National Comparative Audit
of Blood Transfusion

NHS
Blood and Transplant

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2018 Audit of the Management of Major Haemorrhage

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We wish to thank all those who have participated in the 2018 audit of the management of major haemorrhage. This audit would clearly not be possible without their support. We are equally grateful to many colleagues for their valuable and constructive comments.

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Executive Summary

Key findings

- 166 hospitals/trusts enrolled in the organisational audit and 826 cases were analysed where a major haemorrhage episode was reported. The main causes of major haemorrhage were surgery (28%), followed by obstetrics (21%), gastro-intestinal bleeding (20%), and trauma (17%).
- 99% (N = 165) of hospitals had major haemorrhage protocols in place of which 87% audited these protocols, with 31% auditing every case, 17% auditing on a monthly basis and 12% annually.
- Major Haemorrhage Protocols were activated in 81% of major haemorrhage cases but were stood down in only 49% of cases.
- 91% of major haemorrhage protocols contained tranexamic acid. Overall, tranexamic acid was used in 62% of major haemorrhage cases; high usage was reported in trauma cases (83%) and low usage in surgery (42%) particularly cardiac surgery (18%).
- 99% (N=164) of hospitals had transfusion laboratories open 24 hours a day, 7 days a week. Approximately. 80% of hospitals reported only one biomedical scientist working in the laboratory outside working hours or on weekends.
- Access to cell salvage support was reported in 139 (84%) hospitals, though in the clinical audit, cell salvage support was used in only 12% of cases.
- Blood samples for Group and Screen, Full Blood Count and clotting tests with fibrinogen were taken in 89%, 91% and 55% of cases, respectively.
- Of the 432 cases who were non-blood group O, around 41% received group specific red cells only, 28% received only group O red cells and 19% received a combination of group O and group specific red cells.
- 36 (54%) males and 22 (85%) females over the age of 50 were transfused with group O RhD negative RBCs where group O RhD positive could have been given.
- It was only possible to calculate the FFP:RBC ratio for 98 trauma cases, of which 34% received a 1:1 ratio (N=33), 29% received a 1:2 ratio (N=28), and others received either less than 1:1 ratio or more than 1:2 ratio.
- Wastage levels for blood components were 16% for fresh frozen plasma, 9% for cryoprecipitate, 5% for platelets and 3% for red cells.

Recommendations

Organisational

- All hospitals should ensure that tranexamic acid is part of MHP
- All hospitals should perform regular annual drills of their MHP systems to ensure that all mechanisms for contacting relevant members involved with delivering blood component to patients are co-ordinated well and that all clinical teams involved with MHP are trained to implement these protocols effectively
- Clinical and laboratory teams should ensure that MHPs are audited regularly to monitor and minimise blood wastage
- Pre-thawed FFP can be considered by major trauma centres and hospitals with high FFP usage in order to reduce wastage.

Clinical

- Clinical teams must be trained to recognize major blood loss early, and to know when to activate and stand down the major haemorrhage protocol
- Tranexamic Acid (unless contraindicated) should be given to patients with major bleeding
- Intra-operative cell salvage should be used in relevant high blood loss procedures
- Clinical staff should ensure that Group & Save samples are taken during major haemorrhage to allow for transfusion of group specific RBCs as soon as possible, so group O red cells are reserved for extreme emergency
- Clotting screens including fibrinogen should be taken during major haemorrhage to allow for guided transfusion
- For management of major bleeding where patient's blood group is unknown, Group O RhD negative red cells should be used for females of childbearing age (<50 years old) and group O RhD positive red cells for males and women >50yrs old
- Trauma patients should receive a 1-1 ratio of RBC to FFP continuously for management of bleeding

Background

Major haemorrhage can occur in different clinical settings, such as surgery, obstetrics, trauma and gastroenterology, to name a few. There is no universally accepted definition for major or massive haemorrhage, so several arbitrary definitions are used such as loss of one blood volume within a 24 hour period, 50% blood volume loss within 3 hours, or transfusion of 10 or more units of red blood cells (RBC) in 24 hours.[1]

These definitions are difficult to apply in the acute situation. In order to identify bleeding patients early, more dynamic definitions are being introduced that take into consideration the amount of blood loss over a shorter timeframe, clinical assessment (e.g. presence of active bleeding, systolic blood pressure, or heart rate), or the amount of RBC transfused in the first few hours of bleeding.[2-4]
It is important to recognise that these definitions have limitations, and their usefulness in assisting with the management of bleeding have not been validated through large studies.

Transfusion management of major bleeding aims to achieve: 1) tissue oxygenation through RBC; correction of coagulation abnormalities through fresh frozen plasma (FFP) and cryoprecipitate; and 3) optimisation of platelet count (or thrombocytopenia) through platelet transfusion. Historically, transfusion management of major bleeding was guided by the results of full blood count (FBC) and clotting tests. However, the delay in obtaining blood results (~60 minutes), coupled with the need to correct abnormal coagulation (or coagulopathy) early, have resulted in the introduction of major haemorrhage protocols (MHP), which allow for the rapid transfusion of different blood components, before any results become available.

All medical, nursing, laboratory and support staff must know where to find the MHP in relevant areas and be familiar with its contents.[1] Currently, it remains unknown if major haemorrhage is managed appropriately in the UK, as there has been no previous audit to assess this, and to our knowledge no other nation has evaluated this.

This audit provides an opportunity to report on the organizational arrangements for supporting MHP in hospitals, and we also report on the clinical and laboratory response in a sample of major bleeding cases to suggest areas for improvement.

Aims of the audit

1. Determine transfusion laboratory infrastructure for supporting and delivering the major haemorrhage protocol in Trusts/Hospitals

2. Evaluate different standards for management of major haemorrhage cases against existing national guidelines and understand how blood components are utilised in this situation with regards to issuing, usage and wastage.

AUDIT STANDARDS

Several UK guidelines have published standards on transfusion and haemostatic management of patients who develop major bleeding.[1, 5-7] Amongst these guidelines some agreed standards for managing major haemorrhage include:

ORGANISATIONAL STANDARDS

Standard Statement 1:

Hospitals should have specific MHPs for adults and children, to enable a clear process in the management of a major haemorrhage and to ensure the rapid delivery of all blood components. *Assessed in this audit through:*

- Availability of MHP
- Availability of MHP activation form in the laboratory
- MHP delivered in packs
- Availability of remote blood fridges, pre-thawed FFP, flying squad blood
- Number of Biomedical Scientist staffed in the labs
- Distances from clinical areas to the labs.

Standard Statement 2:

Multidisciplinary audit and case reviews should be undertaken to allow for clear communications between all relevant team members and to reflect on the systems in place to assess the effectiveness of the management of major haemorrhages. *Assessed in this audit by the frequency of MHP audits and whether cases were discussed in multidisciplinary meetings*

Standard Statement 3:

Access to 24-hour cell salvage support should be available particularly in cardiac, obstetric, trauma and vascular centres. *Assessed in cell salvage support in organisational audit*

Standard Statement 4:

Clinical staff involved in frontline care must be trained to recognize major blood loss early and know when to activate/trigger the local MHP and take prompt and appropriate action.

CLINICAL STANDARDS

Standard Statement 1:

Blood samples should be obtained for FBC, group and save (G&S) and clotting tests (prothrombin time [PT], activated partial thromboplastin time [APTT] including fibrinogen), and serial haemostatic tests should be taken regularly to guide the appropriate use of haemostatic blood components.

Standard Statement 2:

The use of tranexamic acid should be considered in non-traumatic major bleeding e.g. obstetrics or surgery where there is expected blood loss of more than 500 mls. Tranexamic acid should be given as soon as possible, and within 3 hours in trauma patients with active or suspected active bleeding (1 gram bolus followed by 1 gram infusion). *Assessed in the organisational audit where tranexamic acid was included in the MHP as well as the use of it in the clinical audit.*

Standard Statement 3:

Emergency Group O RBC should be administered for life-threatening bleeding and that patients are moved to group-specific RBCs as soon as possible. Group O RhD negative RBCs should be used for females of child-bearing age (<50 years old) and group O RhD positive RBCs should be considered for male patients.

Standard Statement 4:

In trauma settings, RBCs and FFP should be given in a 1:1 ratio; while for other non-trauma major haemorrhage a ratio of at least 2:1 of RBCs to FFP should be given. *Assessed in this audit only for trauma cases.*

Scope of the audit

The scope of the audit included:

- Adult patients aged 16 years and older
- All hospitals in the UK (independent ones included)
- All types of major haemorrhage

Methodology

All NHS and independent hospitals in the UK were invited to participate in the audit via their respective Blood Services.

Definition of major haemorrhage

There is no agreed definition of what constitutes a major haemorrhage. Most countries use definitions based on blood volume loss or the number of RBCs transfused. Using a definition based on blood volume loss is subjective and it is notoriously difficult to collect. Hence, in the pilot stage of the audit the number of RBCs transfused – defined as transfusion of 5 or more RBCs within 4 hours and/or 10 or more RBCs within 24 hrs - was deemed an appropriate definition to use for case identification. However, the users' feedback at this stage was that hospitals wanted to use their own definition which allows them to trigger the MHP at their site. Hence, during the audit period hospitals were asked to report major haemorrhage cases based on their own definitions.

Data collection

Each hospital was asked to report up to 10 adult cases who were treated for major haemorrhages for any medical or surgical reason in October 2018. In exceptional cases, some sites who experienced few major haemorrhages were able to submit cases that were not seen in the month of October. Sites also provided organisational data either during or after the patient data collection phase. Both organisational and patient questionnaires are shown in **Appendix A & B**.

Data analysis

Data provided by hospitals in each of the questionnaires were analysed separately using descriptive statistics to summarize the data. Several factors, particularly date/time fields and laboratory results, were cleaned within this analysis due to data inconsistences. Any blood components with a high number of units that were considered outliers due to extreme values were excluded from such analyses. Any questions that involved free text were categorized by a clinician into groups.

ORGANISATIONAL RESULTS

A total of 166 hospitals/trusts enrolled in the audit and provided organisational data, accounting for 94% (156/166) of all UK Trusts. Of these, 8 hospitals did not report any major haemorrhage cases during the audit period and in addition, 3 hospitals provided patient data without providing any organisational data. This meant that overall, 161 hospitals were enrolled in the clinical audit.

Organisational Standard 1:

Hospitals should have specific MHPs for adults and children, to enable a clear process in the management of a major haemorrhage and to ensure the rapid delivery of all blood components.

Table 1 describes the Major Haemorrhage Protocols and the accessibility of blood components as well as data on laboratory support in delivering MHP, opening hours and the number of biomedical scientists (BMS) available during weekdays and weekends including distances from clinical areas to the laboratories.

MHP were available in 99% (N=165) of hospitals, and of these 52% had more than one MHP (N=86). It was most common for hospitals that had an MHP to have a protocol for major bleeding (N=136) and obstetrics (N=71). MHP was delivered in packs in 69% (N=113) of hospitals. Most hospitals delivered two types of packs. Information on MHP pack content was provided as a free text field and it was not possible to group all the free text into categories, however there were some similarities in pack content such as; for the 1st pack, 56 (50%) had 4 RBC and 4 FFP, 18 (15%) had 6 RBC and 4 FFP, and 9 (8%) did not have any FFP. Data completion for pack 2 content was very poor and for those who reported this, cryoprecipitate and platelets were added to RBC and FFP in 10 hospitals and platelets only in 2 hospitals.

In 164 (99%) hospitals transfusion laboratories were open 24 hours a day, 7 days a week. During working hours (as defined by each hospital), 59 (36%) had 2 BMS working in the laboratory, and 56 (34%) had 4 or more BMS. Outside working hours and weekends 83% and 79% had only one BMS in the laboratory, respectively. The shortest distance from the lab to the clinical area was reported as 10 seconds and the longest as 40 minutes.

Table 1. Major Haemorrhage Protocols and the accessibility of blood components

	All sites = 166	
	N	**%**
Major Haemorrhage Protocol (MHP)	165	99.4
More than one MHP (N=165)	*86*	52.1
Types of MHP (N=165)		
Major bleeding	*136*	82.4
Obstetrics	71	43.0
Trauma	21	12.7
Cardiothoracic	8	4.8
Surgical	6	4.2
Medical	7	3.6
Other	29	17.6
MHP packs (N=165)	113	68.5
MHP activation form in laboratory (N=165)	149	90.3
Tranexamic acid in MHP protocol (N=165)	*150*	*90.9*
Audit MHPs (N=165)	*144*	*87.3*
Flying squad blood	125	75.3
Cell salvage support	139	83.7
Remote blood fridges	112	67.5
Pre-thawed Fresh Frozen Plasma (FFP)	26	15.7
Opening Hours for the laboratory		
24/7	164	98.8
Not 24/7	0	0
Not stated	2	1.2
Biomedical Scientist (BMS) within working hours[§]		
1	13	7.8
2	*59*	*35.5*
3	35	21.1
4 or more	*56*	*33.7*
Not stated	*3*	*1.8*
BMS outside working hours[§]		
1	*137*	*82.5*
2	*23*	*13.9*
3 or more	*2*	*1.2*
Not stated	*4*	*2.4*
BMS on weekends		
1	*131*	*78.9*
2	*28*	*16.9*
3 or more	*3*	*1.8*
Not stated	*4*	*2.4*
Longest distance between lab and clinical area		
<5 minutes	30	18.1
5 to 9 minutes	65	*39.2*
10 to 14 minutes	*48*	*28.9*
≥15 minutes	22	13.3
Not stated	*1*	*0.6*

Shortest distance between lab and clinical area		
<2 minutes	70	*42.2*
2 to 4 minutes	*67*	*40.4*
≥5 minutes	28	16.9
Not stated	1	0.6

Other types of MHP were reported as free text, 11 (6.7%) reported a paediatric protocol § Working hours defined by hospital sites

Organisational standard 2:

Multidisciplinary audit and case reviews should be undertaken to allow for clear communications between all relevant team members and to reflect on the systems in place to assess the effectiveness of the management of major hemorrhages

Major haemorrhage cases were discussed in multidisciplinary meetings; 14% (N=23) all cases, 59% (N=98) some cases, 27% (N=44) don't discuss cases and 1% (N=1) not stated. MHP audits were performed in 87% (N=144) of the hospitals that had an MHP protocol as shown in **Table 1**, and of these, 31% audited every case (N=44), 17% audited on a monthly basis (N=24), 12% (N=17) annually, 10% (N=14) quarterly, 8% (N=12) biannually, 3% (N=4) weekly, 20% (N=27) reported other and 1% (N=2) did not state the frequency of their audits.

Organisational Standard 3:

Access to 24-hour cell salvage support should be available particularly in cardiac, obstetric, trauma and vascular centres

Access to cell salvage support was reported in 139 (84%) hospitals as shown in **Table 1**. 147 (89%) had an obstetric unit and 63 (38%) hospitals were specialised centres (i.e. cardiac, trauma) of which 124 (84%) and 57 (90%) had access to 24-hour cell salvage support, respectively.

CLINICAL CASE RESULTS

Demographics

A total of 884 cases were reported as major hemorrhage episodes during the audit period from 161 hospitals. Of these, only 826 cases were included in the final analysis because the number of RBC units transfused, or the time of transfusion were not reported for 58 (7%) patients.

A breakdown of demographics, location and causes of major haemorrhage are shown in **Table 2**. The overall median age was 54 years (interquartile range [IQR] 37 to 73) years, with 423 (51%) being male. Accident and emergency departments and theatres were the most common places where bleeding was treated, and of the 826 cases, 522 (63%) were new admissions and 293 (36%) were established inpatients (inpatients for more than 24 hours at the time of the bleed).

The majority of major haemorrhage cases were caused by surgery (28%, N=233), obstetrics (21%, N=177), gastro-intestinal bleeding (20%, N=165) and trauma (17%, N=136). Amongst the surgical group, vascular surgery reported the highest number of cases (N=77), followed by gastrointestinal surgery (N=59), cardiac surgery (N=50) and other surgeries (N=47), respectively.

Table 2. Demographics, location and causes of major haemorrhage cases

	National	
Total	**N = 826**	**100%**
Median age (years; IQR)	54	(35 – 73)
	N	**%**
Gender		
Male	423	51.2
Female	400	48.4
Not stated	3	0.4
Admission status[§]		
New admission	522	63.2
Established inpatient	293	35.5
Not stated	11	1.3
Location		
A&E	298	36.1
Theatre	191	23.1
Obstetric or Gynae ward	139	16.8
Medical ward	58	7.0
Intensive Care Unit	47	5.7
Surgical ward	30	3.6
Acute medical admissions unit	23	2.8
High Dependency Unit	8	1.0
Haematology/Oncology/Day ward	3	0.4
Recovery	3	0.4

Other	26	3.2
Causes		
All Surgery	233	28.2
Vascular surgery	*77*	*9.3*
Gastrointestinal surgery	*59*	*7.1*
Cardiac surgery	*50*	*6.1*
Other surgery	*47*	*5.7*
Obstetrics[Ā]	177	21.4
Gastro-Intestinal Bleeding	165	20.0
Trauma	136	16.5
Gynaecology	43	5.2
Medical	37	4.5
Other	35	4.2
Anticoagulation at the time of bleeding	**129**	**15.6**
Oral	98	76.0
Direct oral anticoagulants	77	59.7
Warfarin	21	16.3
Parenteral (low molecular heparins)	31	24.0
PCC[§] administration for warfarin (N=21)	*13*	*76.5*
FFP[Ā] transfusion for warfarin (N=21)	*14*	*66.7*

[§] A new admission defined as <24 hours in hospital, and inpatient as >24 hours;
[Ā] includes ante-natal and post-partum
[§] PCC: prothrombin complex concentrate; [Ā]FFP: fresh frozen plasma

A total of 129 (16%) patients were on anticoagulants of which 98 (76%) patients were taking oral agents (warfarin, sinthrome, dabigatran, apixaban, edoxaban and rivaroxaban) and 31 (24%) were on parenteral agents (unfractionated heparin, low molecular weight heparin and fondaparinux) at the time of the bleeding.

<u>Organisational Standard 4:</u>
Clinical staff involved in frontline care must be trained to recognize major blood loss early, know when to activate/trigger the local MHP and take prompt and appropriate action

MHP was activated in 667 (81%) cases, and of these 64% activated MHP before the first unit of RBC transfusion (N=429), and in 54% of cases it was activated on a weekend or evening (N=362). MHP activation was stood down in only 49% of cases (N=327). The details of the cases that activated MHP are described in **Table 3** overleaf. Trauma (96%) and obstetrics (92%) proportionately activated MHP the most followed by Gastro-Intestinal (GI) and gynaecology (each 84%), medical (81%) and surgery 62%.

Table 3. Major haemorrhage protocol

	National (N=826)	
	N	**%**
Was this a predicted Major Haemorrhage		
Yes	120	14.5
No	644	78.0
Don't know	56	6.8
Not stated	6	0.7
Major haemorrhage protocol (MHP) activated		
Yes	667	80.8
No	158	19.1
Not stated	1	0.1
MHP activated before the first unit of RBC (N=667)		
Yes	429	64.3
No	79	11.8
Not stated	159	23.8
MHP activated (N=667)		
Weekdays[§]	189	28.3
Weekends/evenings[Ѧ]	362	54.3
Not stated	116	17.4
MHP stood down (N=667)		
Yes	327	49.0
No	276	41.4
Don't know	53	7.9
Not stated	11	1.7

[§] Weekdays defined as Monday to Friday from 9 am to 6 pm, excluding public holidays.

[Ѧ] Weekends/evenings defined as Saturday and Sunday, public holidays and overnight from 6:01 pm to 8:59 am

CLINICAL STANDARDS

Clinical standard 1:

Blood samples should be obtained for FBC, group and save (G&S) and clotting tests (prothrombin time [PT], activated partial thromboplastin time [APTT] including fibrinogen).

Group and screen samples, FBC and clotting tests with fibrinogen were taken in 89%, 91% and 55% of cases, respectively (**Table 4**) overleaf.

Table 4. Laboratory tests and blood groupings

	National, N=826	
	N	**%**
Laboratory tests		
Group & Save sample	737	89.2
FBC[1]	753	91.2
PT[2] and APTT[3]	**650**	**78.7**
PT and APTT without fibrinogen	195	23.6
PT, APTT and fibrinogen	455	55.1
Patients' blood group		
Group O	366	44.3
Group A	312	37.8
Group B	82	9.9
Group AB	38	4.6
Not stated	28	3.4

[1]FBC: full blood count; [2]PT: prothrombin time; [3]APTT: activated partial thromboplastin time

Clinical standard 2:

The use of tranexamic acid should be considered in non-traumatic major bleeding e.g. obstetrics or surgery where there is expected blood loss of more than 500 mls. It should be given as soon as possible, and within 3 hours in trauma patients with active or suspected active bleeding (1gram bolus followed by 1gram infusion).

As shown in **Table 1** of the organisational data, tranexamic acid was part of the MHP in 91% of protocols (N=150), of which 57% indicated that the recommended dose was 1-gram bolus followed by 1-gram infusion over 8 hours (N=86).

Table 5 shows the clinical audit data for the use of tranexamic acid by site of bleed. 512 (62%) patients received tranexamic acid and the proportion of cases in which it was administered was higher in trauma cases (83%) followed by obstetric (67%) and surgical cases (42%) and cardiac surgery (18%). In the cardiac surgery group, 12% of cases received Aprotinin and no tranexamic acid.

432 (84%) of those that received tranexamic acid reported a dosage of 1 gram, 13 (3%) 2 grams, 12 (2%) were other and 55 (11%) were not stated in the free text.
The frequency of the dose of tranexamic acid was not well reported. 36 trauma cases reported a time for MHP activation and when tranexamic acid was administered; the median time it

took in administering tranexamic acid from MHP activation was -25 mins (IQR:-48–0 mins), the negative values suggest that the MHP was activated afterwards.

Table 5. Use of Tranexamic acid and cell salvage use

	National, N=826	
	N	**%**
Tranexamic Acid use - all	**512**	**62.0**
Trauma	*113*	*83.1*
Gynaecology	*30*	*69.8*
Obstetric	*120*	*67.8*
GI bleeding	*111*	*67.3*
Medical	*20*	*54.1*
All surgery	*99*	*42.4*
Gastrointestinal surgery	*31*	*52.5*
Vascular surgery	*29*	*37.7*
Cardiac surgery	*9*	*18.0*
Other surgery	*30*	*63.8*
Other	*19*	*54.3*
Cell salvage use	***95***	***11.8***

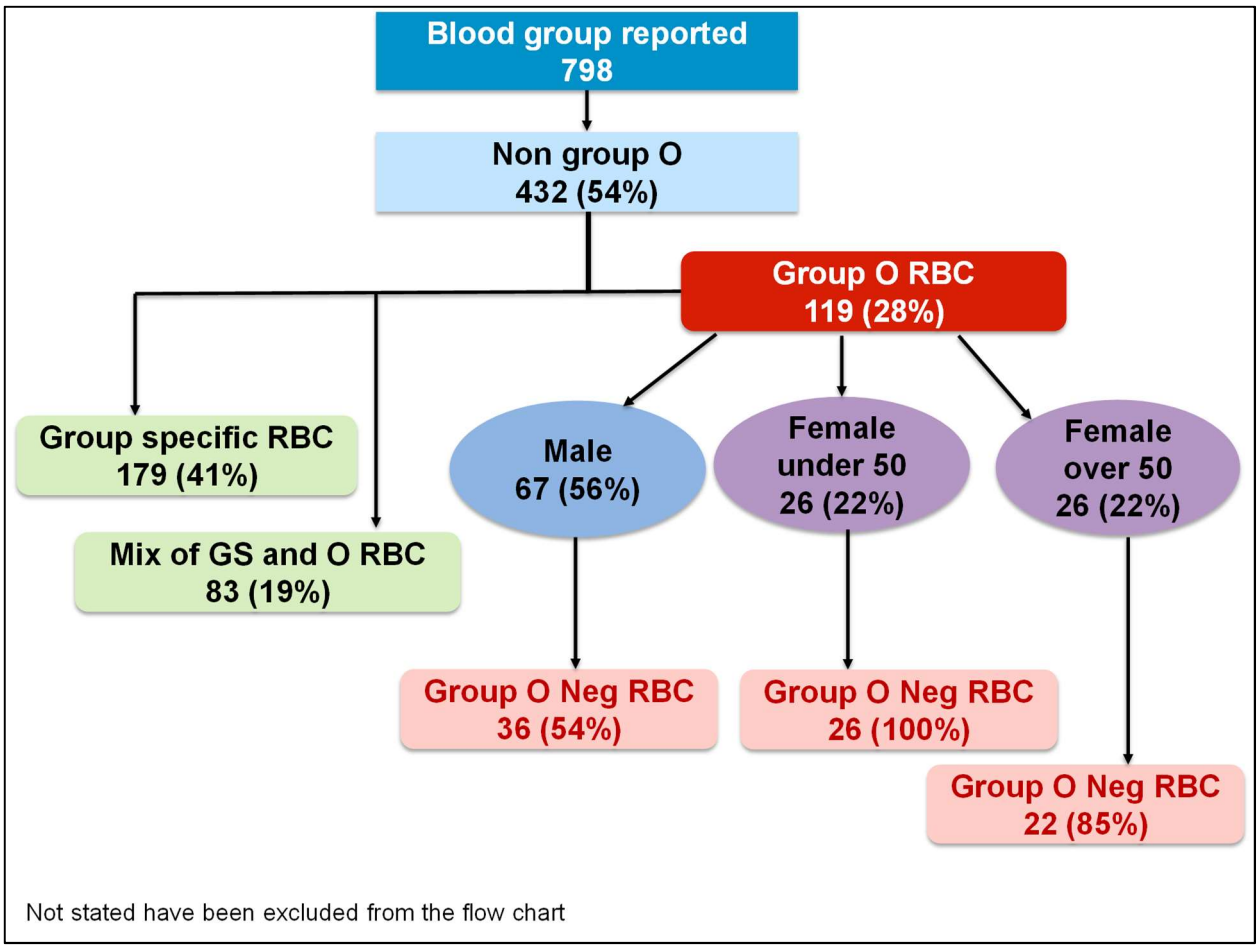
% of cases; for example, 54.1% of medical cases used tranexamic acid

Clinical standard 3:

Emergency Group O RBC should be administered for life-threatening bleeding and that patients are moved to group-specific RBCs as soon as possible. Group O RhD negative RBCs should be used for females of child-bearing age (<50 years old) and group O RhD positive RBCs should be considered for male patients

Blood grouping of all patients is shown in **Table 4** and **Figure 1** illustrates the pathway of the RBCs transfused to non-Group O patients: 51 cases did not state what blood group RBC a patient received; hence they were excluded from the flow chart. Of the 432 cases who were non group O, 179 (41%) received group specific RBCs only, 119 (28%) received only group O RBCs, and 83 (19%) received a combination of group O and group specific RBCs. 36 (54%) males and 22 (85%) females over the age of 50 were transfused with group O RhD negative RBCs where group O RhD positive could have been given.

Figure 1. Group O RBCs transfused to a non-group O patient



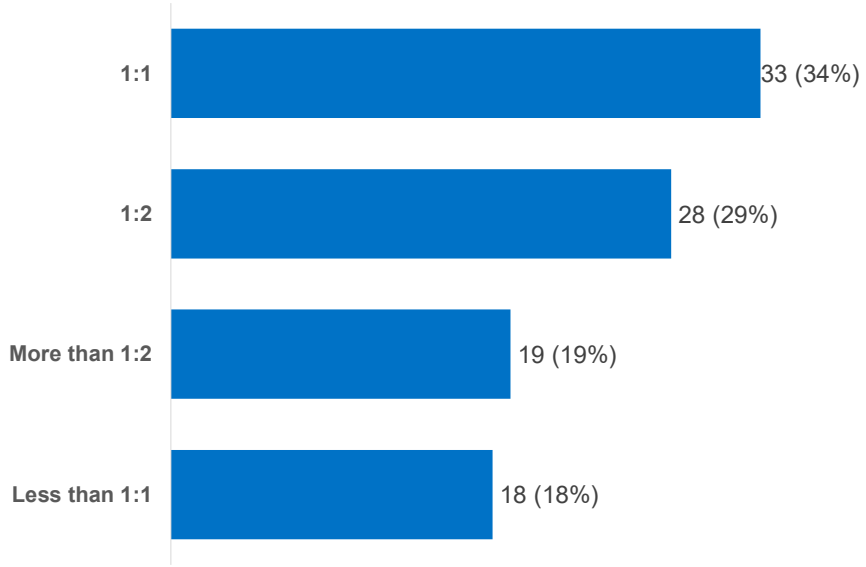
Clinical Standard 4:

In trauma settings, RBCs and FFP should be given in a 1:1 ratio; while for other non-trauma major haemorrhage a ratio of at least 2:1 of RBCs to FFP should be given *(assessed only for trauma)*

Figure 2 show the ratio of FFP to RBC transfused to trauma patients within 24 hours**.** Of the 113 trauma cases reported in the audit, it was only possible to calculate the FFP:RBC ratio for 98 cases, of which 34% received a 1:1 ratio (N=33), 29% received a 1:2 ratio (N=28), and others

received either less than 1:1 ratio or more than 1:2 ratio. The proportions were similar for non-trauma cases (results not shown).

Figure 2. FFP:RBC ratio for trauma cases (N=98)



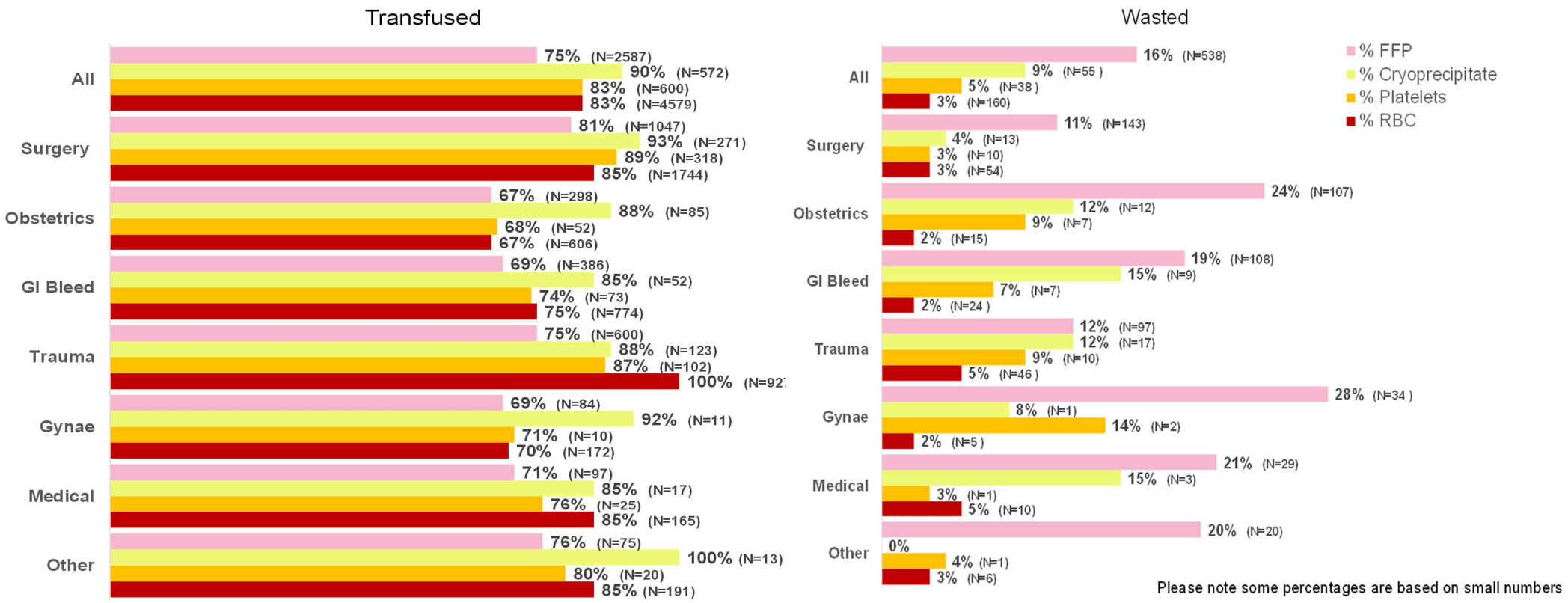
Overall Blood Usage and Wastage

The proportion of issued blood components transfused and wasted by cause of haemorrhage is shown in **Figure 3**. Please note that some hospitals do not consider units that were collected from a fridge as issued. Therefore, the total transfused appears higher than the number issued, particularly in trauma and other cases, which have been rounded to 100% transfused in **Figure 3**. Issued, transfused and wasted blood components are also reported in **Table 6** under the **Appendix D** with your site comparisons**. Table 7** in the **Appendix D** shows the number of patients that received FFP, cryoprecipitate and platelets and the median number of units of RBC received before the use of these blood components.

The highest proportion of blood components transfused was cryoprecipitate (90%) followed by RBC (83%) and platelets (83%) and FFP (75%). Wastage levels were 16% for FFP, 9% for cryoprecipitate, 5% for platelets and 3% for RBC. The proportion of blood components that are returned to stock would be the difference between the rate of transfusion and rate of wastage. A low transfusion rate (75%) and a high wastage rate (16%) for FFP would indicate that FFP is being issued in larger quantities then is being used and as a result being wasted. Gynaecology and obstetrics tended to waste more FFP than other causes of haemorrhage.

A high transfusion rate (90%) and a high wastage rate (9%) for cryoprecipitate would suggest that cryoprecipitate is not being returned to stock. Whilst RBC and platelets had a lower transfusion rate in comparison, low wastage figures suggest that both blood components are generally being returned to stock.

Figure 3. The proportion of issued blood components transfused and wasted by cause of haemorrhage



Figures 4, 5 and **6** show boxplots of blood components issued, transfused and wasted in units for all causes of haemorrhage and by cause of haemorrhage for RBC and FFP, respectively. The median (central horizontal line) indicates the average number of units. All outliers were excluded from this analysis.

Figure 4. Boxplot of issued, transfused and wasted blood components in units for all cases

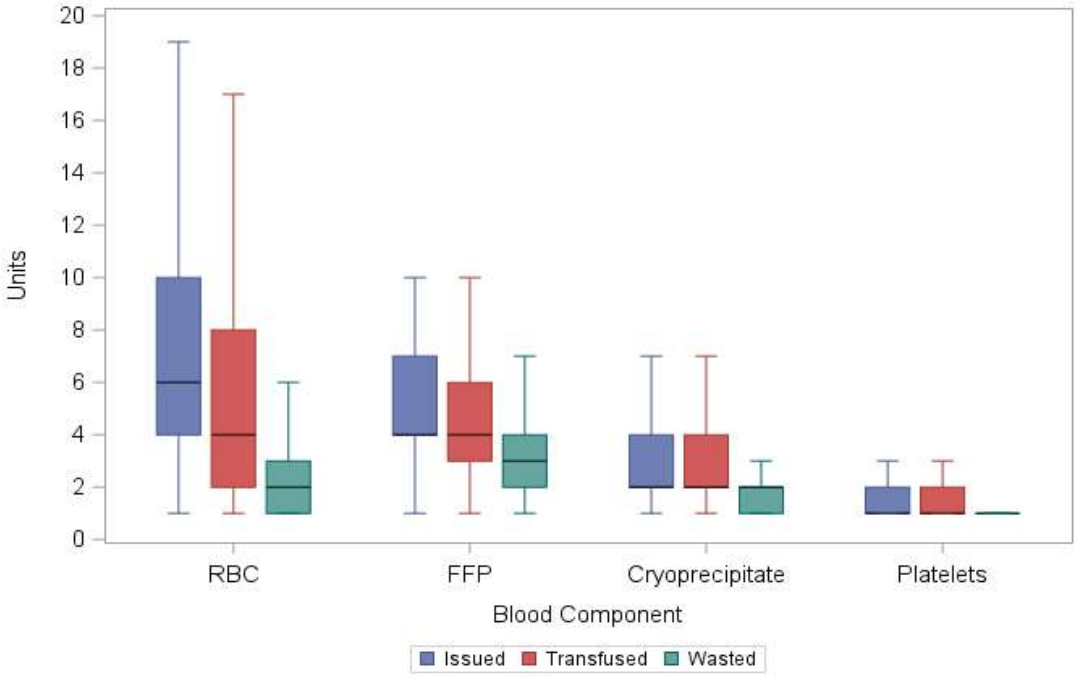
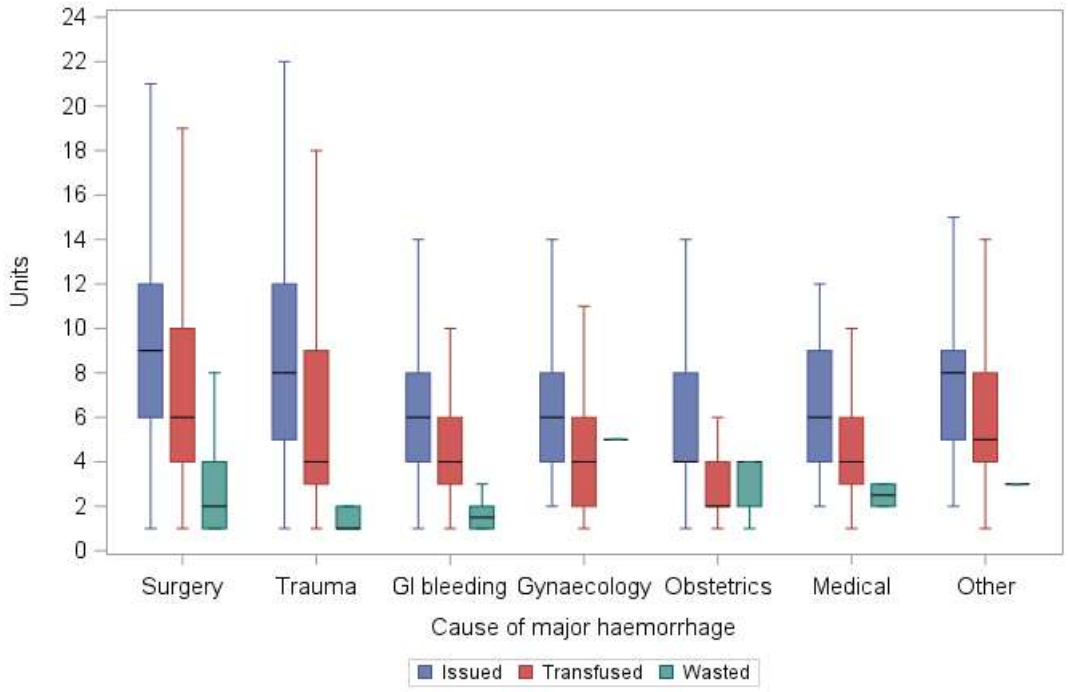
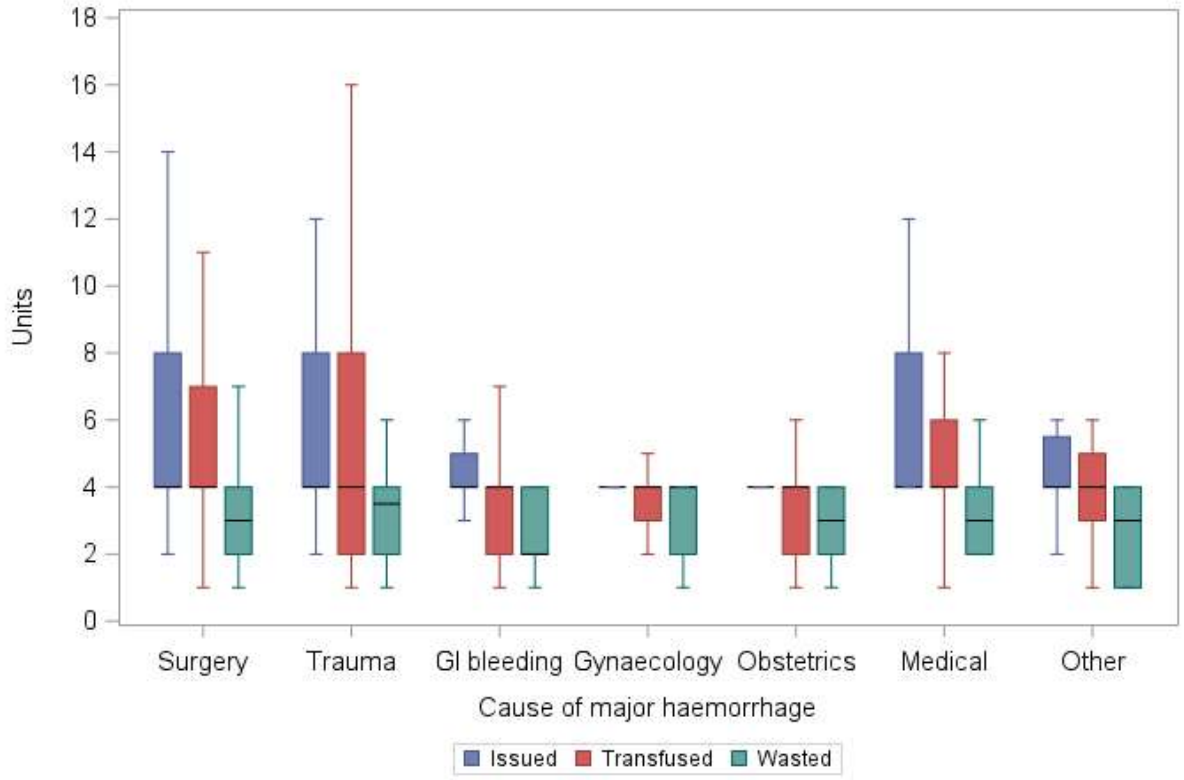


Figure 5. Boxplot of issued, transfused and wasted RBC units by cause of haemorrhage



The line from bottom to top represents the range of data, the black central horizontal line in the box displays the median and the end point of the boxes represent the 25th and 75th percentiles. Outliers were excluded in this analysis.

Figure 6. Boxplot of issued, transfused and wasted FFP units by cause of haemorrhage



The line from bottom to top represents the range of data, the black central horizontal line in the box displays the median and the end point of the boxes represent the 25th and 75th percentiles. Outliers were excluded in this analysis.

The median number of units transfused for all causes of haemorrhage was 4 units of RBC (IQR: 2 – 7), 4 units of FFP (IQR: 3 – 6), 2 units of cryoprecipitate (IQR: 2 – 4) and 1 unit of platelets (IQR: 1 – 2). The average number of units wasted overall for RBC, FFP, cryoprecipitate and platelets were 2 units (IQR: 1 - 3), 3 (IQR: 2 – 4), 2 (IQR: 1 – 2) and 1 (IQR: 1 – 1), respectively. The median of blood components wasted did not vary much between the cause of major haemorrhage for FFP, cryoprecipitate and platelets. The boxplots show the spread of data such that the larger the range of data the higher the fluctuation in the number of units issued,

transfused or wasted for a given cause of haemorrhage. For example, trauma had a larger range of data in the number of units transfused for both RBC and FFP. In contrast, the smaller the range, the less variation in the number of units issued, transfused or wasted. For example, gynaecology and obstetrics would always issue 4 units of FFP as represented by the singular blue horizontal line.

The median of FFP, cryoprecipitate and platelets issued for all causes of major haemorrhage were 4 units (IQR: 4 – 7), 2 units (IQR: 2 – 4) and 1 unit (IQR: 1 – 2), respectively. Surgery and Trauma issued a higher volume of RBC units, the median was 9 units (IQR: 6 – 12) and 8 units (IQR: 5 - 12), respectively, compared with an overall median of 6 units (IQR:4 – 10) for all causes of haemorrhage. Medical cases tended to issue a slightly higher quantity of units for cryoprecipitate and platelets as shown in **Table 6** in **Appendix D.** It also shows the median and interquartile range of issued, transfused and wasted blood components.

DISCUSSION

In this first ever UK wide audit of management of major haemorrhage in hospitals we describe the organisational support for delivering a Major Haemorrhage Protocol and review the standards for treating major haemorrhage cases relating to any causes of haemorrhage. In this audit 99% of hospitals had an MHP in place, and 87% of hospitals said that they audited these protocols regularly, with 31% auditing after every case and 12% only performing audits on an annual basis. While these results are reassuring, hospitals must aim to achieve a 100% target for these key indicators as these would allow for the smooth and prompt delivery of MHP.

In the clinical cases the standards for obtaining blood samples was ~90% for G&S and FBC, and a lot lower for clotting tests with fibrinogen (55%). The low request for clotting tests could be explained by the availability of point of care testing for viscoelastic haemostatic assays (VHA), such as rotational thromboelastometry and thromboelastometry which are increasingly being used in major bleeding relating to cardiac surgery and other settings. The systematic review performed by National Institute for Health and Care Excellence (NICE) concluded that VHA is cost-effective during cardiac surgery, and that further evidence is required for obstetric or trauma haemorrhage [8]. Recently a large randomized control trial in trauma setting comparing the VHA with standard clotting tests (ClinicalTrials.gov, ID: NCT02593877) completed recruitment and its results are awaited. Until further evidence become available to demonstrate the benefit of VHA, routine clotting tests should be taken every 30 – 60 minutes to monitor major haemorrhage in line with the BSH guideline recommendation.[1]

Large randomised control trials have demonstrated the clinical benefits of tranexamic acid use in trauma and obstetric patients who are bleeding,[9, 10] and another trial is due to finish soon in gastro-intestinal bleeding.[11] Currently, national guidelines recommend that tranexamic acid is administered in patients who are bleeding (unless contraindicated) and that this should be given as soon as possible. In this audit, tranexamic acid was part of MHP in 91% of protocols, of those 57% indicated that the recommended dose was 1gram bolus followed by 1gram infusion over 8 hours. Overall trauma patients had the highest rate (83%) of tranexamic acid use in line with NICE and BSH guidelines,[1, 6] while medical and surgery had the lowest (54% and 42%, respectively). All hospitals must ensure that the use of tranexamic acid is part of local MHP and that this is audited regularly to ensure compliance with the national guidelines.

Both NICE and BSH guidelines recommend that RBC and FFP are administered in a 1 to 1 ratio following the results of PROPPR trial.[12] In this audit where all 23 major trauma centres participated, the 1:1 RBC to FFP ratio was only given to over a third of trauma patients, with around 50% of trauma patients receiving a greater than 1:2 ratio. In this audit the ratio was calculated from the total amount of RBC and FFP received over the transfusion period, as it was not possible to collect the timings of all RBC and FFP administered in real time during the major bleeding.

Further, we don't know how many air ambulances are carrying FFP on board, so it is possible that some patients may have been transfused with RBC only in a pre-hospital setting and only on arrival to hospital were the correct ratios administered. Nevertheless, availability of extended thawed FFP from 24 hours to 5 days, should allow major trauma centres to consider carrying pre-thawed FFP outside hospitals or having it ready on standby in laboratories.

In 99% of hospitals, transfusion laboratories were open 24/7 with 90% of laboratories having more than one Biomedical Scientist (BMS) on duty during working hours. However, outside working hours and during the weekend approximately 80% of laboratories had only one BMS on duty. Although in this audit, we were unable to assess if the number of BMSs on duty was appropriate for the laboratory's workload, we did observe that 54% of major haemorrhage cases occurred outside working hours and on weekends and 78% of cases were classified as an unpredicted bleed. Hence, it is important that all laboratories review the number of BMSs on duty at any given time to ensure that it is set at an appropriate level for delivering a safe service for bleeding patients.

Activation of MHP is, by its very nature, likely to utilize a lot of blood components, and in order to strike the right balance between delivering an effective MHP and using resources appropriately, knowledge on how blood components are stored, and robust communication between all parties (i.e. laboratory, porters and all clinical areas) is vital.

Results of this audit show that the highest proportion of blood components that were transfused was cryoprecipitate (90%) followed by RBC/Platelets (83%) and FFP (75%). The wastage level was higher for plasma (FFP 16%, cryoprecipitate 9%), and much lower for platelets (5%) and RBC (3%). Obstetrics, gynecology and medical specialties tended to waste more FFP overall. Reasons for the high wastage are partly explained by the short shelf life of components after thawing, particularly for cryoprecipitate, or the fact that most MHPs are not being stood down (fewer than 50%), resulting in further issuing of blood components.

In the organisational questionnaire, 26 (16%) hospitals stated that they are storing pre-thawed FFP – these are likely to be major trauma centres. However, for other non-trauma hospital who utilize a lot of FFP, it is worth risk-assessing the need for having pre-thawed FFP available in laboratories. Further, if thawed FFP (group AB or group A high titre negative) are not used, hospitals laboratories should work with clinical teams to train them to move the unused unit into a controlled temperature within 30 minutes (either remote fridges or return to laboratories), so that the units can used for other patients who are bleeding: this in turn will result in reduction of FFP wastage.[13, 14]

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Appendix A – Clinical Audit Tool

About this patient

1. What was the patient's year of birth?

2. What was the patient's gender? ☐ Female ☐ Male

3. Where was the patient at the time of the major haemorrhage?

☐ A & E
☐ Acute medical admissions unit
☐ Medical ward
☐ Surgical ward
☐ Obstetric or Gynae ward
☐ Haematology/Oncology/Bone Marrow Transplant ward or day ward
☐ High Dependency Unit
☐ Intensive Care Unit
☐ Theatre
☐ Recovery
☐ Other, please state:

4. Was the patient ☐ An established inpatient? ☐ A new admission?

A new admission is a patient who has been admitted for 24 hours or less

5. What was the nature or site of the major haemorrhage?

☐ Trauma
☐ Cardiac surgery
☐ Gastrointestinal surgery
☐ Vascular surgery
☐ Other surgery
☐ GI bleeding that does not require surgical intervention
☐ Medical (non-surgical bleeding)
☐ Gynaecology
☐ Obstetric (including ante-natal and post-partum haemorrhage)
☐ Other, please state:

6. Was this a predicted major haemorrhage?

☐ Yes ☐ No ☐ Don't know

Previous medical history

7. Did the patient have any previous medical history?

☐ Yes ☐ No ☐ Don't know

7a. If yes, please tick all that apply

☐ Alcohol dependence
☐ Cancer (i.e. active cancer that has required treatment in the last 12 months)
☐ Chronic renal failure
☐ Congestive heart failure
☐ Diabetes mellitus
☐ Hypertension
☐ Ischaemic heart disease
☐ Liver failure
☐ Lung disease (COPD, Asthma,etc.)
☐ Peripheral vascular disease
☐ Previous stroke/ Transient Ischaemic Attack
☐ Other, please state:

8. Was the patient on oral or parenteral anticoagulants at the time of the major haemorrhage?

☐ Yes ☐ No ☐ Don't know

8a. If yes, please give details of name and dose of the anticoagulant

9. Was the Major Haemorrhage Protocol (MHP) activated?

☐ Yes ☐ No

If Yes, go to Q10. If No, go to Q11

10. If yes, please give the date and time of the MHP activation

D D M M ☐☐☐☐ H H : m m ☐☐☐☐ ☐ Date &/or time unknown

Please use 24 hour clock - (e.g.20:15)

11. If no, or date and time of activation is unknown, please give the date and time when the *first* RBC unit was transfused to manage the major haemorrhage

D D M M ☐☐☐☐ H H : m m ☐☐☐☐

Please use 24 hour clock - (e.g.20:15)

12. Was a Group & Screen sample sent to the laboratory, or was there already a valid G&S sample?

☐ Yes ☐ No

Thinking about the first unit of red cells that was transfused. . .

13. Please give the date and time when the first RBC unit was issued by the lab

D D M M ☐☐☐☐ H H : m m ☐☐☐☐

Please use 24 hour clock - (e.g.20:15)

14. Please give the date and time when the first RBC unit was picked up from the lab

D D M M ☐☐☐☐ H H : m m ☐☐☐☐

Please use 24 hour clock - (e.g.20:15)

15. If the first unit was collected from remote fridge and not the lab, please give the date and time when the unit was removed from the remote fridge

D D M M

H H : m m

Please use 24 hour clock - (e.g.20:15)

16. Please give the date and start time when this RBC unit was transfused?

D D M M

H H : m m

Please use 24 hour clock - (e.g.20:15)

17. How much crystalloid was administered before the first RBC unit (including before any emergency Group O given)? *If unknown, please give prescribed amount*

State in mls, please

18. How much colloid was administered before the first RBC unit (including before any emergency Group O given)? *If unknown, please give prescribed amount*

State in mls, please

Thinking about the first unit of FFP, cryoprecipiate and platelets that were transfused . . .

19. Did the patient receive any FFP for this major haemorrhage?

☐ Yes ☐ No

If yes, go to Q20. If no, go to Q24

20. Please give the date and time when the first FFP unit was issued by the lab

D D M M

H H : m m

Please use 24 hour clock - (e.g.20:15)

21. Please give the date and time when the first FFP unit was picked up from the lab

D D M M ☐☐☐☐ H H : m m ☐☐☐☐

Please use 24 hour clock - (e.g.20:15)

22. Please give the date and time when the first FFP unit was transfused

D D M M ☐☐☐☐ H H : m m ☐☐☐☐

Please use 24 hour clock - (e.g.20:15)

23. How many units of RBC were given before the first FFP transfusion?

☐ ☐ **RBCs given at the same time** ☐ **RBCs not given**

24. Was Cryoprecipitate transfused for this major haemorrhage? Yes ☐ No ☐

If yes, go to Q25. If no, go to Q26

25. How many units of RBC were given before the first cryoprecipitate transfusion?

☐ ☐ **RBCs given at the same time** ☐ **RBCs not given**

26. Were platelets transfused for this major haemorrhage? ☐ Yes ☐ No

If yes, go to Q27. If no, go to Q28

27. How many units of RBC were given before first platelet transfusion?

☐ ☐ **RBCs given at the same time** ☐ **RBCs not given**

28. Please provide the following information for red blood cell components issued/used/wasted/returned to stock during the first 24 hours as part of major haemorrhage management.

RBCs	Number			
	Issued	Used	Wasted	Returned to stock
Pre-Hospital BoB* O Neg				
Emergency O Neg				
Emergency O Pos				
Major Haemorrhage Group Specific (if patient is non-group O)				
TOTAL				
Patient's blood group				

*blood on board i.e. used by emergency services

29. When was the Group & Save result available, allowing for group specific blood to be issued?

D D M M

H H : m m

Please use 24 hour clock - (e.g.20:15)

30. When was the first group specific component issued?

D D M M

H H : m m

Please use 24 hour clock - (e.g.20:15)

☐ **Lab was unable to issue group specific red cells for this patient**

☐ **Group specific red cells were not required for this patient**

31. Please record the amounts of other blood components and fluid received in total *in the first 24 hours* for the management of major bleeding (units)

Blood Component	Number			
	Issued	Used	Wasted	Returned to stock
Pre-Hospital BoB* FFP				
FFP				
LG - Octaplas				
Platelets				
Cryoprecipitate				
MB-cryoprecipitate				

***blood on board i.e. used by emergency services**

32. Was the major haemorrhage protocol stood down? ☐ Yes ☐ No

32a. When was the major haemorrhage protocol stood down?

D D M M

H H : m m

Please use 24 hour clock - (e.g.20:15)

33. Please provide the haematological values at the time when bleeding was identified and the values recorded in the 24 hours following the identification of the bleed. Please also provide reference ranges at Q34.

	Value at identification of bleed	Date and time when result was available	Highest or Lowest value at 24 hours	Date and time when result was available
Hb g/dL			*Lowest*	
Platelet count (x10^9/L)			*Lowest* / *Highest*	

Prothrombin time (s)			*Highest*	
Activated prothrombin time (s)			*Lowest*	
Fibrinogen (g/dL)				

What are your normal reference ranges for:

34a. Low PT

34b. High PT

34c. Low APT

34d. High APT

35. Is there documented evidence that cell salvage was used?

☐ Yes ☐ No

35a. If yes, how much was reinfused? *(If not reinfused, write 0)*

mls

36. Is there documented evidence that haemostatic agents below were used to treat bleeding (up to 24 hours of bleeding)?

	Tick if yes	Date and time when administered	Total dose and frequency, and indicate if bolus or infusion
Tranexamic acid			
rFVIIa *(Novo 7)*			
Prothrombin complex concentrate *Octaplex/Beriplex*			
Fibrinogen concentrate			
Vitamin K *Phytonadione, Mephyton*			
Aprotonin			

Thinking about the outcome at 48 hours

37. Was the patient admitted to HDU? ☐ Yes ☐ No ☐ Already in HDU

38. Was the patient admitted to ITU? ☐ Yes ☐ No ☐ Already in ITU

39. Did any other major morbidity occur within 48 hours after the start of bleeding (or time the first component was transfused)? *(tick all that apply)*

☐ Adult respiratory distress syndrome (ARDS)
☐ Cardiac arrest
☐ Disseminated intravascular coagulopathy (DIC)
☐ Persistent vegetative state
☐ Pulmonary oedema
☐ Renal failure
☐ Required ventilation
☐ Septicaemia
☐ Thrombotic event
☐ Other (please state)

40. Did the patient die within 48 hours of the massive haemorrhage?

☐ Yes ☐ No

41. If yes, please give date and time of death

D D M M

H H : m m

☐ Date and/or time of death unavailable

End of questionnaire

Appendix B – Organisational Audit Tool

National Comparative Audit of the Use Management of Massive Haemorrhage

Organizational Audit Tool

1. Is your hospital a specialized centre (i.e. trauma, cardiac, children)? ☐ Yes ☐ No

2. Does your hospital have an obstetric unit? ☐ Yes ☐ No

3. Is your transfusion laboratory open 24 hours a day? ☐ Yes ☐ No

If no, what are your:

3a. Monday to Friday normal operating hours? ☐

3b. Weekend operating hours? ☐

Please tell us about the number of Biomedical Scientists working in your Transfusion Laboratory:

4a. During working hours ☐

4b. Out of working hours ☐

4c. At weekends ☐

5a. In your estimation, how long does it take to get from the Lab to the *nearest* clinical area?

☐ minutes

5b. In your estimation, how long does it take to get from the Lab to the *furthest* clinical area?

☐ Minutes

6. Do you keep pre-thawed FFP? ☐ Yes ☐ No

6a. If yes, how many units of pre-thawed FFP do you keep? ☐

7. Do you have remote blood fridges? ☐ Yes ☐ No

8. Do you use Flying Squads? ☐ Yes ☐ No

9. Do you have a major haemorrhage protocol? ☐ Yes ☐ No

10. If yes, does your protocol cover:

	Tick Yes / No or N/A if you are not a specialist centre (i.e. trauma, cardiothoracic)	If yes, is MHP delivered in packs?	If you use packs, what is contained in the packs?	Do you have Tranexamic acid in the protocol Yes/No If yes, please indicate dose and frequency
One protocol for all major bleeding				
Specific protocol for Trauma				
Specific protocol for Medical				
Specific protocol for Surgical				
Specific protocol for Obstetric				

Specific Protocol for Cardiothoracic				
Other				

11. Do you have an MHP activation form in the laboratory? ☐ Yes ☐ No

12. Do you audit MHP? ☐ Yes ☐ No

12a. If yes, how often do you audit MHP?

13. Do you discuss major haemorrhage cases in an MDT?

☐ We discuss all cases ☐ We discuss some cases ☐ We don't discuss cases

16. If cell salvage is available in your hospital, in which specialities is it used?

☐ Cell salvage is unavailable

End of questionnaire

Appendix C – List of participating sites

Addenbrooke's Hospital
Aintree University Hospital NHS Foundation Trust
Altnagelvin Area Hospital
Aneurin Bevan University Health Board
Ashford and St Peters Hospitals NHS Foundation Trust
Barking Havering and Redbridge University Hospitals NHS Trust
Barnsley Hospital NHS Foundation Trust
Basildon and Thurrock University Hospitals NHS Foundation Trust
Basingstoke & North Hampshire Hospital
Bedford Hospital NHS Trust
Belfast Health and Social Care Trust
Birmingham City Hospital
Birmingham Heartlands Hospital
Birmingham Women's and Children's NHS Foundation Trust
Blackpool Teaching Hospitals NHS Foundation Trust
Bolton NHS Foundation Trust
Bradford Teaching Hospitals NHS Foundation Trust
Calderdale Royal Hospital
Charing Cross Hospital
Chelsea & Westminster Hospital
Chesterfield Royal Hospital NHS Foundation Trust
City Hospitals Sunderland NHS Foundation Trust
Colchester Hospital University NHS Foundation Trust
Countess of Chester Hospital NHS Foundation Trust
Croydon Health Services NHS Trust
Daisy Hill Hospital
Darlington Memorial Hospital
Dartford and Gravesham NHS Trust
Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust
Dumfries & Galloway Royal Infirmary
East Cheshire NHS Trust
East Kent Hospitals University NHS Foundation Trust
East Lancashire Hospitals NHS Trust
East Sussex Healthcare NHS Trust
Epsom Hospital
Forth Valley Royal Hospital
Frimley Park Hospital
Gateshead Health NHS Foundation Trust

Glan Clwyd Hospital
Glangwili General Hospital
Glasgow Royal Infirmary
Good Hope Hospital
Great Western Hospitals NHS Foundation Trust
Guy's and St Thomas' NHS Foundation Trust
HCA International Group Hospitals
Hammersmith Hospital
Harefield Hospital
Harrogate and District NHS Foundation Trust
Homerton University Hospital NHS Foundation Trust
Hospital of St. John & St. Elizabeth
Huddersfield Royal Infirmary
Hull University Teaching Hospitals NHS Trust
Isle of Wight NHS Trust
James Paget University Hospitals NHS Foundation Trust
Kettering General Hospital NHS Foundation Trust
King's College Hospital
Kingston Hospital NHS Foundation Trust
Lancashire Teaching Hospitals NHS Foundation Trust
Lincoln County Hospital
Lister Hospital Stevenage
Liverpool Heart & Chest Hospital
Liverpool Women's NHS Foundation Trust
London North West University Healthcare NHS Trust
Luton and Dunstable University Hospital NHS Foundation Trust
Maidstone and Tunbridge Wells NHS Trust
Manchester Royal Infirmary
Medway NHS Foundation Trust
Mid Cheshire Hospitals NHS Foundation Trust
Mid Essex Hospital Services NHS Trust
Milton Keynes University Hospital NHS Foundation Trust
Morriston Hospital
NHS Ayrshire and Arran
NHS Lothian
National Maternity Hospital Dublin
Newham University Hospital
Norfolk and Norwich University Hospitals NHS Foundation Trust
North Bristol NHS Trust
North Cumbria University Hospitals NHS Trust

North Manchester General Hospital
North Middlesex University Hospital NHS Trust
North Tees and Hartlepool NHS Foundation Trust
Northampton General Hospital NHS Trust
Northern Devon Healthcare NHS Trust
Northern General Hospital
Northern Lincolnshire and Goole NHS Foundation Trust
Northumbria Healthcare NHS Foundation Trust
Oxford University Hospitals NHS Foundation Trust
Peterborough City Hospital
Pilgrim Hospital
Poole Hospital NHS Foundation Trust
Portsmouth Hospitals NHS Trust
Prince Charles Hospital
Princess Royal Hospital Telford
Princess of Wales Hospital Bridgend
Queen Elizabeth Hospital Birmingham
Queen Elizabeth Hospital Greenwich
Queen's Hospital Burton
Queen's Medical Centre
Royal Alexandra Hospital Paisley
Royal Berkshire NHS Foundation Trust
Royal Brompton Hospital
Royal Cornwall Hospitals NHS Trust
Royal Derby Hospital
Royal Free Hospital
Royal Hampshire County Hospital
Royal Marsden Hospital Sutton
Royal Oldham Hospital
Royal Stoke University Hospital
Royal Surrey County Hospital NHS Foundation Trust
Royal Sussex County Hospital
Royal United Hospitals Bath NHS Foundation Trust
Salford Royal NHS Foundation Trust
Salisbury NHS Foundation Trust
Sandwell General Hospital
Scarborough General Hospital
Sherwood Forest Hospitals NHS Foundation Trust
Singleton Hospital
South Tees Hospitals NHS Foundation Trust

South Tyneside NHS Foundation Trust
South Warwickshire
Southend University Hospital NHS Foundation Trust
St. Bartholomew's Hospital
St. George's University Hospitals NHS Foundation Trust
St. Helier Hospital
St. Mary's Hospital Paddington
St. Vincent's University Hospital Dublin
Taunton and Somerset NHS Foundation Trust
The Dudley Group NHS Foundation Trust
The Hillingdon Hospitals NHS Foundation Trust
The Ipswich Hospital NHS Trust
The Leeds Teaching Hospitals NHS Trust
The Mid Yorkshire Hospitals NHS Trust
The Newcastle upon Tyne Hospitals NHS Foundation Trust
The Princess Alexandra Hospital NHS Trust
The Queen Elizabeth Hospital Kings Lynn NHS Foundation Trust
The Queen Elizabeth University Hospital Glasgow
The Rotherham NHS Foundation Trust
The Royal Bournemouth and Christchurch Hospitals NHS Foundation Trust
The Royal Hallamshire Hospital
The Royal Liverpool and Broadgreen University Hospitals NHS Trust
The Royal London Hospital
The Royal Orthopaedic Hospital NHS Foundation Trust
The Royal Wolverhampton NHS Trust
The York Hospital
University College London Hospitals NHS Foundation Trust
University Hospital Lewisham
University Hospital Southampton NHS Foundation Trust
University Hospital of North Durham
University Hospital of Wales
University Hospitals Bristol NHS Foundation Trust
University Hospitals Coventry and Warwickshire NHS Trust
University Hospitals Plymouth NHS Trust
University Hospitals of Morecambe Bay NHS Foundation Trust
Walsall Healthcare NHS Trust
Warrington and Halton Hospitals NHS Foundation Trust
West Hertfordshire Hospitals NHS Trust
West Suffolk NHS Foundation Trust
Western Sussex Hospitals NHS Foundation Trust

Wexham Park Hospital
Whiston Hospital
Whittington Health NHS Trust
Wirral University Teaching Hospital NHS Foundation Trust
Worcestershire Acute Hospitals NHS Trust
Wrexham Maelor Hospital
Wrightington, Wigan and Leigh NHS Foundation Trust
Wye Valley NHS Trust
Wythenshawe Hospital
Yeovil District Hospital NHS Foundation Trust
Ysbyty Gwynedd

Appendix D – Blood components

Table 6. Total of blood components issued, transfused and wasted

	All MH cases		Surgery		Obstetrics		GI bleed		Trauma		Gynae		Medical		Other	
	Median (IQR) N – Total units															
Issued components																
RBC	**6 (4 – 10)**	**5517**	9 (6 – 12)	2061	4 (4 – 8)	906	6 (4 – 8)	1027	8 (5 – 12)	857	6 (4 – 8)	246	6 (4 – 9)	194	8 (5 – 9)	226
FFP	**4 (4 – 7)**	**3461**	4 (4 – 8)	1297	4 (4 – 4)	443	4 (4 – 5)	560	4 (4 – 8)	804	4 (4 – 4)	122	4 (4 – 8)	136	4 (4 – 6)	99
Cryoprecipitate	**2 (2 – 4)**	**633**	2 (2 – 4)	292	2 (2 – 4)	97	2 (2 – 2)	61	2 (2 – 4)	139	2 (1 – 2)	12	4 (2 – 4)	20	2 (2 – 2)	12
Platelets	**1 (1 – 2)**	**722**	2 (1 – 4)	359	1 (1 – 2)	76	1 (1 – 2)	98	1 (1 – 2)	117	1 (1 – 1)	14	2 (1 – 2)	33	2 (1 – 3)	25
Transfused components																
RBC	**4 (2 – 7)**	**4579**	6 (4 – 10)	1744	2 (2 – 4)	606	4 (2 – 6)	774	4 (3 – 9)	927	3 (2 – 6)	172	4 (2 – 6)	165	5 (3 – 8)	191
FFP	**4 (3 – 6)**	**2587**	4 (4 – 7)	1047	4 (2 – 4)	298	4 (2 – 4)	386	4 (2 – 8)	600	4 (3 – 4)	84	4 (4 – 6)	97	4 (3 – 5)	75
Cryoprecipitate	**2 (2 – 4)**	**572**	2 (2 – 4)	271	2 (2 – 4)	85	2 (2 – 2)	52	2 (2 – 4)	123	2 (1 – 2)	11	4 (3 – 4)	17	2 (2 – 2)	13
Platelets	**1 (1 – 2)**	**600**	2 (1 – 4)	318	1 (1 – 2)	52	1 (1 – 2)	73	1 (1 – 2)	102	1 (1 – 1)	10	2 (1 – 2)	25	2 (1 – 2)	20
Wasted components																
RBC	**2 (1 – 3)**	**160**	2 (1 – 4)	54	4 (2 – 4)	15	2 (1 – 2)	24	1 (1 – 2)	46	5 (5 – 5)	5	3 (2 – 3)	10	3 (3 – 3)	6
FFP	**3 (2 – 4)**	**534**	3 (2 – 4)	143	3 (2 – 4)	107	2 (2 – 4)	108	3 (2 – 4)	93	4 (2 – 4)	34	3 (2 – 4)	29	3 (1 – 4)	20
Cryoprecipitate	**2 (1 – 2)**	**55**	2 (2 – 2)	13	2 (1 – 2)	12	2 (2 – 2)	9	2 (2 – 2)	17	1 (1 – 1)	1	2 (1 – 2)	3	-	0
Platelets	**1 (1 – 1)**	**38**	1 (1 – 2)	10	1 (1 – 1)	7	1 (1 – 1)	7	1 (1 – 1)	10	1 (1 – 1)	2	1 (1 – 1)	1	1 (1 – 1)	1
Please note that some hospitals do not consider units that were collected from a fridge as issued, so the number issued appears to be higher in some cases. For your sites figures, cases were not split by site of bleed and medians were not reported due to a small number of cases.																

Table 7 Total blood components received for FFP, Cryoprecipitate and platelets

	All MH cases		**Surgery**		**Obstetrics**		**GI bleed**		**Trauma**		**Gynae**		**Medical**		**Other**	
	Median (IQR) N – Total units															
% who received FFP	**580 (70%)**		191 (82%)		97 (55%)		111 (67%)		113 (83%)		24 (56%)		23 (62%)		21 (60%)	
Amount of RBC before 1st FFP	**3 (2 – 4)**	**502**	4 (2 – 5)	159	3 (2 – 4)	87	3 (2 – 4)	100	2 (2 – 4)	95	4 (2 – 4)	22	3 (2 – 4)	20	3 (2 – 5)	19
% who received cryoprecipitate	**207 (25%)**		86 (37%)		36 (20%)		24 (15%)		43 (32%)		8 (19%)		4 (11%)		6 (17%)	
Amount of RBC before 1st cryoprecipitate	**5 (3 – 8)**	**186**	4 (3 – 6)	73	6 (4 – 7)	34	5 (3 – 6)	22	6 (3 – 10)	40	4 (3 – 6)	8	6 (4 – 6)	3	7 (4 – 8)	6
% who received platelets	**315 (38%)**		128 (55%)		38 (21%)		53 (32%)		60 (44%)		10 (23%)		15 (41%)		11 (31%)	
Amount of RBC before 1st Platelets	**4 (3 – 6)**	**277**	4 (3 – 6)	109	6 (4 – 7)	35	3 (2 – 4)	47	5 (4 – 8)	53	5 (2 – 8)	10	4 (3 – 6)	12	4 (2 – 5)	11