



University of Southern Denmark

Patient Blood Management in Europe

surveys on top indications for red blood cell use and Patient Blood Management organization and activities in seven European university hospitals

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1 **Title page**

2 **Manuscript for Vox Sanguinis**

3 **Title: Patient Blood Management in Europe: Surveys on top indications for red blood cell use and Patient**
4 **Blood Management organisation and activities in seven European University Hospitals**

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18

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21

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3

1 **Abstract**

2
3 **Background and Objectives:** *Patient Blood Management (PBM) in Europe* is a working group of the
4 European Blood Alliance with the initial objective to identify the starting position of the participating
5 hospitals regarding PBM for benchmarking purposes, and to derive good practices in PBM from the
6 experience and expertise in the participating teams with the further aim of implementing and
7 strengthening these practices in the participating hospitals.

8 **Methods:** We conducted two surveys in seven university hospitals in Europe: *Survey on top indications for*
9 *red cell use* regarding usage of red blood cells during one week and *Survey on PBM organisation and*
10 *activities*.

11 **Results:** 3,320 units of red blood cells were transfused in one week at the seven hospitals. Overall, 61% of
12 red cell units were transfused to medical patients and 36% to surgical patients, although there was much
13 variation between hospitals. The organisation and activities of PBM in the seven hospitals were variable,
14 but there was a common focus on optimising the treatment of bleeding patients, monitoring the use of
15 blood components and treatment of pre-operative anaemia.

16 **Conclusion:** Although the seven hospitals provide a similar range of clinical services, there was variation in
17 transfusion rates between them. Further, there was variable implementation of PBM activities and
18 monitoring of transfusion practice. These findings provide a baseline to develop joint action plans to further
19 implement and strengthen PBM across a number of hospitals in Europe.

20 **Introduction**

21 Patient Blood Management (PBM) is an evidence-based, multidisciplinary approach to optimise the care of
22 patients who might need blood transfusion. The objective of PBM is to improve patient outcomes and to
23 reduce unnecessary transfusion. The PBM approach consists of three main pillars: To optimise the
24 haemoglobin concentration, to minimise blood loss and to optimise the patient's tolerance of anaemia[1].
25 The scientific basis for PBM has been described[2], and the evidence for the importance of treating
26 preoperative anaemia[3] and for restrictive transfusion practices[4-7] is increasing.

27 Patient Blood Management in Europe (PaBloE) is a working group of the European Blood Alliance (EBA)
28 which is an association of not-for-profit blood establishments (<http://www.europeanbloodalliance.eu/>).
29 PaBloE was established in 2014 by bringing together specialists with an interest in PBM from seven
30 university hospitals in Europe and associated blood service representatives. Its objectives were to derive

1 good practices in PBM based on the experience and expertise of the participating PaBloE teams, and to
2 develop ways to implement and strengthen these practices in the participating hospitals.

3 In order to develop such action plans the first step was to obtain an understanding of existing practice, for
4 example which groups of patients are using most blood components and the variation in blood component
5 use between hospitals, to identify where it will be most rational to look for improvement in the future.
6 Furthermore, a key issue was to obtain information about how PBM is organised in different hospitals, and
7 what the constraints are to further implementation of PBM. This will provide useful baseline information
8 about PBM and a foundation to create tools to implement PBM across a range of hospitals throughout
9 Europe.

10 To obtain this information, and to be able to initiate the benchmarking processes, we launched two
11 surveys: *Survey on top indications for red cell use* and *Survey on PBM organisation and activities*.

12 **Methods**

13 Members of PaBloE were selected because of their interest in PBM and their willingness to participate in
14 the collaboration. Seven hospitals associated with the PaBloE team members were approached to answer
15 the surveys and all participated; no hospitals outside PaBloE were invited.

16 In the *Survey of top indications for red cell use*[S1], we collected data on all red cell transfusions issued to
17 the seven participating hospitals from Monday 12th May 2014 to Sunday 18th May 2014, inclusive. Data
18 from every transfusion episode were collected using a one page pre-printed form to report the age and
19 gender of the patients, the number of units transfused and the clinical indication for the transfusion.
20 Subsequently the data were entered on-line, and submitted to NHS Blood & Transplant National
21 Comparative Audit team for analysis. The report form was originally developed for surveys of hospitals in
22 the North of England, carried out on three occasions from 1999 to 2009[8], and used again across the
23 whole of England in early 2014[9]. The indication for transfusion was categorised into either: Surgical
24 indications, gynaecological/obstetric indications or medical indications. In six locations, the indication for
25 transfusion was collected manually by a medical doctor, and at one location the indication was based on
26 the ward where the patient was admitted.

27 In the *Survey on PBM organisation and activities*[S2], data were collected about the participating hospitals
28 including the number of beds and surgical procedures and which clinical services were provided.
29 Furthermore, data were collected on the number of surgical and medical patients transfused with red cells
30 (according to location of patient) and the number of blood components transfused. The survey also

1 included information about how PBM was organised, what PBM activities were conducted, which PBM
2 initiatives were successful, what activities will be prioritised in the future and what the constraints are for
3 further implementation of PBM. The survey was developed based on a survey delivered to English hospitals
4 in 2013[10], with some additional questions added by the PaBloE working group. It was launched in January
5 2015 on Survey Monkey (www.surveymonkey.com). The answers regarding number of beds, surgical
6 procedures, transfused patients and blood components correspond to the calendar year of 2013. Answers
7 regarding PBM organisation and activities were collected in January 2015. The ratios of the transfused
8 blood components, red cell:plasma, red cell:platelet and plasma:platelet were calculated from the units of
9 the different blood components, even though we are aware that the content of some of the units vary from
10 hospital to hospital.

11 **Results**

12 The characteristics of the seven participating university hospitals are shown in Table 1. The following
13 services were provided in all seven hospitals: Cardiac, ear, nose and throat (ENT) and gastrointestinal
14 surgery, haematology including haematopoietic transplants and haemoglobinopathy, oncology, organ
15 transplantation, trauma, orthopaedic, urological and vascular surgery. Obstetrics, paediatrics and
16 maxillofacial surgery were provided by six of the seven hospitals. The number of inpatient beds ranged
17 from 953 to 3000. The number of surgical interventions ranged from 18,935 to 114,307 per year.

18

19 **Results of the “2014 Survey of Top Indications for Red cell Use”**

20 The results from this survey are based on transfusion of 3,320 units of red cells in the seven hospitals (Table
21 1). 59% of the red cell units were transfused to men, and the mean age of the patients was 60 years. 61% of
22 red cell units were transfused for medical indications, 36% for surgical indications and 3% for
23 gynaecological or obstetric indications. The proportion of units for medical indications ranged from 45% in
24 Frankfurt to 77% in Mater Dei Hospital, Malta. The top medical indication was haematological disease,
25 followed by gastrointestinal bleeding and critical care (Table 2). Almost half of the medical indications for
26 red cell transfusion and one third of the total indications were haematological. The proportion of
27 haematological red cell transfusions relative to the total red cell transfusions was high at all hospitals and
28 varied from 21% in Odense University Hospital, Denmark, to 43% in Central Manchester University
29 Hospitals, UK. The top surgical indications were cardiothoracic, followed by gastrointestinal and trauma
30 (Table 2).

1 **Results of the “Survey on PBM organisation and activities”**

2 **Blood component consumption**

3 The numbers of blood components transfused in the participating hospitals are shown in Table 1, and the
4 relative use of the three blood components is shown as ratios in Table 3. All of the calculated ratios (red
5 cell:plasma, red cell:platelet and plasma:platelet) varied by more than two fold across the seven hospitals,
6 and the largest variation was found in the red cell:platelet ratio which ranged between 2.5 in University
7 Hospital Frankfurt, Germany to 10.4 in Mater Dei Hospital, Malta. Another noteworthy difference was the
8 plasma:platelet ratio; at Karolinska, almost twice as many plasma units were transfused as platelets, while
9 in Manchester twice as many platelets were transfused as plasma units.

10 There were also large differences between hospitals in the proportion of red cell units transfused per
11 number of inpatient beds (Table 4). Mater Dei transfused 4.8 red cells per inpatient bed while Karolinska
12 transfused 31.3 red cells per inpatient bed. One reason for the low rate of transfusions in Mater Dei
13 hospital is that a large proportion of the beds are for elderly patients in rehabilitation, and Karolinska has
14 highly specialized care.

15 Figure 1 shows the number of medical and surgical patients who received red cell transfusions. At three
16 hospitals more medical than surgical patients were transfused, at one hospital almost an equal number of
17 medical and surgical patients were transfused and at one hospital more surgical than medical patients were
18 transfused; the Frankfurt group only reported number of surgical patients in this survey. The total numbers
19 of transfused medical and surgical patients, in the five hospitals that reported both number of surgical and
20 medical patients, were almost equal (10,727 surgical patients vs. 10,914 medical patients). This is in
21 contrast to the results of our red cell survey in May 2014 and the survey in England, where almost two
22 thirds of the red cells went to medical patients, and a possible conclusion is that transfused medical
23 patients receive more red cell units than transfused surgical patients although these data were not
24 collected in this survey. The differences might also be an outcome of two different ways of allocating the
25 patients to the medical or surgical speciality. In the *Survey on PBM organisation and activities*, patients
26 were divided by location, and in the *Survey of top indications for red cell use* they were divided by
27 indication for transfusion; the latter is likely to provide a more accurate reflection of the reason for
28 transfusion.

29 The number of transfused surgical patients in relation to number of surgical interventions appeared to vary
30 hugely between the participating hospitals although no correction was applied to correct for the relative
31 proportions of major and minor surgery undertaken at each hospital (Table 4).

1 **Results of the “Survey on PBM organisation and activities”**

2 **PBM Activities**

3 Six out of the seven participating hospitals indicated they were implementing PBM in January 2015, and
4 those six hospitals had all facilitated PBM activities that included “safe transfusion practice”, and
5 “appropriate use of blood components”. These six hospitals had a hospital transfusion committee, meaning
6 a group or committee responsible for overseeing transfusion practice in the hospital with the objective to
7 promote best practice through local based protocols based on guidelines, and to promote education and
8 training of all clinical and support staff involved in blood transfusion. Five of the committees had
9 implemented PBM initiatives. Three of the hospitals had staff with time allocated for PBM activities. Two
10 hospitals maintained a database that allowed feedback on performance to all hospital staff involved in
11 blood transfusion. Only Frankfurt evaluated the cost efficiency of PBM.

12 The PBM training at the hospitals was delivered by PBM experts, transfusion practitioners or hospital blood
13 bank staff. In one location training was provided by an e-learning module with an incorporated multiple
14 choice test. Transfusion training for medical doctors was provided in five of the seven hospitals. In less than
15 half of the hospitals, transfusion training took place within the first month that the medical doctors were
16 allowed to prescribe blood components.

17 Three hospitals used electronic blood ordering while three other hospitals were progressing electronic
18 ordering. At two of the hospitals with electronic ordering and at three of the hospitals with paper
19 requesting, the indication for transfusion was included as a field when the components were requested.
20 This field was mandatory at three of the hospitals, and the request was not processed without the
21 information provided.

22 Three out of the seven hospitals undertook audits of blood component transfusion according to their local
23 policies. In five of the seven hospitals, the cost of the blood components was allocated to the clinical
24 specialty. Only three of the hospitals had a system for reporting blood component usage to individual
25 clinicians or clinical teams.

26 In the survey we also asked for standard procedures regarding patient consent and patient information,
27 and following replies were given: Only very few patients received information about risks, benefits and
28 alternatives to blood transfusion. This information was part of routine practice at only one of the seven
29 hospitals. Very few patients were given an information leaflet, and documentation of a valid consent was
30 rarely found in the clinical records of patients who might need transfusion (less than 10% in the majority of
31 hospitals).

1 All of the hospitals provided a range of PBM activities with all providing at least half of the activities listed in
2 Table 5, but none providing all of the activities. Table 6 gives an overview of recent PBM initiatives in the
3 participating hospitals, which were diverse and cover all aspects of PBM. The PBM initiatives prioritised by
4 the hospitals for implementation in the future are also shown in Table 6 indicating a common desire for
5 better pre-operative treatment of anaemia and more monitoring and auditing of blood usage with
6 benchmarking of blood usage for clinical teams.

7 Finally, the participating hospitals were asked to give examples of the local constraints for the successful
8 implementation of the PBM initiatives prioritised for implementation. Common features were lack of
9 training and a hospital culture not supportive of PBM. Other constraints were poor pre-operative patient
10 flow, poor engagement with PBM from medical professionals and hospital managers, and lack of funding,
11 staff and information technology support.

12 **Discussion**

13 Our survey, which followed the fate of red cell units issued in one week in the seven hospitals, found that
14 61% of red cell transfusions went to patients for medical indications which corresponds with the findings of
15 the surveys from the North and the whole of England[8, 9]. Data were also similar for the proportion of red
16 cell transfusions administered to patients with haematological diseases (30% in our survey). This high
17 proportion of transfusions to haematological patients was a general feature seen at all of the hospitals,
18 which makes haematological patients an obvious target for PBM in the future, and specifically the
19 appropriate use of transfusion according to local or national guidelines.

20 Large differences in the relative use of the three blood components were found between the seven
21 hospitals, and the ratios between the three blood components varied considerably. There was also large
22 variation in the proportion of red cell units used per inpatient bed and the proportion of surgical patients
23 transfused per surgical intervention. We know that blood consumption varies considerably between
24 European countries. In *European Directorate for the Quality of Medicines* report from 2012 the number of
25 red cell units per 1,000 inhabitants varies from 27 in the Netherlands to 58 in Germany[11]. However, the
26 variations we found in our survey could also be due to limitations of our study. The definition of “inpatient
27 beds” and “surgical procedures” and definitions of what a medical or a surgical patient is might vary from
28 hospital to hospital, since strict definitions were not provided when the surveys were sent to the hospitals.
29 Other factors may also contribute to these large differences such as variations between hospitals in the
30 allocation of patients to the diagnostic categories used in the survey, differences between hospitals in
31 medical and surgical management, and differences between countries in guidelines for transfusion,

1 availability of blood components and the volume and/or composition of blood components. For example
2 the content in the plasma units in Torino varies from 200 ml to 500 ml, but at the other six hospitals the
3 average volume of plasma units is between 271 ml and 312 ml. Similarly, the dose of platelets in a unit
4 varies from $>200 \times 10^9$ to $>300 \times 10^9$. In conclusion, the limitations mentioned above make it difficult to
5 make robust comparisons in blood transfusion rates between the hospitals participating in this study. The
6 results from the surveys might not reflect the status of European hospitals in general, since the surveys
7 were conducted at university hospitals with a connection to PaBloE team members who have a special
8 interest in PBM, and six out of the seven hospitals have active PBM programmes.

9 The implementation of PBM in January 2015 in the seven university hospitals included in this study was
10 variable, which corresponds with the findings of previous studies[1]. Possible reasons for the variable
11 implementation of PBM are differences in the knowledge of and interest in PBM, despite the fact that PBM
12 is becoming more prevalent in Europe and indeed worldwide, and the principles of PBM are evidence
13 based and widely accepted[2]. Variable support from clinicians and hospital managers, and inadequate
14 financial resources, staff and information technology almost certainly contributed to this variation. Since
15 some of the variability we find is probably due to differences between the countries, it could be interesting
16 to compare the variability we find, with the variability found within one country. Further studies are
17 needed to assess these differences and their significance in the successful implementation of PBM.

18 In conclusion, seven university hospitals across Europe providing a similar range of clinical services were
19 found to have considerable differences in blood usage and transfusion practice. Some of the differences
20 may be due to limitations in the methodology of data collection and also due to a variation in clinical
21 casemix in the hospitals. However, they may also be due to the observed variable implementation of PBM
22 measures found in this study.

23 Further understanding of the reasons for the commonalities and differences in transfusion practice and
24 PBM implementation between these seven university hospitals in Europe provides the opportunity to share
25 experiences and develop new strategies and joint action plans about how best to implement PBM, not only
26 in the seven participating hospitals but in hospitals across Europe using the lessons learned in this project.
27 Guided by the results of these two initial surveys, further work by the PaBloE group will focus on the
28 development of implementation strategies for the management of pre-operative anaemia and clinical
29 studies to better understand transfusion strategies in patients with haematological disorders.

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2 Blood Bank, Mater Dei University Hospital, Malta).

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33

34 **Supporting information:**

35 **S1: Survey tool: 2014 Survey of Top Indications for Red cell Use**

36 **S2: Survey tool: Survey on PBM organisation and activities**

1 **Figure and Table Titles and Legends**

2 **Table 1: Characteristics of the hospitals, transfusions in May 2014 and number of units transfused in 2013**

3 **Table 2: Top medical and surgical indications in May 2014**

4 Top medical and surgical indications for red blood cell transfusions in May 2014 and the percentage

5 of the total transfused units

6 **Table 3: The ratios of the transfused blood components**

7 Red cell:plasma, red cell:platelet and plasma:platelet ratios, calculated from the number of

8 transfused units of the different blood components

9 **Figure 1: Number of transfused surgical and medical patients**

10 **Table 4: Relation between the number of transfused red cell units and the number of beds, and the**

11 **proportion of transfused surgical patients/number of surgical interventions**

12 **Table 5: Examples of PBM activities and the hospitals where the activities are provided**

13 **Table 6: Examples of recent PBM initiatives and PBM initiatives prioritised for implementation in the**

14 **future**

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1 **Figures and Tables**

2 Table 1:

	University Hospital Frankfurt, Germany	Karolinska University Hospital, Stockholm, Sweden	Central Manchester University Hospitals NHS Foundation Trust, UK	Mater Dei Hospital, Msida, Malta	Molinette University Hospital, Torino, Italy	Odense University Hospital, Denmark	Radboud University Medical Centre, Nijmegen, The Netherlands
Charcteristics of the hospitals:	n	n	n	n	n	n	n
Beds in 2013	1,286	1,6	1,42	3	1,126	1,225	953
Surgical inter- ventions in 2013	25	51,916	77,724	47,274	18,935	114,307	45,495
Transfusions in one week, May 2014:	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
Red cell units to medical indications	210(45)	531(61)	344(76)	224(77)	292(60)	278(56)	150(58)
Red cell units to surgical indications	257(55)	313(36)	85(19)	43(15)	196(40)	207(42)	98(38)
Red cell units to gyn/obs indications	1(0)	24(3)	21(5)	23(8)	-	12(2)	11(4)
Total red cell units transfused	468 (100)	868 (100)	450 (100)	290 (100)	488 (100)	497 (100)	259 (100)
Transfusions in 2013	n	n	n	n	n	n	n
Red blood cells	21,363	50,089	21,174	14,274	24,549	29,561	12,109
Platelet units	8,432	8,075	5,971	1,376	5,735	5,224	4,398
Plasma units	7,972	13,587	2,735	2,231	5,91	6,368	2,764

3

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1 Table 2:

Top medical indications		Top surgical indications	
Haematological	30.0%	Cardiothoracic	9.8%
Gastro-intestinal bleeding	7.0%	Gastrointestinal	5.7%
Critical Care	4.4%	Trauma	3.9%
Cancer non-haematological	4.2%	Orthopaedics	3.5%
Neonatal	3.0%	Vascular	3.0%

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3

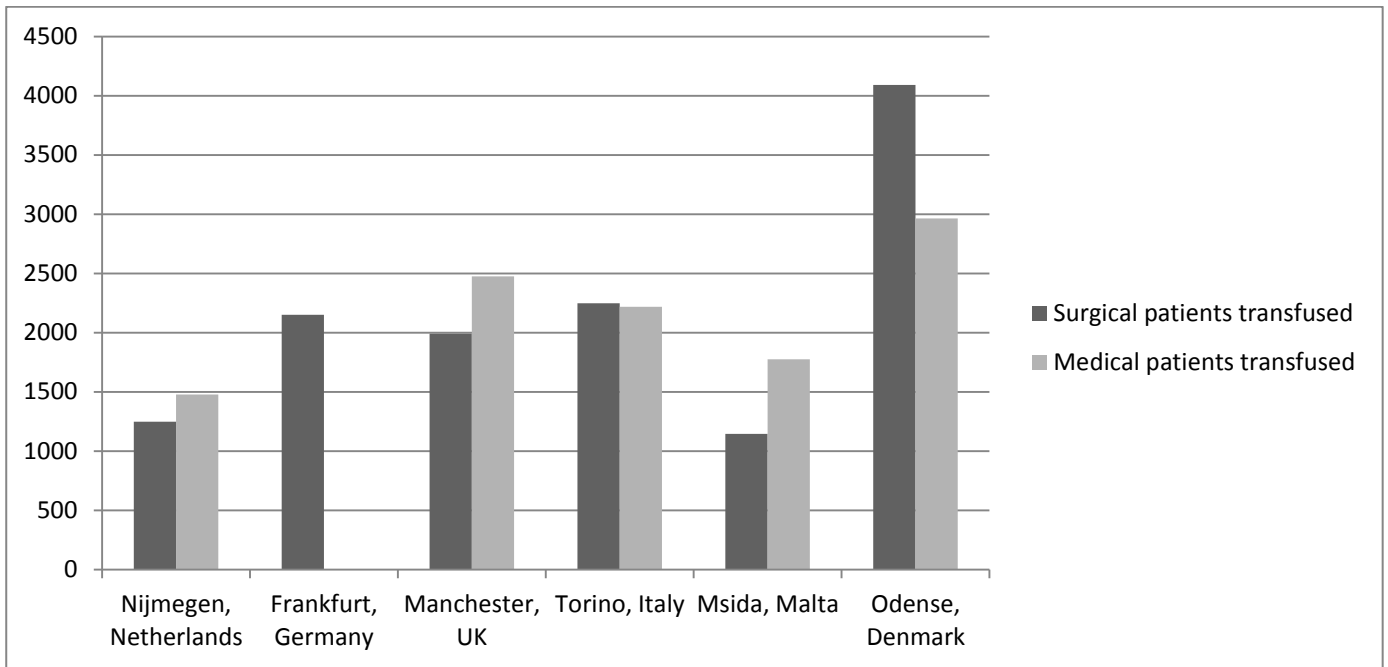
1 Table 3:

Hospital	Red cell:Plasma ratio	Red cell:Platelet ratio	Plasma:Platelet ratio
Radboud University Medical Centre, Nijmegen, The Netherlands	4.4	2.8	0.6
University Hospital Frankfurt, Germany	2.7	2.5	0.9
Central Manchester University Hospitals NHS Foundation Trust, UK	7.7	3.5	0.5
Molinette University Hospital, Torino, Italy	4.2	4.3	1.0
Mater Dei Hospital, Msida, Malta	6.4	10.4	1.6
Odense University Hospital, Denmark	4.6	5.7	1.2
Karolinska, Stockholm, Sweden	3.7	6.2	1.7

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1 Figure 1:



2
3 *Data not provided by Karolinska. The Frankfurt group only reported number of surgical patients

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1 Table 4:
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Hospital	Number of red cell transfusions/number of beds	Proportion of transfused surgical patients/number of surgical interventions
Radboud University Medical Centre, Nijmegen, The Netherlands	12.7	2.7%
University Hospital Frankfurt, Germany	16.6	8.6%
Central Manchester University Hospitals NHS Foundation Trust, UK	14.9	2.5%
Molinette University Hospital, Torino, Italy	21.8	11.8%
Mater Dei Hospital, Msida, Malta	4.8	2.4%
Odense University Hospital, Denmark	24.1	3.5%
Karolinska, Stockholm, Sweden	31.3	Data not provided

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1 Table 5:

PBM activities provided	Frankfurt	Karolinska	Manchester	Malta	Torino	Odense	Radboud	Comments
Policy to identify and correct anaemia before considering transfusion	X		X	X			X	3 in medical patients, 2 preoperative
Access to i.v. iron	X	X	X	X		X	X	
Policy to reduce phlebotomy	X					X		Not all specialities
Protocol for management of anticoagulant patients bleeding or requiring surgery	X	X	X	X		X	X	Including bleeding patients on novel anticoagulants
Protocol for management of abnormal haemostasis in patients with major haemorrhage	X	X	X	X		X	X	
Use of tromboelastography to guide therapy in patients with haemorrhage	X	X	X	X	X			Use varies by indication
Use of anti-fibrinolytics (e.g. Tranexamic Acid) for major bleeding	X	X	X	X	X	X	X	Use varies by indication
Use of intraoperative cell salvage (IOCS)	X	X	X	X	X	X	X	Use varies by indication
Use of pre-operative autologous blood donation (PABD)	X	X			X			
Use of locally agreed triggers for transfusion based on national or local guidelines	X	X	X	X	X	X	X	6 based on national guidelines
Policy for transfusing one unit at a time in non-bleeding patients		X	X		X	X	X	2 RBC/5 platelets
Protocols that empower transfusion laboratory staff to question and challenge requests			X	X	X			

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1 Table 6:

	University Hospital Frankfurt, Germany	Karolinska University Hospital, Sweden	Central Manchester University Hospitals NHS Foundation Trust	Mater Dei Hospital, Malta	Molinette University Hospital, Torino, Italy	Odense University Hospital, Denmark	Radboud University Medical Centre, Nijmegen/ The Netherlands
Recent PBM initiatives	Introduced anemia walk-in-clinic for elective patients ahead of surgery	ROTEM targeted therapy in trauma, cardiac surgery, liver surgery	Big data project linking transfusion and lab data to patient data	MSBOS (Maximal Surgical Blood ordering Schedule)	N/A	N/A	Implementing Type and Screen procedure
	Ideas' competition among students	Close collaboration between transfusion medicine specialists and clinicians	Algorithm for requesting platelets in cardiac surgery based on TEG and platelet mapping	Auditing of blood component use	N/A	N/A	Promoting a policy for transfusing one unit of red cells at a time in stable patients
	Reduced size of blood collecting tubes	PhD students in different blood transfusion projects	Pilot study of management of pre op anaemia in cardiac surgery	Intraoperative cell salvage	N/A	N/A	Starting pilot of ROTEM based transfusion policy in post operative patients
Priorities for PBM	Further bloodless surgery	Employ a nurse dedicated for PBM and transfusion safety	Hospital wide anaemia management service	Database for capturing of information	Evaluation and treatment of pre operative anaemia	Implement new evidence based national guidelines	Implementing ROTEM for bleeding patients
	Improve preoperative patient flow	Improved statistics of blood usage and feedback to clinicians	Dashboard to monitor key performance indicators for PBM	More frequent auditing	Single RBC unit policy	Optimise the treatment of bleeding patients..	Audit and feedback on performance
	Treat non-iron-deficiency-anemia	Evaluation and treatment of pre operative anaemia	Single RBC unit policy	Recruitment of additional FTE (full-time equivalents) for PBM	Reduction of sample blood volume for blood tests	Evaluation and treatment of pre operative anaemia	Promoting iron therapy in case of iron deficiency anemia

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