 1).

The breakdown of transfusion by type and year are shown in figure 2. In 2009, whole blood started being used; the busiest year was 2011, when there were 586 casualties and 16 261 units received. This was also the year in which most whole blood was given (76 units). The ratio of packed red blood cells to plasma to PLTS to CRYO (red blood cells (RBC):fresh frozen plasma (FFP):PLTS:CRYO) transfused also moved towards more equal ratios and balanced transfusion over time (figure 2), although the ratio of RBC:FFP:PLTS:CRYO never reached 1:1:1:1.

Prehospital blood

A total of 52 casualties received blood products on the MERT with 111 units transfused. One casualty received 8 units; 12 received 4 units; 4 received 3 units; 8 received 2 units; and 27 received a single unit. Those who received blood products on the MERT received a higher number of units after reaching the MTF.

Mechanism of injury

Those wounded by explosion accounted for 58.0% (1571 of 2709) of patients requiring a blood transfusion. Casualties wounded by explosive device required almost twice the amount of blood product transfusion as those wounded by small arms fire or in a motor vehicle collision (18 units, 9 units, and 10 units, respectively) (figure 3). As the number of injured body regions increased, so did the amount of blood transfused (to survivors), rising from a median of 6 units with one body region injured to 28 units in those with seven body regions injured (figure 4).

Timings

The time from point of arrival at Camp Bastion to blood transfusion was known for 93% (55 761 of 59 842) of JTTR linked blood usage records. Of the blood products, 51.7% (28 806 of 55 761) were transfused within the first 2 hours of arrival at Camp Bastion. Patients with a maximum AIS of 3 and 4 were responsible for 80.1% (47 920 of 59 842) of blood products transfused, of which they received 30.2% (14 452 of 47 920) within the first hour.

DISCUSSION

This study represents the largest retrospective analysis of blood use at any deployed MTF during the military campaign in Afghanistan. The results correlate well with previously published data: those patients with more severe injuries required a larger volume of blood transfusion[9 10]; those wounded by explosion required almost twice as much blood as any other mechanism of injury[11]; and those injured in more than one body region

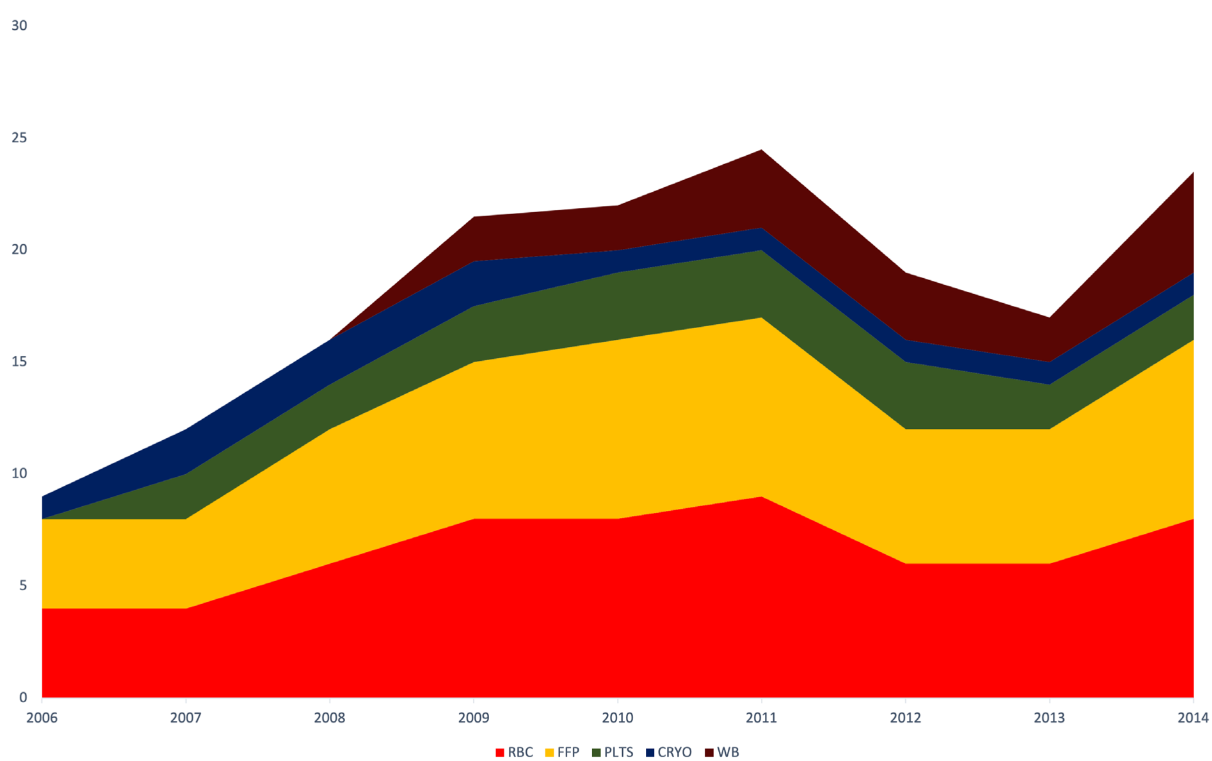

Figure 2 Median units of blood and blood products transfused during Operation HERRICK from 2006 to 2014. CRYO, cryoprecipitate; FFP, fresh frozen plasma; PLTS, platelets; RBC, red blood cells; WB, whole blood.

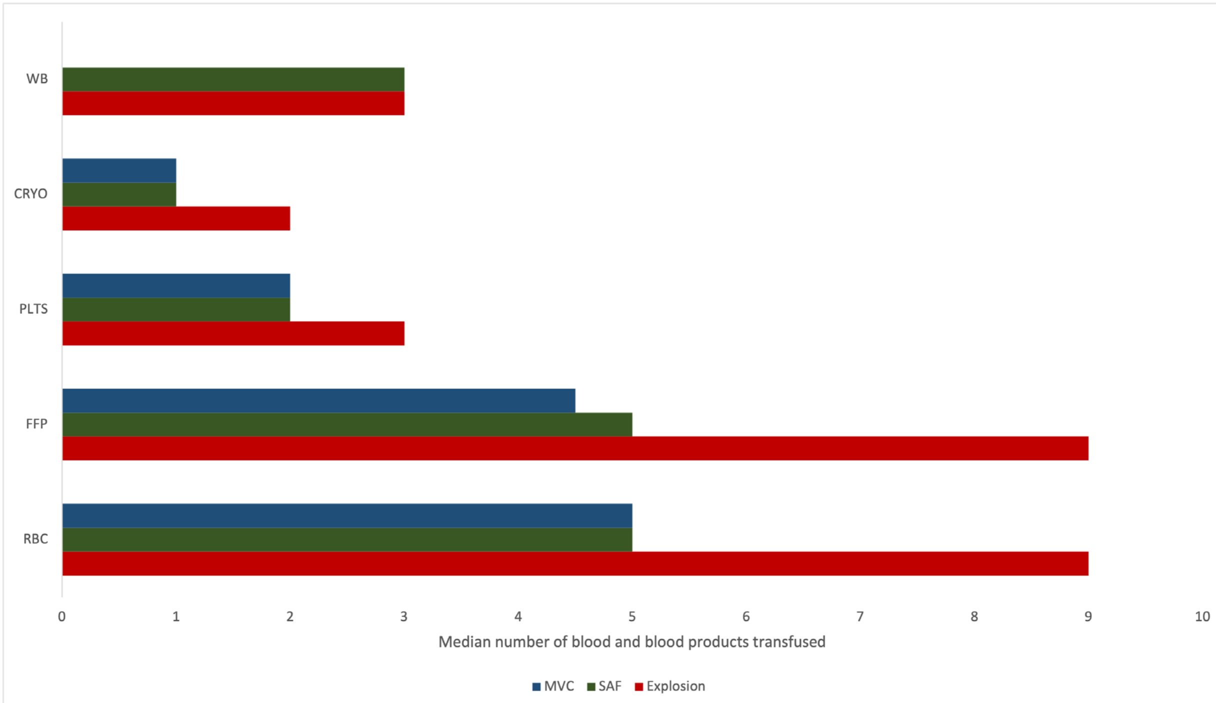

Figure 3 Median blood and blood product transfused to casualties with different mechanisms of injury including explosion, SAF and MVC. CRYO, cryoprecipitate; FFP, fresh frozen plasma; MVC, motor vehicle collision; PLTS, platelets; RBC, red blood cells; SAF, small arms fire; WB, whole blood.

required larger transfusions.[11 12] This study also shows definitively that most blood products were transfused during the initial 2 hours after arrival at the MTF.

The number of units of blood products administered reached a peak of over 16 000 units per year in 2011, and the median amount of blood products used for each casualty also peaked at 17 units per patient in the same year. This coincides with the time at which the lowest prehospital and in-hospital case fatality rates (CFRs) were seen for UK casualties with an overall CFR of 13%.[13] The most frequently used component was packed RBCs, followed by FFP, PLTS and CRYO. Whole blood was used from 2009 onwards. Over time, transfusion practice developed, and the ratios of these components changed with a move towards equal ratios of RBC and FFP. Platelet transfusions increased to a peak of 1226 units in 2011, with the ratio of PLTS given to other blood products also changing in this time with an increase from

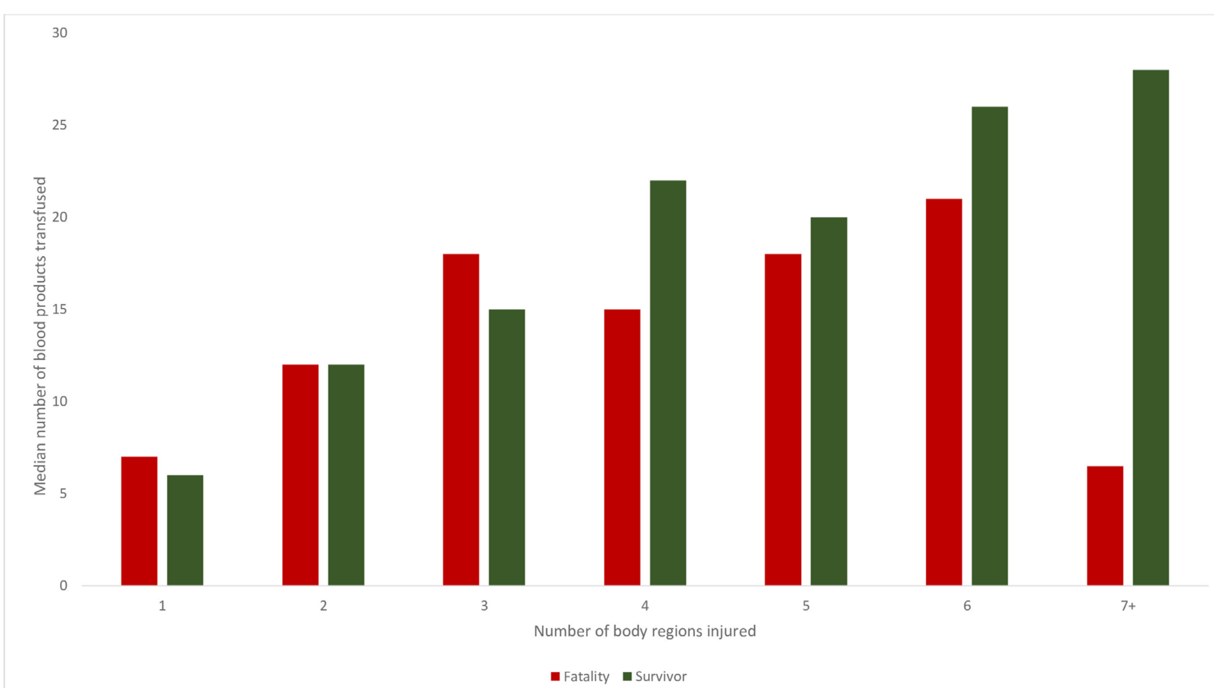

Figure 4 Median number of blood products transfused by number of body regions injured during Operation HERRICK, 2006–2014. CRYO, cryoprecipitate; FFP, fresh frozen plasma; MVC, motor vehicle collision; PLTS, platelets; RBC, red blood cells; SAF, small arms fire; WB, whole blood.

1.0:0.2 to 1.0:0.8, coinciding with the introduction of viscoelastic haemostatic assays. In early 2008, an operational platelet apheresis capability was introduced,[14] and in January 2009, rotational thromboelastometry was installed in the operating theatres at Camp Bastion, allowing for more targeted transfusion practice.[15]

This study has demonstrated that over 50% of the total units transfused were given within the first 2 hours of arrival at the MTF. Once surgical haemostasis was achieved, a more controlled targeted individualised transfusion was possible due to the coagulopathy testing available, potentially reducing the need for further protocolised blood transfusion. It is also demonstrated that more blood products were used in resuscitation with more body regions injured. Understanding blood product usage requirements, as well as planning for resupply and future conflicts, is important not only for clinicians but also for logisticians. This paper sets the foundations and first step for progressing that understanding.

Limitations

This study and indeed the new database have limitations. This is a retrospective analysis, reliant on accurate data entry into the JTTR, and handwritten timings on the pink slips. Not all blood products transfused could be linked to a patient in the JTTR; overall, 83% (59 842 of 72 138) of all blood products transfused at Camp Bastion could be linked to a JTTR entry. Further scrutiny of MERT patient report forms may allow for a more detailed understanding and accurate description of the patient cohort.

CONCLUSION

This study has described the epidemiology of blood transfusion during Operation HERRICK and described transfusion practice during this time. The DBTD is the largest combined trauma database of its kind, and it will allow further research questions to be answered in this important area of resuscitation practice. Further research may seek to determine transfusion profiles for specific injury types to guide clinicians in early transfusion practice.

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