National Comparative Audit of Blood Transfusion

2015 Audit of Patient Blood Management in Adults undergoing elective, scheduled surgery

"Standard" report

Foreword

Clinicians and managers in the UK have focussed on reducing inappropriate blood transfusion for some time, and a strong body of evidence has backed this up. However, a highly successful new programme was recently introduced in Western Australia, which was unique in its multi-disciplinary organisation and implementation and this was introduced in England last year. Patient Blood Management (PBM) is a true peri-operative multi-specialty collection of interventions designed to focus on blood at all points in the patient pathway before admission to hospital, during surgery and during recovery.

There have been a number of single centre audits and studies aimed at reducing inappropriate blood transfusion, but no nationwide studies that included a breadth of surgical specialties. Therefore, this National Comparative Audit of Blood Transfusion initiative was set up to find out exactly what is going on with regards to blood transfusion and the different aspects of surgical Patient Blood Management in the UK in early 2015, soon after the programme was rolled out. Every audit should identify standards, and these have been carefully described and form the main recommendations for Patient Blood Management. However, compliance with standards is not the only output of this audit. It also describes what specialties are doing in respect of each of the interventions, and which are successful in terms of transfusion rates. It also provides a baseline as a benchmark, which will be compared with future transfusion audits once compliance with recommendations has improved as the programme matures.

This audit shows very clearly that most if not all hospital Trusts in the UK need to focus on Patient Blood Management over the next 12-24 months if this vital NHS-mandated quality improvement programme is to succeed. Dedicated focused staff may be required to co-ordinate local policies and get buy-in from all clinical teams. Anaesthetists, Surgeons, Haematologists and Transfusion staff will all need to work together – the Hospital Transfusion Committee is the obvious place to start, but a Trust-lead in Patient Blood Management should be appointed. There is also clearly a requirement for anaemia clinics in every NHS hospital to diagnose and treat anaemia before surgery. Intra-operatively, the anaesthetist would seem to be best-placed to implement many of the recommendations, including rapid (point-of-care) Hb and haemostasis testing, single-unit transfusion with Hb testing before and after each unit of blood, and much more frequent administration of Tranexamic Acid and use of cell salvage. Finally, surgical teams have to continue this approach on the wards, and this appears from the results of this audit to be a major barrier, which requires much work in terms of education and agreeing protocols.

This National Comparative Audit is unique, both in the UK and worldwide, and provides excellent data to examine the impact of Patient Blood Management in all surgical specialties during elective surgery. The authors hope that by reporting data and repeating the audit in more and more hospitals, inappropriate blood transfusion will dramatically decrease over the next few years nationwide, and that this will truly benefit all our patients.

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Acknowledgements

We wish to thank all those who have participated in the 2015 Audit of Patient Blood Management in Adults undergoing elective, scheduled surgery. We recognise that those giving up their valuable time have been many and that this will inevitably have been on top of a heavy workload. This audit would clearly not be possible without their support. We are equally grateful to many colleagues for their valuable and constructive comments.

HOSPITALS THAT AGREED TO PILOT THE AUDIT

Barking, Havering & Redbridge University Hospitals NHS Trust; Bedford Hospital NHS Trust; Central Manchester Hospitals NHS Foundation Trust; Conquest Hospital ; Dorset County Hospital NHS Foundation Trust; Eastbourne Hospital; Great Western Hospitals NHS Foundation Trust; Kettering General Hospital NHS Foundation Trust; North Bristol NHS Trust; Papworth Hospital NHS Foundation Trust; Queen Elizabeth Hospital, King's Lynn; South Tees Hospital NHS Foundation Trust; Taunton & Somerset Hospital; The Leeds Teaching Hospitals NHS Trust; University of South Manchester NHS Foundation Trust.

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Executive Summary

Patient Blood Management (PBM) is a program of quality improvement in transfusion practice. PBM is patient centred with emphasis on the management of anaemia, minimisation of blood loss and the use of blood only when appropriate. An internationally recognised initiative, PBM is now actively being promoted in the UK. 'PBM the future of transfusion' was launched by the National Blood Transfusion Committee in England in conjunction with NHS Blood and Transplant (NHSBT) in 2014. The large national audit reported here aimed to assess the current application of PBM in surgical patients.

Based on current practice recommendations and clinical guidelines, a series of PBM algorithms were developed and designed as audit standards. For instance, when managing a patient before surgery the key parameters used included whether or not the haemoglobin (Hb) level was checked and if the finding of anaemia prompted appropriate investigations and management; at operation whether any haemostasis measures including use of Tranexamic Acid, cell salvage or point of care haemostasis testing were utilised; and whether a single unit of blood at a time was transfused, and if this was for an appropriate Hb level.

We audited elective procedures likely to be associated with high transfusion use including orthopaedic, cardiac, colorectal, urological, gynaecological and vascular surgery. Patients with a fractured neck of femur were also included since they represent a large transfusion user group providing an opportunity to assess the scope for PBM measures in the urgent care setting, acknowledging that pre-operative management is often impractical. Approximately 8500 units of red cells were transfused in 3897 patients from 190 sites over a 3 month period in 2015 confirming that the appropriate population was studied for this audit. Surgical patients were assessed against 11 PBM algorithms, in preoperative (5) operative (2) and post-operative care settings (4).

Preoperative anaemia was common and was present in half of patients but was often identified relatively late prior to surgery with only half of patients having an Hb level tested at least 14 days preoperatively. This was despite an average of 42 days between listing for elective surgery and operation. Overall 46% of patients had attempts made to manage anaemia pre-operatively (PBM 1). Blood transfusion in the preoperative setting was rarely performed appropriately against given standards (PBM 2, 12%; PBM 3, 2%; PBM 4, 28%).

At operation most patients received one PBM measure prior to blood transfusion (PBM 6, 83%) but rarely all those PBM measures recommended (PBM 7, 16%). In particular there was much variation in the use of Tranexamic Acid. Post-operative blood transfusion was not often performed within recommendations (PBM 8, 24%) with a single unit policy adopted only in a third of cases (PBM 9, 38%). Post operatively, in those who received a transfusion, most patients had received one of the proposed PBM measures (PBM 10, 85%) but blood transfusion was performed following all recommended PBM measures in only 8% of cases (PBM 11).

This large audit highlights the need to develop a standard of practice in surgical PBM to promote appropriate use of transfusion in surgery. Certain aspects of PBM are low cost and can be readily implemented such as the use of Tranexamic Acid in orthopaedic surgery. Mechanisms to identify, investigate and manage preoperative anaemia and a single unit transfusion policy need to be developed and implemented at Trust level.

The forthcoming NICE guidelines on transfusion to be published in November 2015 will strongly reinforce the need for robust action to ensure appropriate use of transfusion and alternatives where available. This patient focused approach can reduce unnecessary transfusion with clear benefits not only for patients but in terms of reducing healthcare costs for Trusts and the wider NHS.

Summary of recommendations

Leadership
The implementation of Patient Blood Management needs clinical leadership with strong support from Trust management.

PBM pathways
Hospitals should establish PBM multidisciplinary teams in collaboration with the Hospital Transfusion Committee (HTC). PBM pathways should be implemented as part of risk management and the WHO checklist should be used in a multidisciplinary PBM programme with integration into anaesthetic and surgical pathways.

Pre-operative
Hospitals should have a preoperative management pathway/protocol with clear stated arrangements for the following:

- Timely identification and treatment of anaemia before elective surgery
- Pre-operative haemostasis assessment with review and management of anticoagulant and antiplatelet therapy
- An individualised PBM strategy incorporating key interventions as below, proportionate to the anticipated blood loss
- Discussion with patients with explanation of risks, benefits and transfusion alternatives available

Intra-operative

- Hospitals should have protocols for the routine use of Tranexamic acid in surgery
- Use of cell salvage and near patient haemostasis testing should be in line with national recommendations

Transfusion triggers and protocols

- Hospitals should have protocols agreed between surgical, anaesthetic and transfusion teams for the management of major bleeding in surgery
- A restrictive transfusion threshold should be used for patients without active bleeding
- A single unit transfusion policy should be adopted as the 'standard practice' for blood transfusion

Patient information
Patients should be provided with information to support valid consent for transfusion (with retrospective information if emergency transfusion was needed during surgery).

Education & training
Education of all clinicians should be provided to ensure awareness of Patient Blood Management to support decision making around appropriate use of transfusion and alternatives.

Ongoing audit and monitoring of practice
Hospitals should undertake ongoing audit of PBM practice facilitated by the use of IT to collect data for regular feedback to clinicians. There is a need for the development of key performance indicators in relation to transfusion with benchmarking of practice.

Introduction

Patient Blood Management (PBM) is a program of care that focuses on a patient centred approach to the management and utilisation of blood transfusion. In relation to surgery, PBM has been described as a "three-pillar" approach aimed at optimising the patient's red cell mass, reducing surgical blood loss and harnessing the patient's physiological reserve including the restrictive use of blood transfusion[1,2]. This integrated approach has the potential to improve patient outcomes with reduced healthcare costs[3-7].
In the UK, successive Better Blood Transfusion initiatives [8] introduced in 1998, 2002 and 2007 have made recommendations on appropriate transfusion practice. However, benchmark surveys of practice and audits of appropriate blood have shown wide variation in implementation[9]. PBM is a more recently introduced concept that has been adopted in several centres in USA and Australia [10, 11] as part of a quality improvement program, with sporadic implementation in Europe.

There have been some highly successful models of PBM implementation, such as in Western Australia (WA) where a 5-year project was introduced in 2008 to implement a comprehensive Patient Blood Management Programme across the healthcare system. From 2008 to 2011 there was a stepwise reduction in blood usage in WA from 31.8 units to 27.9 units per 1000 population. The greatest reduction was noted in surgery with fewer patients (3% to 2.5%) being transfused and transfused patients receiving less blood (average 3.5 units to 3.0 units transfused). After wider introduction in 2012, further work demonstrated that a 27.4% reduction in blood usage could be achieved across five elective surgical groups with significant savings achieved.

In June 2012 a joint NHS Blood and Transplant (NHSBT)/National Blood Transfusion Committee (NBTC) Patient Blood Management seminar was held at the Royal College of Pathologists in London. Following this, a PBM working group of the NBTC, supported by NHSBT and NHS England, developed PBM recommendations that have been circulated as 'best' transfusion practice to all Trusts in 2014[12].
The National Comparative Audit programme [13] has previously undertaken several audits to assess red cell use, transfusion in medical practice and also cardiac surgery. Although red cell usage in surgical patients has decreased over recent years, surgery still accounts for a quarter (450,000 units) of total UK red cell use[14].
PBM is a novel method of quality improvement, applicable to all areas of transfusion practice but to date the wider implementation of PBM measures in patients has not been assessed. Surgery is ideally suited to PBM as both anaemia and use of blood transfusion are common. Therefore there is a need to assess the current role of PBM in surgical practice to establish a benchmark and set audit standards in the UK.

Aims of the audit

The audit collected information on blood management practice and transfusion decisions in a sample of scheduled surgical patients who have received transfusion (Patient audit tool – see Appendix A).

This provides a baseline of practice prior to full implementation of the national PBM recommendations.
It serves to highlight areas of good practice as well as variability in practice and enable hospitals to prioritise implementation of PBM initiatives.

Audit standards and PBM algorithms

A variety of international guidelines have been produced on PBM including the Australian National Blood Authority Patient Blood Management Guidelines for the Perioperative Period[15] as well as the American Association of Blood Banks (AABB guidance) on PBM principles[10]. The standards in this audit were based on the National Patient Blood Management Recommendations for hospitals in England [12] published in 2014, supplemented by the recently published BCSH guidelines on the investigation and management of pre-operative anemia[16].

PBM algorithms:
Eleven PBM audit algorithms were developed (Table 1) and the development of these is described in more detail in Annex 1. Data collected on practice were summarised as 'appropriate' or 'inappropriate' using these algorithms.

The following categories have been identified:
PBM measures used and patient transfused appropriately
PBM measures not used and patient transfused appropriately
PBM measures used but patient transfused inappropriately
PBM measures not used and patient transfused inappropriately

Table 1: Patient Blood Management algorithms: definition

PBM1	Pre-operative anaemia management
PBM2	Pre-operative transfusion allowed
PBM3	Pre-operative transfusion allowed only if preoperative anaemia optimisation has been attempted where appropriate
PBM4	Pre-operative transfusion - single unit transfusion policy
PBM5	Pre-operative anticoagulant and antiplatelet management
PBM6	Patients having intra operative transfusion in whom at least one PBM measure has been attempted (where appropriate)
PBM7	Patients having intra operative transfusion in whom all PBM measures have been attempted (where appropriate)
PBM8	Post operative transfusion allowed (whether or not PBM measures attempted) - FIRST EPISODE
PBM9	Post operative transfusion following the single unit policy – FIRST EPISODE
PBM10	Post operative in whom at least one PBM measure has been attempted (where appropriate)- FIRST EPISODE
PBM11	Post operative in whom all PBM measures have been attempted (where appropriate) FIRST EPISODE

Rationale for surgical procedures audited:
The largest per patient users for red cell transfusion are Cardiac Surgery and Vascular Surgery whereas Orthopaedic Surgery overall uses more red cell transfusions due to the larger number of operations performed. In major abdominal surgery, Colorectal Surgery, Nephrectomy, Cystectomy and Hysterectomy there is strong associative evidence for the impact and effect of preoperative anaemia and transfusion on outcomes. Therefore these operations were chosen for assessment (Table 2).
Patients presenting with fractured neck of femur were also included as they represent a large transfusion user group and provided an opportunity to assess the scope for PBM measures in the urgent care setting, acknowledging that pre-operative management is frequently impractical.

Methodology

Hospitals/Trusts were asked to collect data on all consecutive cases of patients who had undergone any of the audit index operations and received transfusion pre-operatively and/or intra-operatively and/or post operatively. Cases were to be collected from patients who were operated on during the period 1st Feb 2015 to 30th April 2015 with audit data completed and returned by 30th June 2015. Sites were asked to provide data from at least 45 cases and preferably up to 70. In the first instance data was collected for all consecutive cases operated on during the whole of February 2015, irrespective of the number of cases. Thereafter, consecutive cases were audited from those operated on in March and April. Sites with fewer than 45 cases overall were asked to audit all those that were eligible from February to April. The Royal College of Anaesthetists were asked to provide support for the audit and some sites were able to involve anaesthetic trainees in data collection.
A list of OPCS4 codes was provided for the index operations and sites were asked to liaise with their Informatics Department to collect a list of patients who had undergone one or more of these procedures. Transfused cases were identified with reference to laboratory data.
Patients were included only once, i.e. any subsequent operations/re-admissions were not included. Where a patient had more than one operation, only the first operation was audited, because it was expected that the patient would be optimised for surgery at that point and hence may be better prepared for subsequent surgery, and so give a false impression of PBM.
It was recommended that the HTT / HTC identify an auditor to collect data, preferably from anaesthetic or surgical teams. Support might also have been available from the hospital transfusion team or Clinical Audit Department.

Data Collection

A total of 3925 audit records were received, after extending the deadline for submission by an extra week. A total of 28 duplicate records were identified and removed from the dataset leaving 3897 cases for analysis, submitted by 190 sites, median 18, IQR 9-30, range 1-69. Geographically these were; NHS England/N Ireland/Scotland/Wales: 3628 from 155 sites, median 21, IQR 13-32, range 1-69 and the Republic of Ireland: 104 from 7 sites, median 16, range 4-26. Data were also included from Independent hospitals: 165 from 28 sites, median 6, IQR 2-10, range 1-12

The audit period specified for including operations was February to April 2015 inclusive, with 1783 in February, 1314 in March and 683 in April. Details were also received for a further 105 operations (from 46 sites) that fell outside the audit period; these were included in the analysis, with 72 in January, 30 in May, 2 in June and 1 in July. Also included were 12 operations for which the date of surgery was not stated.

In summary, the national results in this audit report are derived from all 3897 cases from 190 sites. Overall distribution of operations audited is given in Table 2 below. To see which sites participated in this audit, please see Appendix C.

Table 2: Type of surgical procedure audited

	National	Your site
• Primary unilateral total hip replacement	16% (610)	
• Primary bilateral total hip replacement	1% (30)	
• Primary unilateral total knee replacement	9% (341)	
• Primary bilateral total knee replacement	1% (27)	
• Unilateral revision hip replacement	7% (258)	
• Unilateral revision knee replacement	2% (67)	
• Colorectal resection for any indication (open or laparoscopic)	8% (300)	
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	4% (157)	
• Primary coronary artery bypass graft	3% (116)	
• Valve replacement +/- CABG	11% (423)	
• Simple or complex hysterectomy	9% (342)	
• Cystectomy	1% (37)	
• Nephrectomy	3% (130)	
• # neck of femur (arthroplasty)	27% (1044)	
Not known	(15)	

Results

Overall, 3897 cases were reviewed from 190 sites. Median age was 76 years (66-84); 65% (2519) of patients were female and 35% male (1354). The distribution of ages by operation is given in table D1 of Appendix D.

Overview of PBM practice

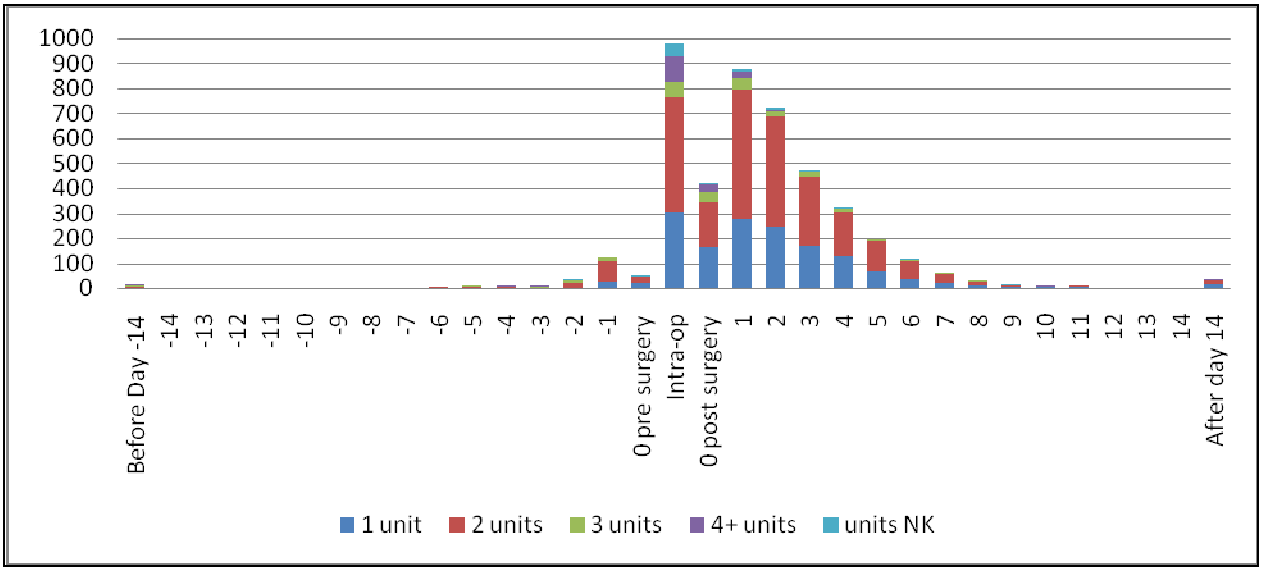
The use of PBM and transfusion practice as assessed against the PBM algorithms is summarised in Table 3. Approximately 8500 units of red cells were transfused and the distribution of these blood transfusions in relation to the pre-operative, intra-operative and post-operative period is summarised in Figure 1. Practice in relation to the PBM algorithms in different procedures is shown in Table 4.

Table 3: Patient Blood Management algorithms: overall performance (see algorithms in Annex 1)

Algorithm	Standard MET	Standard NOT MET	EXCLUDED	INSUFFICIENT DATA	% standard MET*	YOUR SITE: % standard MET*
PBM1	1305	1531	1044	17	46%	%/
PBM2	28	214	3529	126	12%	% (/)
PBM3	3	129	3655	110	2%	% (/)
PBM4	71	182	3529	115	28%	% (/)
PBM5	340	201	3279	77	63%	% (/)
PBM6	661	134	3027	75	83%	% (/)
PBM7	133	675	3027	62	16%	% (/)
PBM8	669	2088	996	144	24%	% (/)
PBM9	920	1492	1358	127	38%	% (/)
PBM10	1714	312	1748	123	85%	% (/N
PBM11	175	1910	1748	64	8%	% (/)

**** MET/(MET+NOT MET)***

Figure 1: Volume and distribution of red Blood Cell Transfusions around the date of operation (Day ZERO)



NB: Figure 1 gives the number of patients transfused on each post op day, stratified by the number of units received on that day.

Table 4: Patient Blood Management performance by type of procedure

	Primary unilateral total hip replacement	Primary bilateral total hip replacement	Primary unilateral total knee replacement	Primary bilateral total knee replacement	Unilateral revision hip replacement	Unilateral revision knee replacement	Colorectal resection for any indication
PBM1	57% (346/610)	50% (15/30)	63% (215/341)	70% (19/27)	50% (128/258)	52% (35/67)	27% (81/300)
PBM2	0% (0/14)	-	0% (0/1)	-	11% (1/9)	0% (0/2)	18% (7/40)
PBM3	0% (0/15)	-	0% (0/1)	-	0% (0/9)	0% (0/2)	2% (1/42)
PBM4	33% (5/15)	-	0% (0/1	-	33% (3/9)	0% (0/2)	19% (8/42)
PBM5	67% (48/72)	25% (1/4)	68% (21/31)	-	47% (20/43)	70% (7/10)	74% (23/31)
PBM6	92% (68/74)	86% (6/7)	92% (12/13)	-	91% (77/85)	100% (10/10)	38% (42/110)
PBM7	34% (26/77)	14% (1/7)	42% (5/12)	0% (0/1)	9% (8/86)	0% (0/10)	3% (3/116)
PBM8	16% (79/487)	14% (3/22)	18% (51/279)	16% (4/25)	23% (37/163)	12% (7/57)	30% (45/151)
PBM9	31% (144/460)	29% (5/17)	27% (72/264)	39% (9/23)	46% (63/138)	21% (11/53)	34% (44/128)
PBM10	89% (435/491)	86% (19/22)	91% (262/287)	100% (25/25)	87% (146/167)	91% (53/58)	35% (53/153)
PBM11	0.4% (2/519)	18% (4/22)	1% (4/292)	16% (4/25)	17% (29/169)	13% (7/56)	0% (0/159)

	Open arterial surgery	Primary CABG	Valve replacement +/- CABG	Simple or complex hysterectomy	Cystectomy	Nephrectomy	# neck of femur (arthroplasty)
PBM1	32% (51/157)	29% (34/116)	43% (183/421)	38% (129/342)	38% (14/37)	42% (55/130)	-
PBM2	20% (2/10)	0% (0/1)	0% (0/2)	14% (4/29)	0% (0/3)	33% (4/12)	8% (10/118)
PBM3	10% (1/10)	0% (0/1)	0% (0/4)	3% (1/32)	0% (0/4)	0% (0/12)	-
PBM4	36% (4/11)	0% (0/1)	67% (2/3)	11% (3/28)	25% (1/4)	8% (1/12)	35% (44/124)
PBM5	68% (38/56)	78% (35/45)	61% (80/132)	58% (7/12)	0% (0/1)	72% (13/18)	55% (47/86)
PBM6	90% (55/61)	96% (43/45)	99% (182/184)	83% (90/108)	82% (9/11)	78% (54/69)	72% (13/18)
PBM7	5% (3/62)	22% (10/45)	28% (51/181)	8% (9/112)	8% (1/13)	4% (3/68)	72% (13/18)
PBM8	33% (28/85)	47% (42/90)	38% (110/292)	40% (83/209)	28% (7/25)	33% (21/64)	19% (151/798)
PBM9	47% (32/68)	87% (55/63)	83% (171/206)	24% (36/151)	24% (5/21)	41% (21/51)	32% (247/761)
PBM10	85% (73/86)	98% (89/91)	97% (292/300)	83% (165/198)	83% (20/24)	82% (50/61)	51% (32/63)
PBM11	1% (1/90)	23% (21/91)	22% (67/299)	0% (0/211)	8% (2/25)	3% (2/64)	51% (32/63)

A: Pre-operative Patient Blood Management (in period from listing for surgery to going to theatre) *NB: Some "your site" results are shown in Appendix D, and the reader is directed to these throughout the text*

This section describes practice as assessed against five pre-operative PBM algorithms with data also shown on some key pre-operative PBM interventions including management of pre-operative anaemia, anticoagulant and antiplatelet therapy. Additional tables are included in Appendix D.

Preoperative PBM algorithms (see algorithms in Annex 1)

PBM1	Pre-operative anaemia management
PBM2	Pre-operative transfusion allowed
PBM3	Pre-operative transfusion allowed only if preoperative anaemia optimisation has been attempted where appropriate
PBM4	Pre-operative transfusion - single unit transfusion policy
PBM5	Pre-operative anticoagulant and antiplatelet management

Preoperative assessment was performed in 87% of cases, at an average of 19 (8-48) days before elective surgery (Appendix D, tables D3 &D4).

Interval between listing and surgery

Table 5: Days from listing to actual surgery by procedure

TYPE OF PROCEDURE	% (N) listed	Days between listing and surgery: Median (IQR)
• Primary unilateral total hip replacement	94% (572/610)	64 (20-115), n=571
• Primary bilateral total hip replacement	97% (29/30)	61 (13-99), n=28
• Primary unilateral total knee replacement	94% (322/341)	92 (50-144), n=322
• Primary bilateral total knee replacement	100% (27/27)	105 (36-137), n=27
• Unilateral revision hip replacement	95% (245/258)	48 (9-102), n=245
• Unilateral revision knee replacement	97% (65/67)	50 (19-102), n=65
• Colorectal resection for any indication (open or laparoscopic)	94% (281/300)	18 (8-36), n=280
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	94% (148/157)	23 (5-59), n=148
• Primary coronary artery bypass graft	89% (103/116)	12 (5-43), n=103
• Valve replacement +/- CABG	91% (384/423)	42 (12-90), n=384
• Simple or complex hysterectomy	96% (329/342)	28 (14-71), n=329
• Cystectomy	92% (34/37)	32 (14-53), n=34
• Nephrectomy	98% (127/130)	26 (12-42), n=127
• # neck of femur (arthroplasty)	0% (0/1044)	-
Procedure not stated	80% (12/15)	6 (0-64), n=12

Preoperative Assessment Pathways

Overall most (89-100%) elective patients were listed several weeks (median 42 days (13-93), n=2675) before their operation with patients undergoing elective orthopaedic surgery having the longest interval period. Patients undergoing colorectal surgery (often for cancer) had a median 18 days before operation. Most patients underwent operation on the day of planned procedure (77%) with only 2% occurring before the planned date and 18% being postponed for two or more days (Appendix D table D2).
At preoperative assessment clinics senior doctors reviewed results of investigations for 21% (519/2466) of patients, while the remaining 325 patients had their results reviewed by a junior doctor. Nurses reviewed the results of 52% of patients (1278/2446) (Appendix D, tables D5 & D6). Reasons for pre-operative assessment being within 28 days of surgery were because of cancer or urgent surgery for 30% of patients, routine practice for 22% and not known for 47% (Appendix D, tables D7 & D8).

PBM 1: Preoperative Anaemia Management

Assessment of whether patients had anaemia was performed at least 14 days before surgery in half (53%) the elective patients who were listed; 1407 patients had FBC results a median of 22 (IQR 0-61) days from listing (n=1336), and there was a median of 33 (IQR 20-64) days between FBC and surgery (n=1407). At this time, of those who had an Hb performed, 46% of females and 48% of males were anaemic. Of these, 15% had further investigation by Ferritin performed although few (<15) had a transferrin saturation performed (Appendix D, tables D9 & D10). In those anaemic 25% (941/3793) of patients received some form of intervention for anaemia in the preoperative setting (Table 6).

Table 6: Was the patient on any of the following treatments before they had their operation?

	National	Your site
Known for	3793	
• Oral iron	11% (399)	
• IV iron	0.8% (29)	
• Erythrocytosis-stimulating agent (ESA) therapy	0.3% (12)	
• B_{12}	2% (71)	
• Folic acid	4% (151)	
• Red cell transfusion*	7% (279)	
• None	79% (3009)	

** this means the patient had a red cell transfusion before they went to theatre.*

PBM 2: Pre-operative transfusion allowed

In 278 cases patients received a blood transfusion preoperatively, 124 (45%) of these being the day before and 53 (19%) being immediately before the operation on the day of surgery (Appendix D, table D11). The decision to transfuse was by consultant in 41% of cases and a senior trainee in a further 15%. The anaesthetist was responsible for preoperative transfusion in 13% (Appendix D, table D12). Median pre transfusion Hb was 82 (76-89) g/L (Appendix D, table D13).

PBM 3: Pre-operative transfusion allowed only if preoperative anaemia optimisation has been attempted where appropriate

In those receiving a blood transfusion preoperatively only three patients had had some form of preoperative anaemia management before they received a transfusion. (See Algorithm for PBM standard 3 in Annex 1)

PBM 4: Pre-operative transfusion - single unit transfusion policy

A single unit transfusion policy was rarely adopted. Most patients received more than one unit of blood (Table 7); 15% of patients had their Hb checked between transfusions of red cells (Appendix D, table D14). Unstable cardiac disease was reported as an indicator in 6% of transfusions; defined as STEMI (ST segment elevated myocardial infarction); NSTEMI (Non ST segment elevation myocardial infarction); or unstable angina within last 14 days). In those patients transfused at a pre-transfusion Hb of >70g/L (without acute coronary syndrome) or >80g/L (with acute coronary syndrome)(N=224), the reason for transfusion was either due to apparent symptoms of anaemia (shortness of breath, hypotension) or optimisation in 12% of patients or blood loss in 22% (Table 8)

Table 7: Red cell units given pre-operatively (N=277)

	National	Your site
One	20% (56)	
Two	61% (168)	
Three	13% (35)	
Four or more	6% (18)	

Table 8: Reason for red cell transfusion

	National
Reason known	147/224
• Acute blood loss	11% (16)
• Anticipated blood loss	11% (16)
• Anaemia	22% (32)
• Anti-platelet / Anti-coagulant	3% (5)
• Other cardiac history	16% (23)
• Infection	3% (4)
• COPD	1% (2)
• Renal disease	2% (3)
• Cancer	10% (14)
• Clinical decision - no other given for the clinical decision	6% (9)
• Hypotension	1% (1)
• Shortness of breath	1% (2)
• Optimisation	10% (15)
• Other	3% (5)

*These categories were formed from free-text stated by auditors

PBM 5: Pre-operative anticoagulant and antiplatelet management

A record of any anticoagulant or antiplatelet medication (excluding aspirin) prior to surgery was documented for 18% (710/3890) of patients. 14 of those (710) had *both* an anticoagulant and an anti-platelet, while 347 had an anti-coagulant *or* 349 an anti-platelet. In those on anticoagulation overall half (48%) had this stopped 5 days before surgery. Cessation of drug by procedure and days before cessation for each drug is shown in Appendix D, tables D15 -18.

Table 9: Anticoagulation management

In the month leading up to surgery:	National	**Your site**
Patients on any oral anticoagulation	9% (361/3890)*	**% (/)**
Stopped drug	87% (315/361) stopped	
Stopped at least 5 days pre-op	48% (139/287)	

**One patient was on two drugs (Dabigatran & warfarin) both stopped the day before surgery*

Table 10 gives INR results on patients on pre-operative warfarin. Anticoagulation was normalised in two thirds of cases with the INR being greater than 1.4 in a third.

Table 10: Pre-operative warfarin

	National	Your site
Patients on Warfarin pre-operatively	8.3% (318/3813)	% (/)
INR result taken closest before surgery for those on Warfarin pre-operatively:		
• ≤1.0	49	
• 1.1-1.4	164	
• 1.5-1.9	50	
• 2.0-2.4	17	
• 2.5-2.9	6	
• 3.0-3.4	7	
• 3.5-4.4	8	
• 4.5-5.9	2	
• 6.0-7.9	-	
• ≥8.0	2	
Median (IQR) INR result	1.3 (1.1-1.5), n=305	
Days between INR and surgery:		
• Same day as op	106	
• Day before op	131	
• Earlier	63	
Median (IQR) days before op	1 (0-1), n=300	

Results for antiplatelet therapy including clopidogrel, prasugrel, and ticagrelor are shown in Table 11. When looking at specific types of operation, antiplatelets were least likely to be stopped in open arterial surgery (55%, 23/420) and #NOF (66%, 75/114) cases, while orthopaedic and general surgeons were more likely to cease antiplatelets (Appendix D, table D17). Details of reasons for not stopping antiplatelet drugs are shown in Appendix D, table D19.

Table 11: Antiplatelet management

	National	Your site
Patients on any antiplatelet therapy*	9.3% (363/3890)	% (/)
Stopped therapy	77% (279/363)	
Stopped at least 5 days pre-op	57% (149/261)	

** this count excludes aspirin. Note also that there were five of these patients who were on clopidogrel and ticagrelor. Two stopped clopidogrel within 5 days of surgery while three were not stopped. All five stopped ticagrelor, four at least 5 days before surgery. However only two stopped both drugs, which is what is counted here and none had both drugs stopped at least 5 days before surgery.*

Pre-operative haemoglobin

The haemoglobin was checked in most patients [95% (3685/3897)] in the immediate preoperative period, at a median of 2 days before operation. The percentage of patients found to be anaemic within the different surgical groups is shown in Table 13.

Table 12: Pre-operative Hb taken closest before the date of surgery

	National	Your site
Hb result, g/L:		
All patients: median (IQR)	118 (105-131), n=3685	**Median: ,**
Female: median (IQR)	116 (104-127), n=2371	**Median:,**
Male: median (IQR)	122 (106-138), n=1291	**Median: ,**
Gender NK: median (IQR)	102 (95-126), n=23	
Females with Hb<120 g/L	57% (1355/2371)	**%**
Males with Hb<130 g/L	60% (781/1291)	**%**
Total anaemic (F<120, M<130)	58% (2136/3662)	
Days between pre-op Hb and surgery: median (IQR)	2 (1-13), N=3622	**Median: , N=**

Table 13: Anaemic patients by surgical group

TYPE OF PROCEDURE	Total anaemic (F<120, M<130)
• Primary unilateral total hip replacement	52% (287/557)
• Primary bilateral total hip replacement	54% (15/28)
• Primary unilateral total knee replacement	53% (167/313)
• Primary bilateral total knee replacement	33% (9/27)
• Unilateral revision hip replacement	49% (118/243)
• Unilateral revision knee replacement	69% (43/62)
• Colorectal resection for any indication (open or laparoscopic)	69% (192/279)
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	47% (68/144)
• Primary coronary artery bypass graft	34% (39/113)
• Valve replacement +/- CABG	37% (151/406)
• Simple or complex hysterectomy	53% (168/317)
• Cystectomy	50% (17/34)
• Nephrectomy	66% (84/127)
• # neck of femur (arthroplasty)	77% (768/999)
Procedure not stated	77% (10/13)
Total	58% (2136/3662)

B: Patient Blood Management while in theatre and recovery

This section describes practice as assessed against two intra -operative PBM algorithms with further data also shown on some key intra-operative PBM interventions including use of antifibrinolytic therapy, intra-operative cell salvage and near patient testing. Additional tables are included in Appendix D

PBM6	Patients having intra operative transfusion in whom at least one PBM measure has been attempted (where appropriate)
PBM7	Patients having intra operative transfusion in whom all PBM measures have been attempted (where appropriate)

(see algorithms in Annex 1)

A quarter of audited patients were transfused in the immediate operative period. In most cases (84%) the decision to transfuse was made by an anaesthetist (Appendix D, table D21). Hb was performed in 70% within 1 hour of transfusion, mostly using near patient methods (blood gas analyser or HemoCue). Median (IQR) pre-transfusion Hb was 83 (75-95), n=604 (Appendix D, table D22). The reason for transfusion was given as 'active bleeding' in 65% of patients with a median estimated blood loss of 1184 ml (644-1940), n=406. A drop in Hb was the next most common reason for transfusion. A single unit transfusion was given to 32% of patients with two units of blood given in half of patients (table 19, below) The haemoglobin level was checked in recovery in 35% of patients and the median value was 97g/L (87-109), n=1277.

Antifibrinolytic therapy

Data on use of antifibrinolytic therapy including Tranexamic Acid and Aprotinin are shown in tables 14 to 16. Overall Cardiac surgery used Tranexamic Acid in 76% of cases, orthopaedic surgery in 48% of cases and it was used in 11% of the remaining known procedures.

Table 14: Use of Tranexamic Acid (TXA)

	National	Your site
Tranexamic Acid used	33% (1252/3805)	% (/)
Oral, before surgery started	25	
Oral, during surgery	1	
Oral, after surgery	7	
IV, before surgery started	368	
IV, during surgery	912	
IV, after surgery	66	
Intra-articular, during surgery	1	
Not known when TXA given known	18	

Table 15: Use of Tranexamic Acid per procedure

TYPE OF PROCEDURE	Tranexamic Acid used
• Primary unilateral total hip replacement	47% (279/588)
• Primary bilateral total hip replacement	53% (16/30)
• Primary unilateral total knee replacement	38% (126/333)
• Primary bilateral total knee replacement	52% (14/27)
• Unilateral revision hip replacement	64% (162/255)
• Unilateral revision knee replacement	50% (33/66)
• Colorectal resection for any indication (open or laparoscopic)	6% (16/287)
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	7% (10/152)
• Primary coronary artery bypass graft	88% (101/115)
• Valve replacement +/- CABG	73% (304/419)
• Simple or complex hysterectomy	15% (51/332)
• Cystectomy	12% (4/34)
• Nephrectomy	10% (13/130)
• # neck of femur (arthroplasty)	12% (120/1026)
Procedure not stated	27% (3/11)
Total	33% (1252/3805)

Table 16: Use of Aprotinin

	National	Your site
Aprotinin used*	0.8% (32/3795)	% (/)

**Valve replacement +/- CABG (n=20), Primary coronary artery bypass graft (n=7), Primary unilateral total hip replacement (n=2), Open arterial surgery (n=2), Simple or complex hysterectomy (n=1)*

Intraoperative cell salvage

Cell salvage was collected in 521 (14%) of cases and reinfused in 459 with a median (IQR) volume of 496 (303-714) mls returned. A clinical contraindication was given in 11%, but more commonly it was not used as felt to be not worthwhile (40%) or not available: on the day of surgery (7%) or in the hospital (11%). No reason given in 24% (Appendix D, table D20). Table 17 below shows the usage of IOCS in relation to type of surgery. Overall, cardiac and vascular surgery most often used cell salvage (more than half of cases) while revision hip surgery in orthopaedic surgery used it less (one quarter of cases).

Table 17: IOCS and type of surgery

TYPE OF PROCEDURE	intra-operative cell salvage (IOCS) commenced
Primary unilateral total hip replacement	4% (25/591)
Primary bilateral total hip replacement	13% (4/30)
Primary unilateral total knee replacement	8% (26/335)
Primary bilateral total knee replacement	7% (2/27)
Unilateral revision hip replacement	24% (62/256)
Unilateral revision knee replacement	5% (3/66)
Colorectal resection for any indication (open or laparoscopic)	0% (0/294)
Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	42% (64/154)
Primary coronary artery bypass graft	63% (72/115)
Valve replacement +/- CABG	55% (229/420)
Simple or complex hysterectomy	4% (13/337)
Cystectomy	6% (2/35)
Nephrectomy	8% (10/130)
# neck of femur (arthroplasty)	1% (6/1025)
Procedure not stated	27% (3/11)
Total	14% (521/3826)

Near Patient testing for Haemostasis

Near patient testing of haemostasis was undertaken in 15% (579/3778) of all procedures. The use for cardiac surgery formed the largest group with the tests used summarised in table 18 below

Table 18: Near patient testing of haemostasis: Primary coronary artery bypass graft and valve replacement +/- CABG

	National	Your site
Near patient testing of haemostasis undertaken	89% (462/517)	% (/0)
Near patient testing options undertaken:	Known for 459	
• TEG	40% (183)	
• RoTEM	5% (25)	
• Platelet function testing	1% (6)	
• Activated Clotting Time	82% (376)	
Other**	2% (11)	

***the remainder consisted of free text entries which largely consisted of blood gas analysis rather than near patient testing of haemostasis.*

Allogeneic blood transfused in theatre or recovery (intra-operative transfusion)

PBM 6: Patients having intra operative transfusion in whom at least one PBM measure has been attempted (where appropriate)

Intraoperative transfusion was undertaken in 25% of patients (n=982). In most cases (83%) one of the PBM measures described above was used before a blood transfusion was given.

PBM 7: Patients having intra operative transfusion in whom all PBM measures have been attempted (where appropriate)

Although cardiac surgery and to a lesser extent orthopaedic surgery used PBM measures regularly, overall only 16% of those transfused were managed using all PBM measures before a blood transfusion was given.

Table 19: Units of red cells transfused intra-operatively (n=890/931)

	National	Your site
Not known	0.5% (4)	
One	32% (288)	
Two	50% (443)	
Three	7% (63)	
Four	6% (57)	
Five to Nine	3% (30)	
Ten or more	0.6% (5)	

C: Post-operative Patient Blood Management *(when the patient had returned to the ward or had gone to HDU or similar)*

This section describes practice as assessed against the following four PBM algorithms. Data on post-operative PBM measures are also shown in the additional tables in Appendix D.

PBM8	Post operative transfusion allowed (whether or not PBM measures attempted) - FIRST EPISODE
PBM9	Post operative transfusion following the single unit policy – FIRST EPISODE
PBM10	Post operative in whom at least one PBM measure has been attempted (where appropriate)- FIRST EPISODE
PBM11	Post operative in whom all PBM measures have been attempted (where appropriate) FIRST EPISODE

(see algorithms in Annex 1)

In the postoperative period, most patients were transfused, 74% (2878/3874) (data for all transfusion episodes is shown in figure 1 and tables 20, 21 and 22 below). The first Hb taken the day after surgery was available in 88% of patients with a median value of 91g/L (IQR 83-102). Post operative management of anaemia was in the most part reliant on blood transfusion; a small minority [1.9% (70/3782)] of patients had postoperative cell salvage (Appendix D, table D23). Iron therapy was given postoperatively for 17% of patients (Appendix D, table D24), mostly as oral replacement. This section assesses the appropriateness of blood transfusion, whether a single unit policy was adopted and if the afore mentioned PBM measures had been used.

PBM 8: Post operative transfusion allowed (whether or not PBM measures attempted) - FIRST EPISODE

Blood Transfusion was considered appropriate where the patient was stable and without cardiac disease for an Hb > 70g/L. Almost all had had their Hb checked within 12 hours of the blood transfusion and 362 patients considered to be bleeding were all deemed to have an appropriate transfusion. Overall, a quarter of patients (24%) transfused across all surgical categories were considered to have met this standard.

PBM 9: Post operative transfusion following the single unit policy – FIRST EPISODE

2447 patients received a post operative transfusion in the absence of active bleeding, and of those 777 (32%) patients had one unit of blood transfused. 1652 were known to have had more than one unit and, of those, 143 had their Hb checked between units but most (1492) did not.

PBM 10: Post operative in whom at least one PBM measure has been attempted (where appropriate) - FIRST EPISODE

At least one PBM measure had been attempted in 85% of cases undergoing a first post operative transfusion.

PBM 11: Post operative in whom all PBM measures have been attempted (where appropriate) FIRST EPISODE

All PBM measures had been attempted (where appropriate) in 8% of cases before a blood transfusion was given.

The following tables show data on any allogeneic red cells that were transfused once the patient had left recovery.

Table 20: Transfusion on any of the first seven post-operative days *(i.e. Day 1 to day 7)*

	National	Your site
Transfusion	74% (2878/3874)	% (/)
How many episodes:*		
One	80% (2307)	
Two	13% (360)	
Three	2.2% (62)	
Four	0.3% (10)	
Five	<0.1% (2)	
Not known	4.8% (137)	

**A transfusion episode = any red cells transfused within a 24 hour period*

Table 21: Transfusion per surgical category

TYPE OF PROCEDURE	Transfusion on any of the first seven post-operative days
Primary unilateral total hip replacement	86% (520/607)
Primary bilateral total hip replacement	73% (22/30)
Primary unilateral total knee replacement	87% (293/336)
Primary bilateral total knee replacement	93% (25/27)
Unilateral revision hip replacement	67% (172/257)
Unilateral revision knee replacement	88% (59/67)
Colorectal resection for any indication (open or laparoscopic)	54% (161/297)
Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	59% (90/153)
Primary coronary artery bypass graft	80% (92/115)
Valve replacement +/- CABG	72% (302/421)
Simple or complex hysterectomy	62% (212/342)
Cystectomy	70% (26/37)
Nephrectomy	49% (64/130)
# neck of femur (arthroplasty)	80% (827/1040)
Procedure not stated	87% (13/15)
Total	74% (2878/3874)

Table 22: Details of each post-operative transfusion episode *(up to 5 episodes were requested)*

	Episode 1 N=2868	Episode 2 N=428	Episode 3 N=77	Episode 4 N=8	Episode 5 N=2
Days from surgery: median (IQR)	2 (1-3) N=2805	3 (2-4) N=422	5 (3-6) N=74	6 (-) N=8	13,14
Who made decision to transfuse: (These categories were formed from free-text stated by auditors)					
• Consultant- Anaesthetics & critical care	226	49	9	2	1
• Consultant - Other specialty	332	49	11	2	1
• Consultant - Specialty not known	259	30	4	-	-
• Senior trainee - Anaesthetics & critical care	61	13	3	-	-
• Senior trainee - Other specialty	242	35	4	2	-
• Senior trainee - Specialty not known	142	25	3	-	-
• Junior trainee - Anaesthetics & critical care	14	-	-	-	-
• Junior trainee - Other specialty	225	26	1	-	-
• Junior trainee - Specialty not known	469	54	9	-	-
• Grade NK - Anaesthetics & critical care	149	24	9	-	-
• Grade NK - Other specialty	205	39	9	1	-
• Grade NK - Specialty not known	536	84	14	1	-
• Nurse	8	-	1	-	-
Pre-transfusion Hb*, g/L: median (IQR)	79 (74-85) n=2717	81 (75-86) n=392	81 (76-86) n=71	82 (-) N=8	77,84
Units of red cells given:	N=2842	N=424	N=77	N=7	N=2
• One	31% (892)	59% (249)	61% (47)	71% (5)	50% (1)
• Two	61% (1729)	38% (162)	32% (25)	14% (1)	50% (1)
• Three	5% (149)	2% (9)	5% (4)	14% (1)	
• Four or more	3% (72)	1% (4)	1% (1)	-	
Hb recorded after each unit of red cells	29% (823/2818)	48% (203/421)	56% (40/72)	75% (6/8)	50% (1/2)
Patient had acute coronary ischaemia**	6.0% (167/2794)	8.8% (36/409)	14% (10/74)	0% (0/6)	-
Reason for transfusion:					
• Active bleeding***	256	36	11	3	1
• An Hb <70 g/L without acute coronary syndrome	304	33	-	1	-
• An Hb <80 g/L with acute coronary syndrome	134	25	5	-	1
• Other****	2115	327	60	4	-
• Low BP or other haemodynamic reason	394	Free-text not was not categorised for subsequent transfusions			
• Hb drop	1242				
• Blood loss - any volume recorded	107				
• Not known	372				
• Not known	59	7	1	-	-

**within 12 hours of transfusion*

*** Definition of acute coronary ischaemia: STEMI (ST segment elevated myocardial infarction), NSTEMI (Non ST segment elevation myocardial infarction) unstable angina) within last 14 days.*

**** Active post operative bleeding defined as bleeding causing systolic Hb <90mmHg, and or heart rate >110bpm, and or return to theatre because of bleeding and or activation of major haemorrhage pathway.*

*****These categories were formed from free-text stated by auditors: FIRST transfusion only*

Discussion

This audit aimed to assess the implementation of PBM measures in patients undergoing surgery associated with a relatively high probability of needing transfusion. During the course of the audit approximately 8500 units of red cells were used in 3897 operations confirming the high use of blood in the operations assessed and therefore appropriateness of the population surveyed in this audit. The distribution of these blood transfusions was predominantly in the operative and post-operative time period (Figure 1).

Preoperative anaemia is common and associated with worse outcomes in surgery[17, 18], and is also the strongest predictor of need for blood transfusion at operation. However, only half of patients had timely Hb levels assessed, and of those few had anything done to manage their anaemia. This is of concern because it was common to find that patients were anaemic at the time of operation, highlighting an area for improvement.

A barrier to preoperative anaemia identification and management could be the drive to reduce the time from decision to operate to the actual date of surgery, particularly in cancer patients. These data suggest that this is not the case and there is in fact ample time in the current pathways. For example, for colorectal resection patients the median time from listing to surgery was 18 days, with 68% having more than 10 days between listing and their operation. Therefore identification and management of anaemia in these 'urgent' case is feasible and preoperative pathways should be adapted in hospital trusts to enable this to happen. Similarly, for orthopaedic and other non-urgent (non-cancer) surgeries there was often one month from listing to operation.

In those patients who did have timely identification of anaemia, little was done. A minority of patients (15%) had anaemia investigated with a ferritin level. There was evidence that a proportion of those identified appropriately were treated; oral iron was given preoperatively in 11%, B_{12} and folate supplementation in 2% and 4% respectively. There is a need to increase these figures for the investigation and management of preoperative anaemia in the UK.

Without management of preoperative anaemia in a timely manner, the use of blood transfusion becomes increasingly necessary. The decision to transfuse should be part of the operative plan with patients being informed and consented as appropriate. Anaemia was managed by blood transfusion preoperatively in 7% of patients, with the decision for transfusion rarely being made by the anaesthetist (13%) and in most cases by a trainee (33%). Despite an average Hb of 82g/L, single unit transfusion was rare (20%) with most patients receiving two or more units of blood. This raises concerns about appropriateness of current preoperative transfusion use and indicates a need for hospitals to review their training and pathways to develop protocols for patients before surgery.

Several PBM measures can reduce blood loss. Tranexamic Acid is a commonly available and cheap drug but despite this it was used in only a third of cases in this audit. This was most frequently employed in cardiac surgery (73-88%) and orthopaedic surgery (38-64%) but rarely in other surgical specialities (6-15%). Aprotinin is notable for its presence following recent relicensing for use in myocardial revascularisation, after its used was suspended in 2007. Tissue sealants and haemostatic dressings are another recommended means of haemostasis but there is no clear guidance for their use. In all they were used in 5.3% of cases, with cardiac surgery (17-24%) and nephrectomy (16%) predominating, with lesser use in other surgeries.

Intra Operative Cell Salvage (IOCS), a key therapy to minimise transfusion of allogenic blood, is recommended where major blood loss is anticipated.

The PBM standard employed by this audit defined situations where IOCS would be expected (revision total hip replacement, open arterial surgery, cardiac surgery) or may be considered optional (hip replacement, urological surgery, hysterectomy). Overall IOCS was used in 14% of cases and in 88% the collected blood was reinfused. Predominantly, IOCS was used in cardiac surgery (55-63%) and revision hip arthroplasty (24%) which, in our audit standards, were designated as key indications for its use. IOCS was not used in 3305/3826 cases, and this was typically because the anticipated blood loss deemed it non-worthwhile (40%). Nevertheless, overall for the operations in this audit the median blood loss was over 1L, so IOCS should have been considered routinely and from the data reported here it appeared very worthwhile with ½ litre of processed blood returned on average (therefore saving at least one unit of red cells). It is notable that for 18% of patients IOCS was not available.

Near patient testing of haemostasis was undertaken in 15% of patients, predominantly within cardiac surgery. The routine assessment of heparinisation during cardiac surgery using Activated Clotting Time (376/459 cases) dominates the results, with visco-elastic testing performed in 45%. Outside cardiac surgery, haemostatic monitoring was infrequently used (117/3261, 4% of patients). With 10% of patients requiring 4 or more units of blood in the operation itself, the question of near patient testing of haemostasis is highly relevant for guiding appropriate red cell and other blood component use.

The decision to undertake intraoperative transfusion must account for clinical circumstances, anticipated blood loss and blood volume status and, as such, no trigger for haemoglobin standard was defined for this audit. The decision to transfuse was preceded by a blood test in 70% of cases (91% near patient testing) during the hour before transfusion. In these cases the median haemoglobin was 83g/L suggesting the majority of cases adopted a “restrictive” transfusion strategy in line with current guidelines. Further comment regarding the appropriateness of intraoperative transfusion is not straightforward, and secondary analyses are planned to investigate this in additional detail. However it would seem pertinent that near patient testing of Hb is readily available to assist with decision making in these acute scenarios.

Most patients in this audit (74%) received transfusion in the post- operative period. These patients were distributed across all categories of surgery. Whilst 80% of patients presenting with fractured neck of femur were transfused there were also relatively high rates seen following elective orthopaedic procedures (67 - 93%), coronary artery surgery (72- 80%) and cystectomy (70%). The rates following hysterectomy and arterial surgery were 62% and 59% respectively with a somewhat lower proportion of patients transfused following colorectal surgery (54%) and nephrectomy (49%). Of patients transfused at the first episode, only 31% were given as a single unit transfusion with the majority (61%) as two unit transfusions suggesting that single unit transfusion policies are not currently common practice in the UK.

The use of PBM and transfusion practice in line with available guidelines was uniformly poor, although knowledge of PBM was apparent as in many cases one PBM measure had been attempted prior to transfusion (PBM 6 &10). Nevertheless, the overall compliance with best practice in PBM and transfusion was low at 8% (PBM 11).

The way forward?

This audit demonstrates considerable room for improvement in the assessment of patients before surgery: there is a need to question why elective procedures are being undertaken without investigation and management of preoperative anaemia, when the temporal course of the patient pathway suggests it should be easily feasible. Perhaps highlighting the need for a more integrated approach to preoperative anaemia testing, and perioperative care would lead to improvement. Recognition of preoperative anaemia should trigger a multidisciplinary response, in addition to management of the anaemia itself.

In those cases where surgical delay is not indicated (the patient with preoperative anaemia being ‘unfit’) recognition of preoperative anaemia should trigger need for further PBM strategies to be employed as part

of the perioperative care pathway including the use of Tranexamic Acid, cell salvage, single unit transfusion and predefined transfusion triggers.

In those patients where time is less of a factor (elective, non-urgent surgery) further work is required to elucidate the specific failings in the preoperative setting. However, this likely reflects the complexity of the preoperative pathway on patients' journey to surgery. A multidisciplinary integrated approach to perioperative assessment and optimisation is required – and this is the vision of the recently announced Royal College of Anaesthetists Perioperative Medicine programme, to deliver a structured national programme for perioperative medical care. (www.rcoa.ac.uk/perioperativemedicine). The British Committee for Standards in Haematology (BCSH) has recently published UK guidelines on the management of pre-operative anaemia[16]. The forthcoming NICE guidelines underwent consultation in July 2015 (www.nice.org)[19] with strong recommendations included on the detection and treatment of preoperative anaemia with oral iron. Intravenous iron is currently under review in this setting as part of a national trial (PREVENTT)[20]. At operation, Tranexamic Acid has been shown to be highly effective (and cost effective) in reducing blood loss and should be used in patients undergoing surgery who are expected to have at least moderate blood loss (greater than 500 ml). Intra-operative cell salvage should be considered with Tranexamic Acid for patients who are expected to lose a very high volume of blood (for example, in complex cardiac and vascular surgery).

A recent NICE systematic review [21] on the use of visco-elastic devices recommended that these devices should be used to manage and monitor haemostasis during and after cardiac surgery but that in other situations such as obstetric haemorrhage or trauma there was insufficient evidence for use except as part of a research study (NICE Diagnostic Guideline 13). In relation to red cell transfusion, in patients without major haemorrhage or acute coronary syndrome, a restrictive threshold should be considered with a haemoglobin trigger of 70 g/L and a target of 70–90 g/L after transfusion. A somewhat higher transfusion threshold of 80 g/L with a target of 80–100 g/L after transfusion should be considered for patients with acute coronary syndrome. In patients not actively bleeding a single unit transfusion should be given with further units given only if deemed necessary following clinical reassessment and haemoglobin testing. Whilst these suggestions are based on the present best available evidence and consensus, we are acutely aware of emerging research which may suggest that a more liberal approach may be warranted across a broader scope of patient groups than just those with an acute coronary syndrome.[22,23] This area would benefit from further high quality trials to guide our future practice.

PBM promotes a patient focused approach and so it is essential to provide patients with adequate information on the indication, risks and benefits of transfusion with any alternatives available, in order to support informed decision making with valid consent. These principles have been further reinforced with an update on the UK law on consent[24].

Trusts should have clear pathways supported by training of relevant healthcare professionals involved to effectively implement PBM strategies. Current good surgical practice encompasses the use of the WHO surgical checklist[25, 26].

Consideration should be given to the incorporation of a checklist into local procedures. Table 23 gives an example of a tool that could be adapted to guide PBM practice in relation to surgery.

Conclusions

There is considerable heterogeneity of practice for the use of PBM in current surgical practice. The timely identification and management of preoperative anaemia is lacking, as is identifying patients at increased surgical risk and thus there is a need to urgently address this. At operation the knowledge and practices of PBM strategies are apparent as this audit showed that most cases had at least one appropriate intervention although in few cases were all used. Blood transfusion usage was often inappropriate and there is a need for trusts to introduce a single unit transfusion policy with clearly defined transfusion triggers**.**

Table 23*: Surgical Patient Blood Management Checklist*

Sign in

- Pre-operative haemoglobin within normal range
- Consideration made of withholding antiplatelet and anticoagulant medication
- Consideration of minimally invasive or laparoscopic technique
- Point of care testing available
- Discussion with patient regarding the above

Time out

- Careful patient positioning to maintain venous drainage
- Avoidance of hypothermia
- Tranexamic Acid 1g to all patients undergoing surgery where blood loss >500mls likely or possible
- Use cell salvage if expected to lose a high volume of blood – set up collection reservoir and process if sufficient blood actually collected
- Use of topical haemostatic agents
- Haemorrhage protocols with triggers on use of red cells and components if needed

Sign out

- Restrictive transfusion thresholds implemented (Hb 70-80 g/L depending upon patient characteristics and haemodynamics)
- Maintain oxygen delivery targeting oxygen saturation levels >95%
- Single unit blood transfusion policy – reassessing Hb level and clinical need between units
- Post operative drain or cell salvage
- Patient information and valid consent for transfusion (or retrospective information if emergency transfusion was needed during surgery)

Quality Account Statement

This certifies that contributed data to the 2015 Audit of Patient Blood Management in Adults undergoing elective, scheduled surgery, and contributed data on , which is 100% of the sample size requested.

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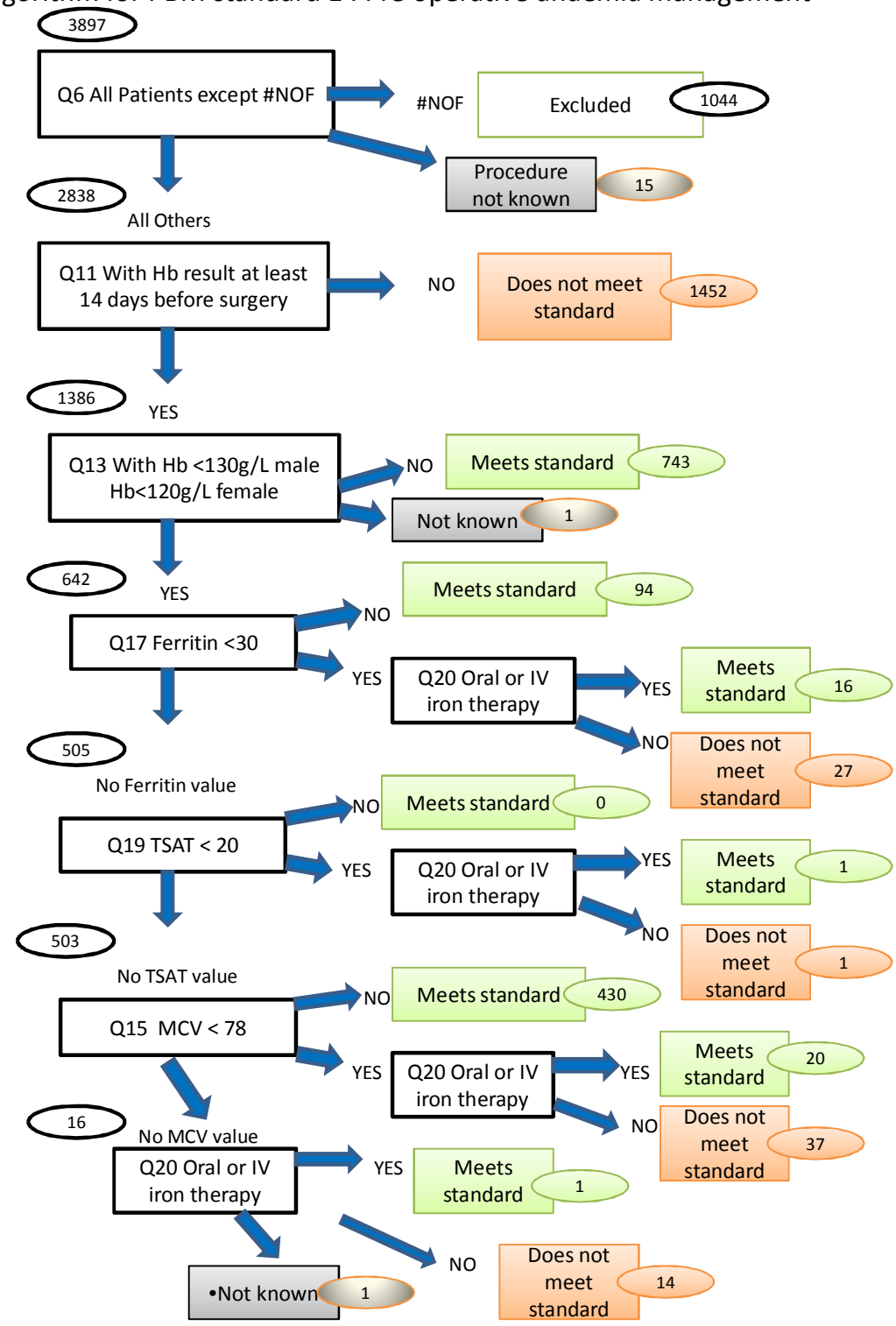
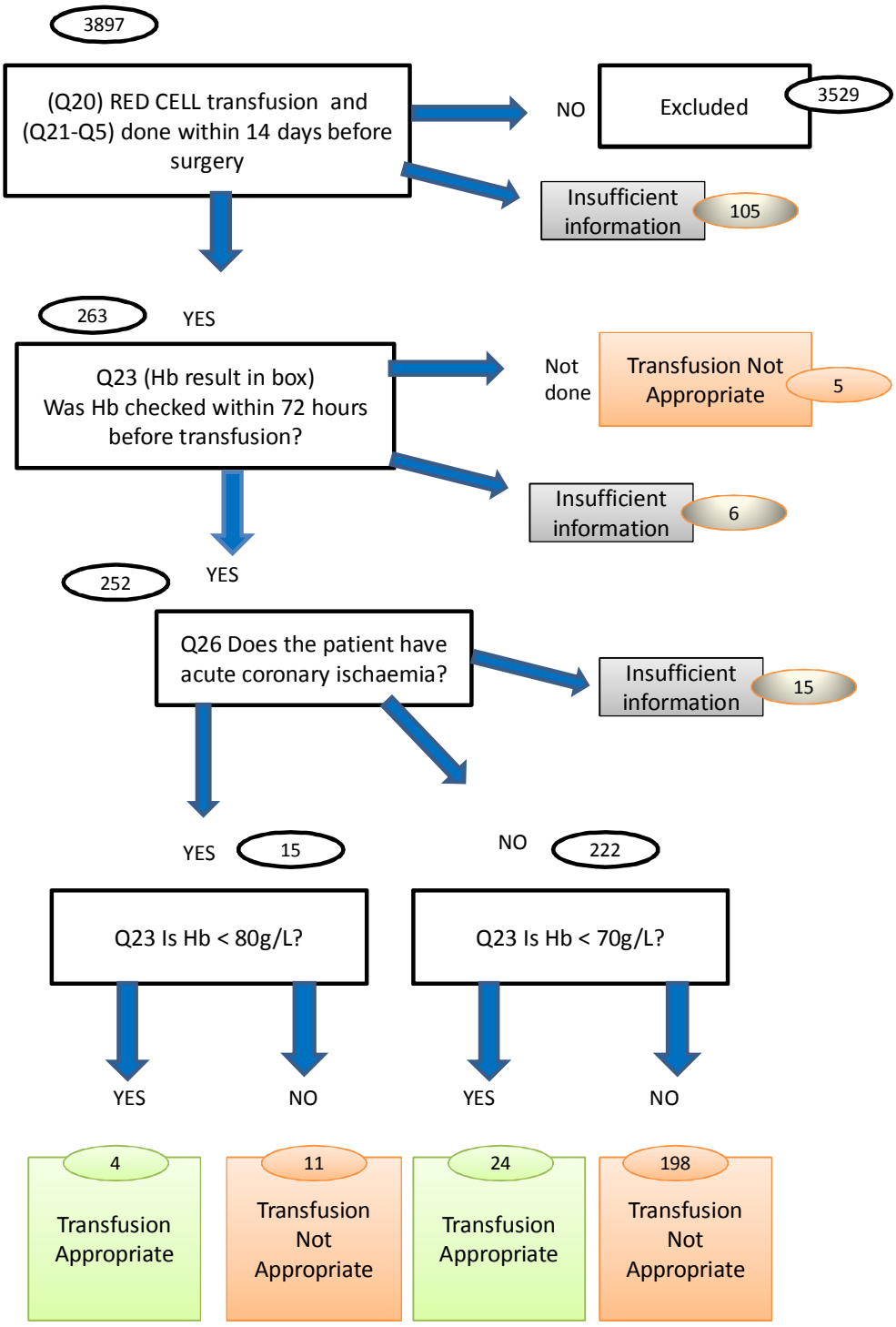
Annex 1 – PBM Algorithms 1 - 11

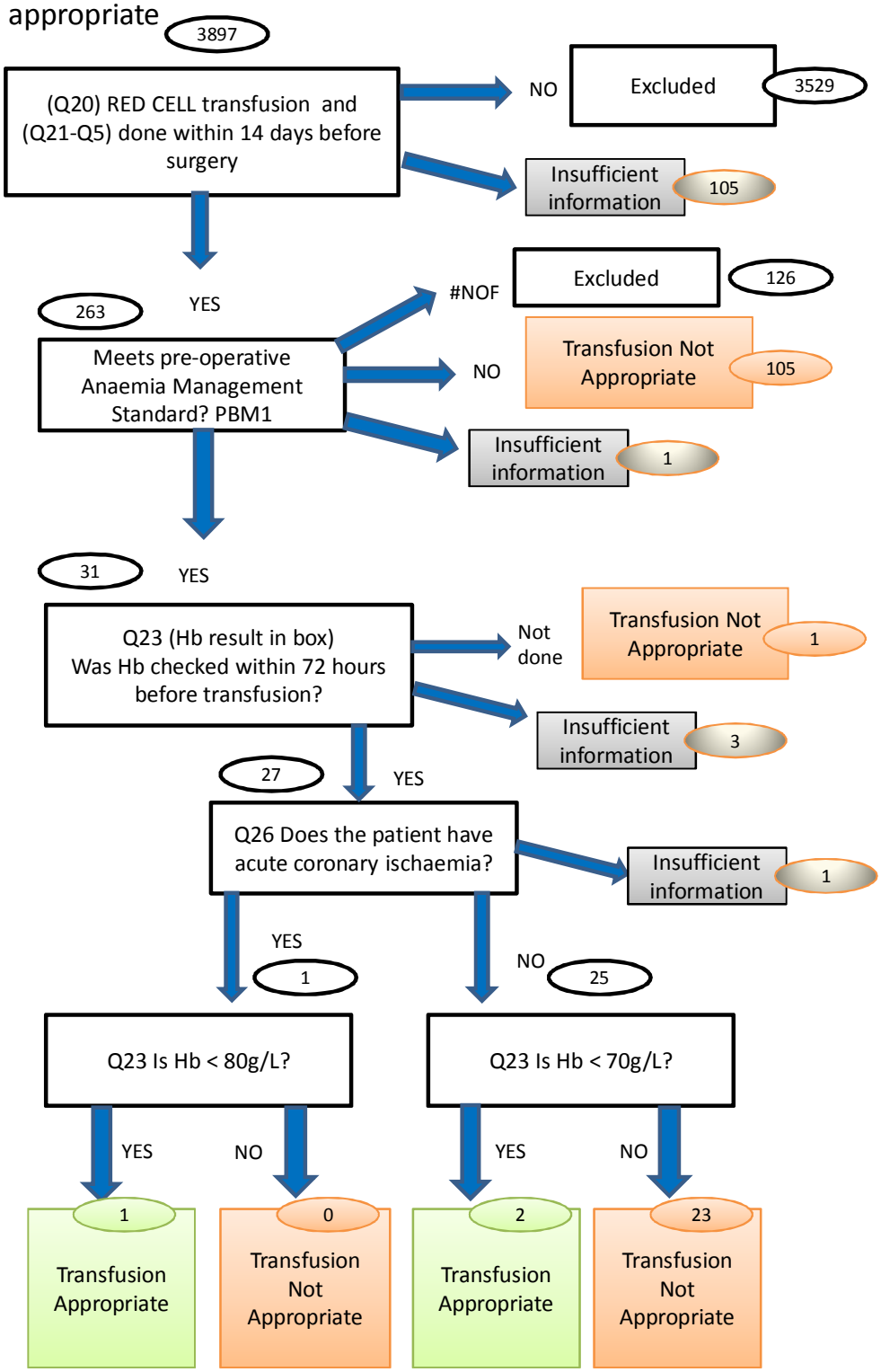
Algorithm for PBM standard 1 : Pre operative anaemia management



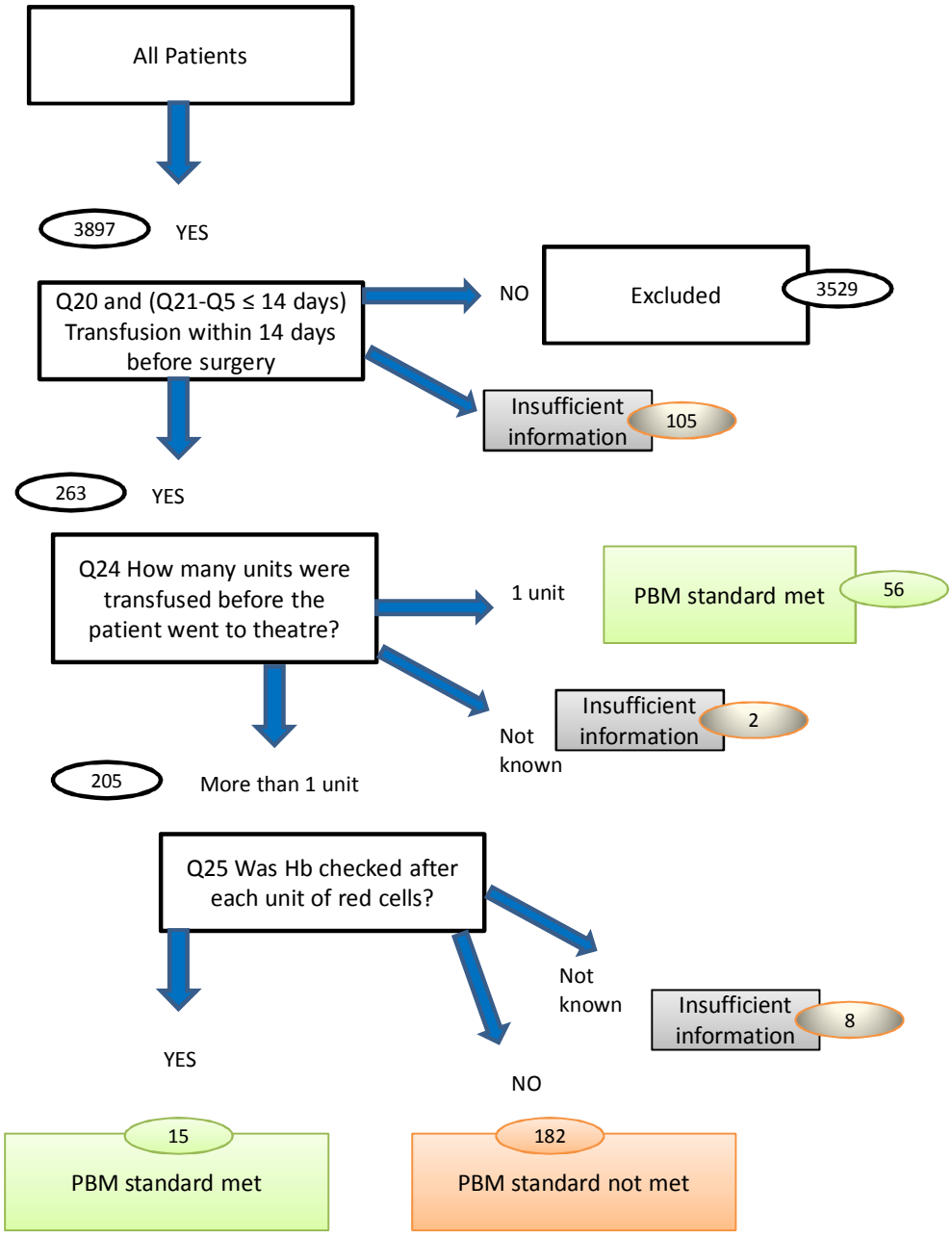
Algorithm for PBM standard 2 : Pre operative transfusion allowed



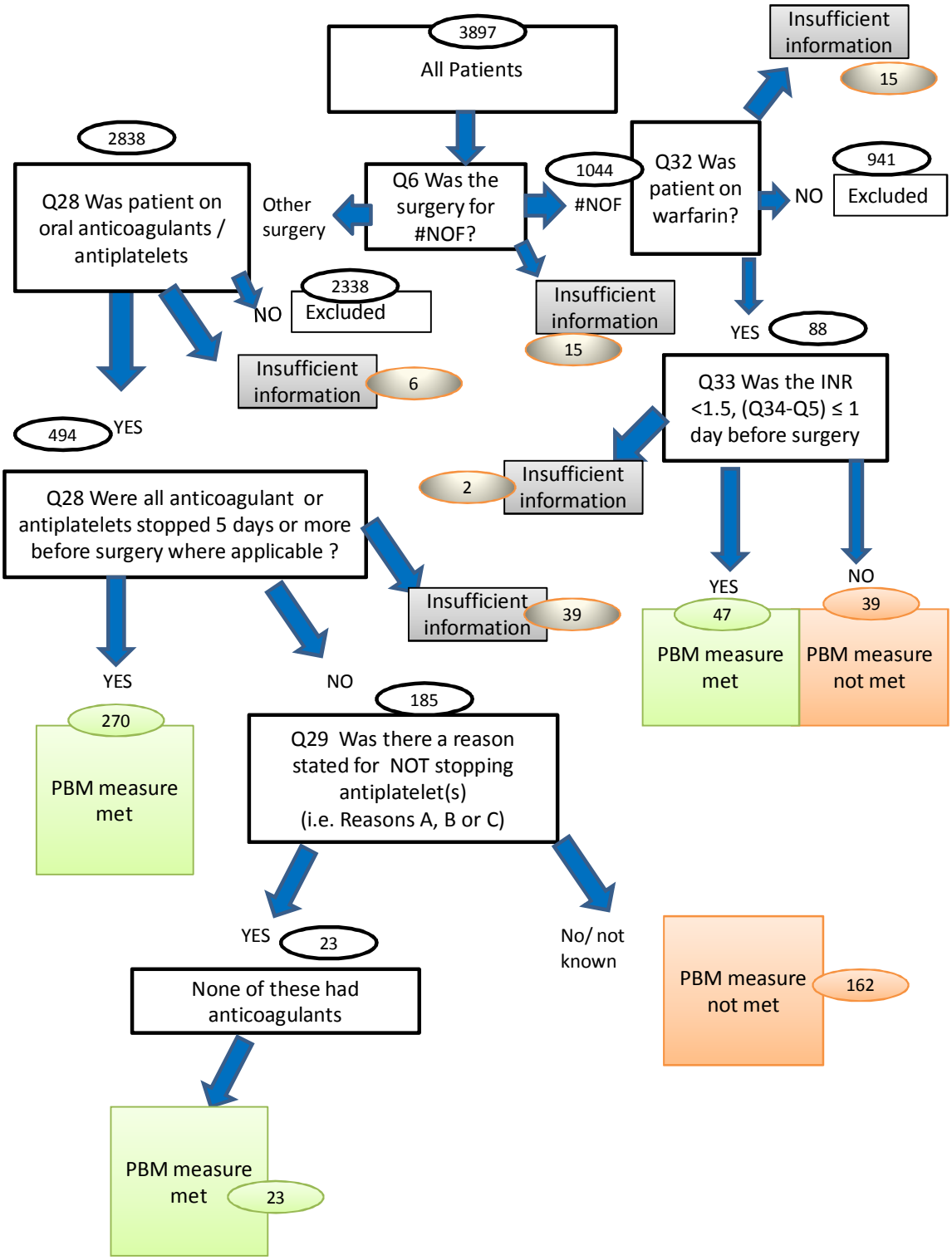
Algorithm for PBM standard 3 : Pre operative transfusion allowed only if preoperative anaemia optimisation has been attempted where appropriate



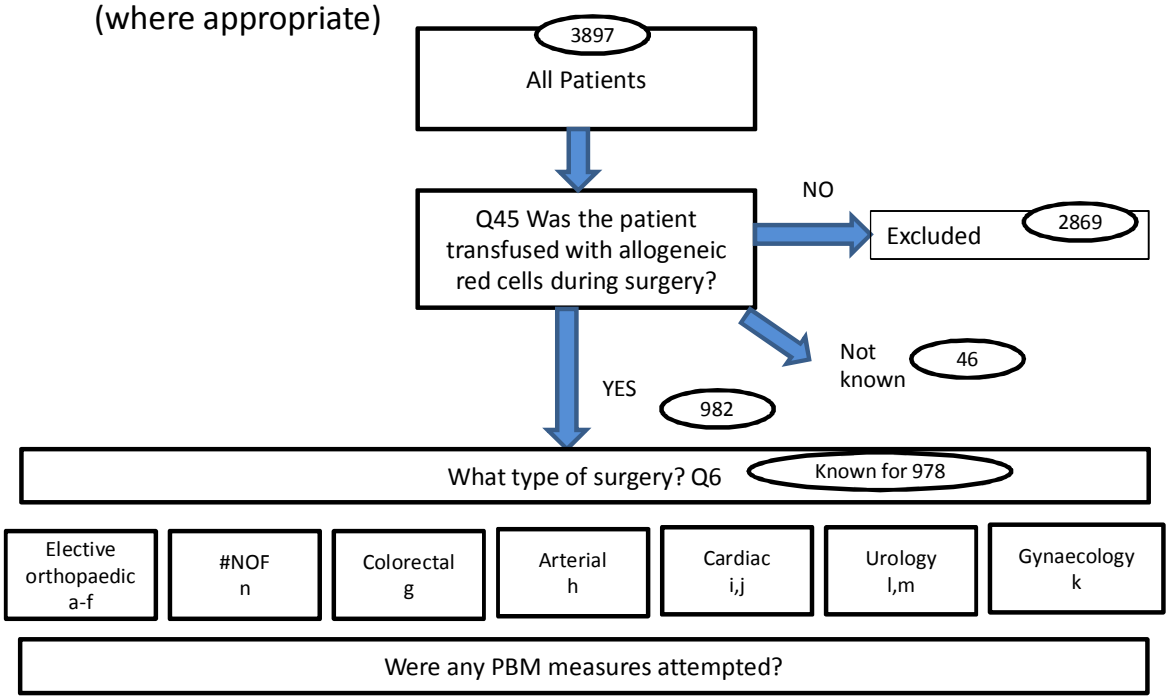
Algorithm for PBM standard 4 : Pre operative transfusion – single unit transfusion policy



Algorithm for PBM standard 5 : Pre operative anticoagulant and antiplatelet management



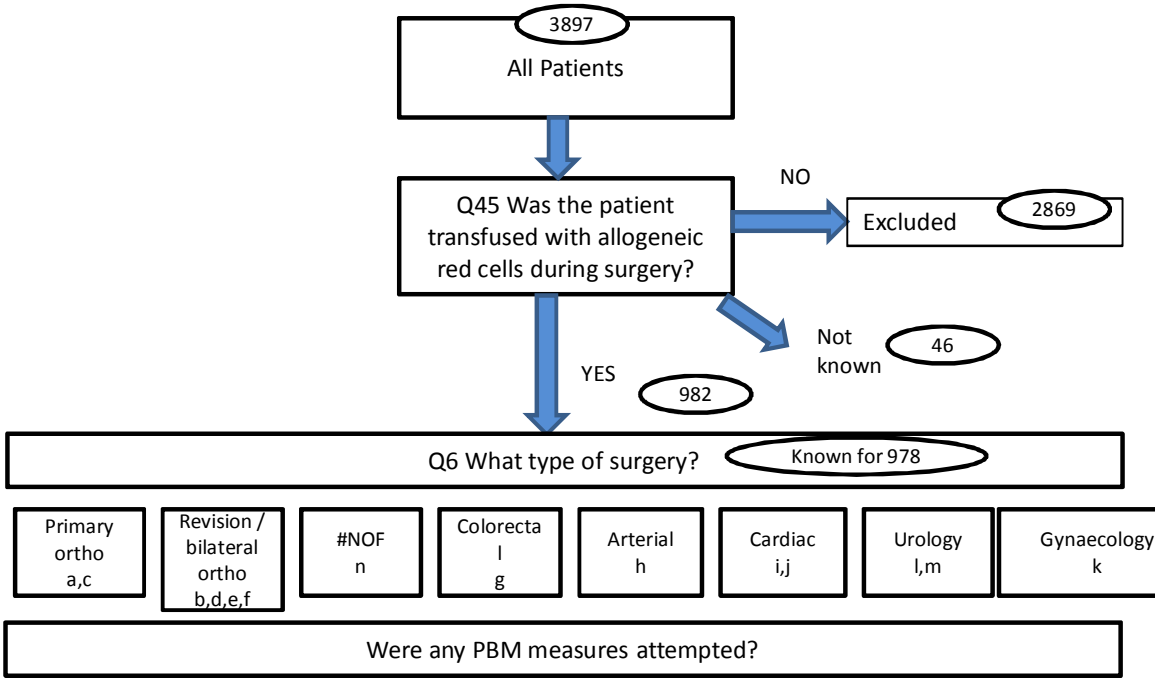
Algorithm for PBM standard 6 : Patients having Intra operative transfusion in whom at least one PBM measure has been attempted (where appropriate)



Meets pre op anaemia standard? Standard 1						
Yes / No / NK 93 / 102 / 0	N/A	Yes / No / NK 30 / 86 / 0	Yes / No / NK 22 / 40 / 0	Yes / No / NK 106 / 122 / 1	Yes / No / NK 28 / 54 / 0	Yes / No / NK 37 / 77 / 0
Meets pre op anticoagulant / antiplatelet standard? Standard 5						
Yes / No / Ex / NK 13 /14 /166 / 2	Yes / No / Ex / NK 13 / 5 / 158 / 4	Yes / No / Ex / NK 5 /3 /107 /1	Yes / No / Ex / NK 16 / 9 / 37 / 0	Yes / No / Ex / NK 54 / 25 / 144 / 6	Yes / No / Ex / NK 4 / 3 / 74 / 1	Yes / No / Ex / NK 2 / 1 / 111 / 0
Meets TXA / Aprotonin standard? Q35=pre/intra TXA or Q36=yes						
Yes / No / NK 124 / 64 / 7	N/A	Yes / No / NK 12 / 98 / 6	Yes / No / NK 8 / 53 / 1	Yes / No / NK 187 / 39 / 3	Yes / No / NK 11 / 68 / 3	Yes / No / NK 25 / 83 / 6
Meets cell salvage standard Q40 yes or Q40 no plus Q42=reasons b,c,d,e						
Yes / No / NK 99 / 86 / 10	N/A	N/A	Yes / No / NK 45 / 14 / 3	Yes / No / NK 166 / 57 / 6	Yes / No / NK 48 / 30 / 4	Yes / No / NK 64 / 40 / 10

If yes to any (where applicable) standard is met
If no to all (where applicable) standard is not met

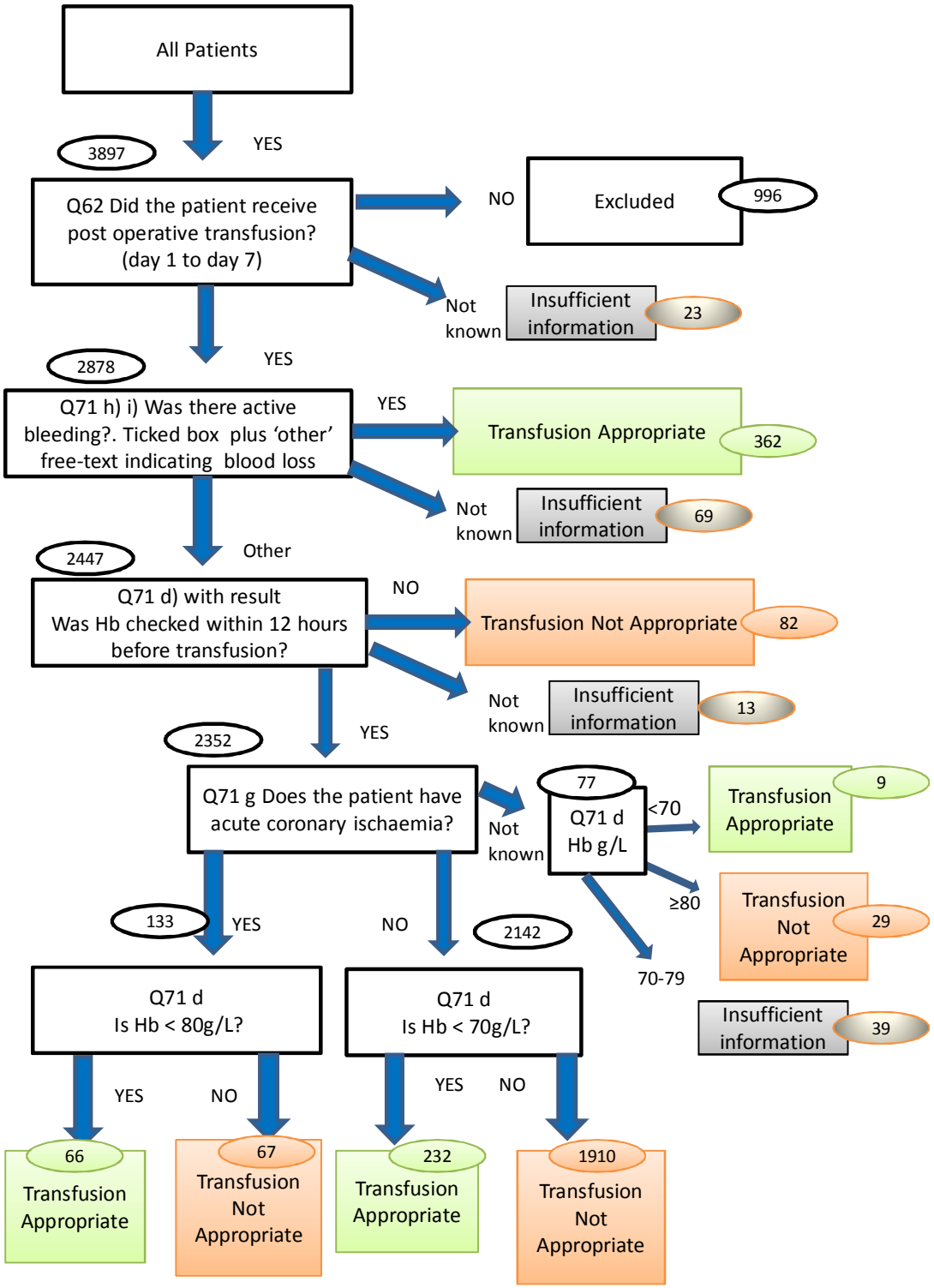
Algorithm for PBM standard 7 : Patients having Intra operative transfusion in whom all PBM measures have been attempted (where appropriate)



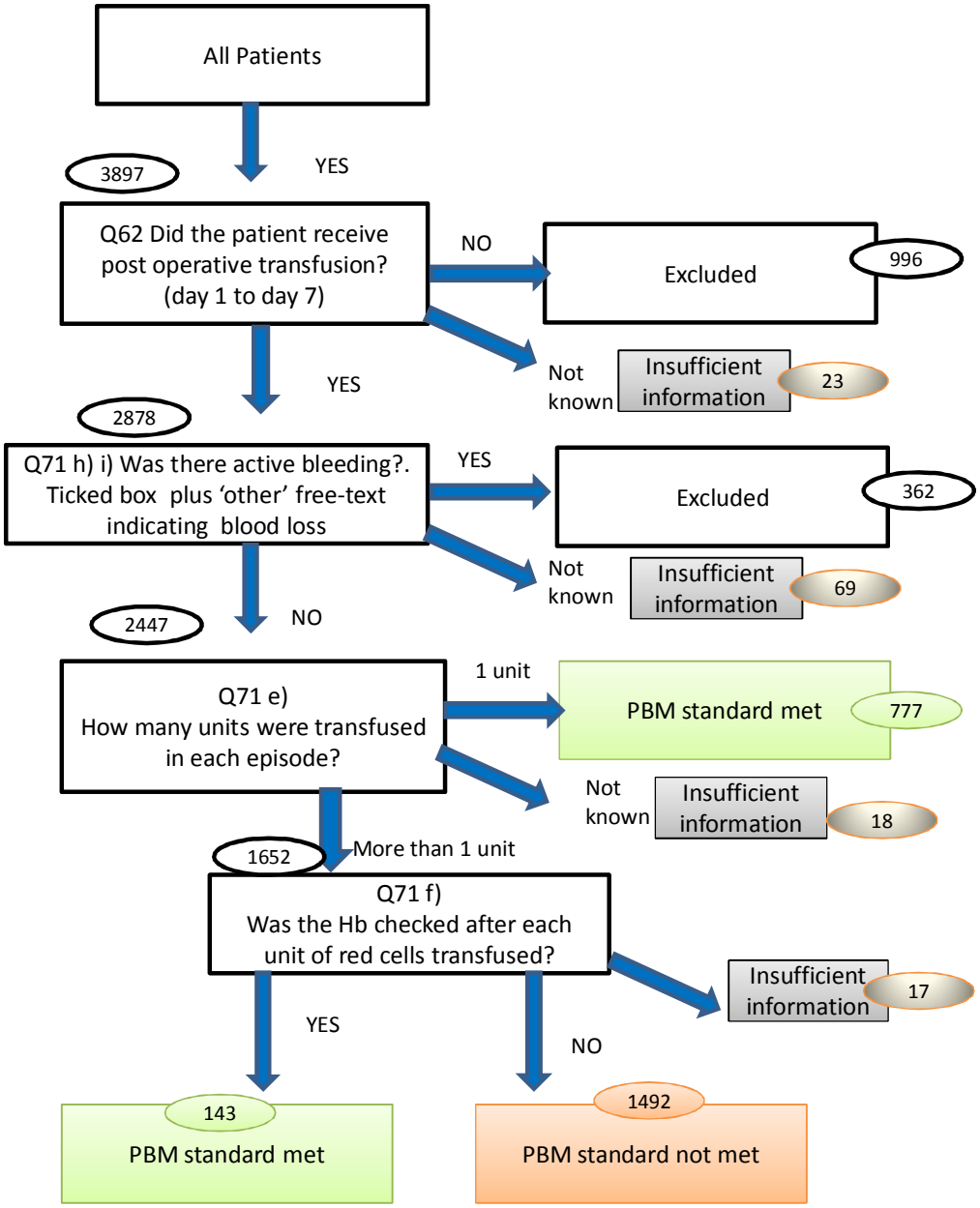
Meets pre op anaemia standard? Standard 1							
Yes /No/ NK 49 / 42 / 0	Yes /No/ NK 44 / 60 / 0	N/A	Yes / No / NK 30 / 86 / 0	Yes / No / NK 22 / 40 / 0	Yes / No / NK 106 / 122 / 1	Yes / No / NK 28 / 54 / 0	Yes / No / NK 37 / 77 / 0
Meets pre op anticoagulant / antiplatelet standard? Standard 5							
Yes/No/Ex/NK 6 / 2 / 83 / 0	Yes/No/Ex/NK 7 / 12 / 83 / 2	Yes/No/Ex/NK 13 / 5 / 158 / 4	Yes/No/Ex/NK 5 /3 /107 /1	Yes/No/Ex/NK 16 / 9 / 37 / 0	Yes/No/Ex/NK 54 /25 / 144/6	Yes/No/Ex/NK 4 / 3 / 74 / 1	Yes/No/Ex/NK 2 / 1 / 111 / 0
Meets TXA / Aprotonin standard? Q35=pre/intra TXA or Q36 = yes							
Yes /No / NK 57 / 30 / 4	Yes /No / NK 67 / 34 / 3	N/A	Yes / No / NK 12 / 98 / 6	Yes / No / NK 8 / 53 / 1	Yes / No / NK 187 / 39 / 3	Yes / No / NK 11 / 68 / 3	Yes / No / NK 25 / 83 / 6
Meets cell salvage standard Q40 yes or Q40 no plus Q42=reasons b,c,d,e							
N/A	Yes /No / NK 47 / 54 / 3	N/A	N/A	Yes / No / NK 45 / 14 / 3	Yes / No / NK 166 / 57 / 6	N/A	N/A

If yes to all (where applicable) standard is met
If no to any (where applicable) standard is not met

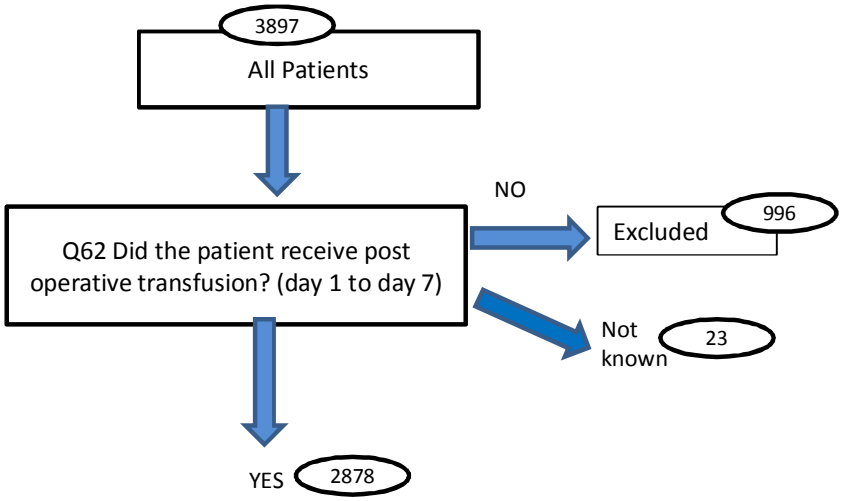
Algorithm for PBM standard 8 : Post operative transfusion allowed (whether or not PBM measures attempted) – FIRST transfusion episode



Algorithm for PBM standard 9 : Post operative transfusion following the single unit policy (FIRST episode)?



Algorithm for PBM standard 10 : Patients having post operative transfusion in whom at least one PBM measure has been attempted (where appropriate) (FIRST EPISODE)



What type of surgery? Known for 2865

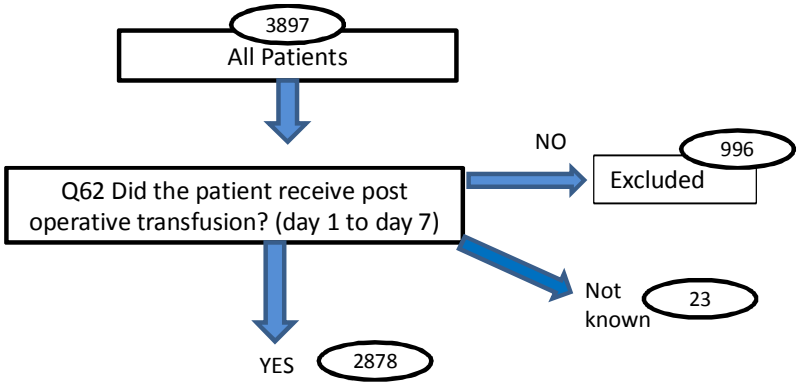
Elective orthopaedic a-f	#NOF n	Colorectal g	Arterial h	Cardiac i,j	Urology l,m	Gynaecology k

Were any PBM measures attempted?

Meets pre op anaemia standard? Standard 1						
Yes /No / NK 621 / 470 / 0	NA	Yes /No / NK 43/ 118 / 0	Yes /No / NK 30 / 60 / 0	Yes /No / NK 151 / 241 / 2	Yes /No / NK 39 / 51 / 0	Yes /No / NK 83 / 129 / 0
Meets pre op anticoagulant / antiplatelet standard? Standard 5						
Yes/No/Ex/NK 76 / 50 / 947 / 18	Yes/No/Ex/NK 32 / 31 / 752 / 12	Yes/No/Ex/NK 11 / 4 / 143 / 3	Yes/No/Ex/NK 23 / 9 / 57 / 1	Yes/No/Ex/NK 81 / 49 / 251 / 13	Yes/No/Ex/NK 10 / 3 / 76 / 1	Yes/No/Ex/NK 5 / 5 / 200 / 2
Meets TXA / Aprotonin standard? Q35 =yes or Q36 = yes						
Yes /No / NK 475 / 583 / 33	N/A	Yes /No / NK 3 / 148 / 10	Yes /No / NK 7 / 80 / 3	Yes /No / NK 312 / 80 / 2	Yes /No / NK 8 / 80 / 2	Yes /No / NK 29 / 175 / 8
Meets cell salvage standard Q40 yes or Q40 no plus Q42=reasons b,c,d,e						
Yes /No / NK 578 / 437 / 76	N/A	N/A	Yes /No / NK 56 / 27 / 7	Yes /No / NK 289 / 94 / 11	Yes /No / NK 57 / 23 / 10	Yes /No / NK 116 / 74 / 22
Meets post op cell salvage standard Q55=yes						
Yes /No / NK 37 / 1021 / 33	N/A	N/A	N/A	Yes /No / NK 11 / 376 / 7	N/A	N/A

If yes to any (where applicable) standard is met
If no to all (where applicable) standard is not met

Algorithm for PBM standard 11 : Patients having post operative transfusion in whom all PBM measures have been attempted (where appropriate) (FIRST EPISODE)



What type of surgery? Known for 2865

Primary ortho a,c	Revision / bilateral ortho b,d,e,f	#NOF n	Colorectal g	Arterial h	Cardiac i,j	Urology l,m	Gynaecology k

Were any PBM measures attempted?

Meets pre op anaemia standard? Standard 1							
Yes /No / NK 481 / 332 / 0	Yes /No / NK 140 / 138 / 0	N/A	Yes /No / NK 43/ 118 / 0	Yes /No / NK 30 / 60 / 0	Yes /No / NK 151 / 241 / 2	Yes /No / NK 39 / 51 / 0	Yes /No / NK 83 / 129 / 0
Meets pre op anticoagulant / antiplatelet standard? Standard 5							
Yes/No/Ex/NK 56/28/716/13	Yes/No/Ex/NK 20/22/231/5	Yes/No/Ex/NK 32 /31/752/12	Yes/No/Ex/NK 11 / 4 / 143 / 3	Yes/No/Ex/NK 23 / 9 / 57 / 1	Yes/No/Ex/NK 81 /49 /251/13	Yes/No/Ex/NK 10 / 3 / 76 / 1	Yes/No/Ex/NK 5 / 5 / 200 / 2
Meets TXA / Aprotonin standard? Q35 =yes or Q36 = yes							
Yes /No / NK 325 / 459 / 29	Yes /No / NK 150 / 124 / 4	N/A	Yes /No / NK 3 / 148 / 10	Yes /No / NK 7 / 80 / 3	Yes /No / NK 312 / 80 / 2	Yes /No / NK 8 / 80 / 2	Yes /No / NK 29 / 175 / 8
Meets cell salvage standard Q40 yes or Q40 no plus Q42=reasons b,c,d,e							
N/A	Yes /No / NK 142 / 119 / 17	N/A	N/A	Yes /No / NK 56 / 27 / 7	Yes /No / NK 289 / 94 / 11	N/A	N/A
Meets post op cell salvage standard Q55=yes							
Yes /No / NK 28 / 760 / 25	N/A	N/A	N/A	Yes /No / NK 1 / 86 / 3	N/A	N/A	Yes /No / NK 0 / 206 / 6

If yes to all (where applicable) standard is met
If no to any (where applicable) standard is not met

Appendix A – Patient Audit Tool

A. Patient demographics

Q1. What was the patient's year of birth? ☐☐☐☐

Q2. Was the patient ☐ Male? ☐ Female?

.....

B. Patient Blood Management in the period from listing for surgery to going to theatre

Q3. On what date was the patient listed for surgery? *ddmmyy* ☐☐ ☐☐ ☐☐

Q4. For what date was the surgery scheduled? ☐☐ ☐☐ ☐☐

Q5. What was the actual date of surgery? ☐☐ ☐☐ ☐☐

Q6. What was the type of procedure? *(Tick one option)*

☐ Primary unilateral total hip replacement
☐ Primary bilateral total hip replacement
☐ Primary unilateral total knee replacement
☐ Primary bilateral total knee replacement
☐ Unilateral revision hip replacement
☐ Unilateral revision knee replacement
☐ Colorectal resection for any indication (open or laparoscopic)
☐ Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass
☐ Primary coronary artery bypass graft
☐ Valve replacement +/- CABG
☐ Simple or complex hysterectomy
☐ Cystectomy
☐ Nephrectomy
☐ # neck of femur (arthroplasty)

Q7. Did the patient have a pre-operative assessment?

☐ Yes ***Now go to Q8*** ☐ No ***Now go to Q11***

Q8. On what date did the patient have their first pre-operative assessment? ☐☐ ☐☐ ☐☐

Q9. Who is responsible for reviewing the results of investigations taken at the pre-operative assessment?

☐ Not known
☐ Nurse
☐ Doctor – discipline and rank

Q10. If the pre operative assessment took place less than 4 weeks before surgery what was the reason?

Q11. Were FBC results available in the time between listing for surgery and up to 14 days before surgery?

☐ Yes ***Now go to Q12*** ☐ No ***Now go to Q20***

Q12. On what date during the time between listing for surgery and up to 14 days before surgery were the FBC results first available?

☐☐ ☐☐ ☐☐

Q13. What was the Hb result? ☐☐☐ *g/L*

Q14. What was the MCH result? ☐ *picograms* **OR** ☐ Not available

Q15. What was the MCV result? ☐ *femolitres* **OR** ☐ Not available

Q16. Was ferritin checked? ☐ Yes ***Now go to Q17*** ☐ No ***Now go to Q18***

Q17. If yes, what was the ferritin result?
(State unit of measurement as well as value, and include reference range) ***THEN GO TO Q18***

Value	Unit of measurement	Reference range

Q18. Was a transferrin saturation test done?

☐ Yes ***Now go to Q19*** ☐ No ***Now go to Q20***

Q19. What was the transferrin saturation? ☐ *%*

Q20. Was the patient on any of the following treatments before they had their operation?

- ☐ None
- ☐ Oral iron
- ☐ IV iron
- ☐ Erythrocytosis-stimulating agent (ESA) therapy
- ☐ B12
- ☐ Folic acid
- ☐ Red cell transfusion - *Ticking this means the patient had a red cell transfusion before they went to theatre.* ***Now go to Q21*** *to record details of that transfusion episode. Details of allogeneic red cell transfusion in theatre are recorded at Q45.*

NB: If you did not tick Red cell transfusion DO NOT complete this section. Go to Q28.

Q21. What was the date and time of transfusion of the first unit?

Date ddmmyy ☐☐ ☐☐ ☐☐ *Time hh:mm* ☐☐ ☐☐

Q22. Who made the decision to transfuse? (*Please state job title and, if doctor, give discipline and rank if possible)*

Q23. What was the pre-transfusion Hb in g/L? *(up to 72 hours before first unit transfused)*

☐☐☐ g/L OR ☐ Not done

Q24. How many units of red cells were given in all before the patient went to theatre?

☐☐

Q25. Was the Hb recorded after each unit of red cells? ☐ Yes ☐ No

Q26. Did the patient have acute coronary ischaemia*? ☐ Yes ☐ No

*(*definition of acute coronary ischaemia: STEMI (ST segment elevated myocardial infarction); NSTEMI (Non ST segment elevation myocardial infarction); Unstable angina within last 14 days)*

Q27. If the patient was transfused at a pre-transfusion Hb of >70g/L (without acute coronary syndrome) or >80g/L (with acute coronary syndrome), please state reason for transfusion:

Q28 Was the patient on any of the following medications at any time in the month leading up to surgery *(that is up until the time of Nil by Mouth)*, and if so were they stopped? If they were, give the date they were stopped. *If they were not on any of them, tick" None/ No record" and go to Q30.*

	Tick if patient on drug	**Tick if stopped prior to surgery / or there is a note that patient was asked to stop**	**On what date was it stopped /or was the patient asked to stop?**
Apixaban			
Dabigatran			
Rivaroxaban			
Warfarin			
Other oral anticoagulant (please state)			
Clopidogrel			
Prasugrel			
Ticagrelor			
Other antiplatelet agent (please state)			

☐ None / No record of any of the above medication prior to surgery

Q29. If the patient was on clopidogrel, prasugrel or ticagrelor or other antiplatelet agent **and it was not stopped**, give details of the documented clinical reason for continuing it:

*Use a **code** to tell us the reason for continuing: **A** = coronary artery stent within last 12 months, **B** = acute coronary syndrome, **C** = other, **D**= don't know. If you use code **C**, please provide brief details*	
Clopidogrel	
Prasugrel	
Ticagrelor	
Other antiplatelet agent	

Q30. What was the pre-operative Hb taken closest before the date of surgery?

☐☐☐ g/L ***Now go to Q31*** **or** ☐ Not done ***Now go to Q32***

Q31. What was the date of that Hb check? ☐☐ ☐☐ ☐☐

Q32. Was the patient on Warfarin pre-operatively?

☐ Yes ***Now go to Q33*** ☐ No ***Now go to Q35***

Q33. What was the INR result taken closest before the date of surgery? ☐☐☐☐

Q34. What was the date of that INR check? ☐☐ ☐☐ ☐☐

C: Patient Blood Management while in theatre and recovery

Q35. Was tranexamic acid used for this patient?

☐ Yes ***Complete the table below, then go to Q36*** ☐ No ***Now go to Q36***

If used, write dose in relevant box	Before surgery started	During surgery	After surgery
Oral			
IV			
Intra-articular			

Q36. Was aprotonin used for this patient?

☐ Yes ***Now go to Q37*** ☐ No ***Now go to Q38***

Q37. What was the dose used? *(Please state in mls and not KIU)* Dose ☐

Q38. Were haemostatic agents or sealants used for this patient?

☐ Yes ***Now go to Q39*** ☐ No ***Now go to Q40***

Q39. Which agents or sealants were used?

☐

Q40. Was collection for intra-operative cell salvage (IOCS) commenced?

☐ Yes ***Now go to Q41*** ☐ No ***Now go to Q42***

Q41. Which of these describes the outcome of using IOCS?

☐ Collected but not reinfused due to insufficient volume

☐ Collected and reinfused – (state volume reinfused) ☐ mls

Q42. Why was cell salvage not commenced?

☐ IOCS was not available on the day of surgery

☐ Not worthwhile in this procedure as anticipated blood loss generally too low

☐ Not considered in this procedure because of contaminated field

☐ Not considered in this procedure because of sepsis

☐ Not considered in this procedure because of malignancy

☐ Other, please state:

Q43. Was near patient testing of haemostasis undertaken?

☐ Yes ***Now go to Q44*** ☐ No ***Now go to Q45***

Q44. Which of these near patient testing options were undertaken? *(tick as many as apply)*

☐ TEG
☐ RoTEM
☐ Platelet function testing
☐ Activated Clotting Time
☐ Other, please state:

*Questions 45 to 52 ask about allogeneic blood that was transfused in theatre or recovery, in other words intra-operative transfusion. If allogeneic blood **was** used, answer Yes to Q45 and continue through to Q52. If allogeneic blood **was not** used, answer No to Q45 and go to Q53.*

We ask you to give details of post-op cell salvage and post-op allogeneic transfusion in Section D

Q45. Was there any intra-operative transfusion with allogeneic red cells issued by the transfusion laboratory?

☐ Yes ***Now go to Q46*** ☐ No ***Now go to Q53***

Q46. Who made the decision to transfuse? (*Please state job title and, if doctor, give discipline and rank if possible)*

Q47. Was the pre-transfusion Hb checked within 1 hour before transfusing the first unit?

☐ Yes ***Now go to Q48*** ☐ No ***Now go to Q50***

Q48. How was the pre-transfusion Hb checked?

☐ Laboratory Hb from FBC sample
☐ Hb from blood gas analyser
☐ Hb from 'Masimo'
☐ Hb from Haemocue
☐ Other, please state

Q49. What was the first intra-operative pre-transfusion Hb?

☐☐☐ g/L **or** ☐ Not done

Reason for intra-operative transfusion:

Q50. Did the patient have active bleeding?

☐ Yes ***Now complete the boxes below, then go to Q52*** ☐ No ***Now go to Q51***

Please state how the active bleeding was recorded in the notes: give estimated blood loss (EBL) and / or change in physiological parameters:

EBL (mls)	Change in parameters

Q51. The patient did not have active bleeding, so why were they transfused?

Q52. How many units of red cells were transfused intra-operatively? ☐☐

On arrival in recovery:

Q53. Was an Hb taken on arrival in recovery?

☐ Yes ***Now go to Q54*** ☐ No ***Now go to Q55***

Q54. What was the Hb taken on arrival in recovery? ☐☐☐ g/L

.....

D: Post-operative Patient Blood Management *(when the patient had returned to the ward or had gone to HDU or similar)*

Q55. Was post-operative cell salvage used?

☐ Yes ***Now go to Q56*** ☐ No ***Now go to Q58***

Q56. Which post-op cell salvage technique(s) was/were used:

☐ Reinfused shed blood
☐ Washed red cells
☐ Other *(You do not need to gives us details of other techniques)*

Q57. What was the total volume in mls of post-operative salvaged blood infused? ☐☐☐☐

Q58. What was the first Hb taken on day 1? ☐☐☐ g/L **or** ☐ Not done
(Day 1 is the next calendar day after surgery)

Q59. Did any of these complications of surgery occur? *(Tick as many as apply)*

☐ No complications noted

☐ Return to theatre ☐ VTE ☐ Wound infection
☐ Positive blood culture ☐ Other, please state:

Q60. Was the patient given post-operative iron?

☐ Yes ***Now go to Q61*** ☐ No ***Now go to Q62***

Q61. Was it given ☐ orally ☐ IV *(Tick one or both as applicable)*

This is where you tell us about any allogeneic red cells that were transfused once the patient had left recovery. A transfusion episode is all units of red cells given against one prescription.

Q62. Was there transfusion on any of the first seven post-operative days? *(i.e. Day 1 to day 7)*

☐ Yes ***Now go to Q63*** ☐ No ***Now go to Q66***

Q63. How many post-operative transfusion episodes were there?
(A transfusion episode = any red cells transfused within a 24 hour period)

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

If there were more than 5 episodes of post-operative allogeneic red cell transfusion in the 7 post-operative days, please contact us for advice on how to proceed.

Q64. Did the patient have an adverse reaction to ANY transfusion?

☐ Yes ***Now go to Q65*** ☐ No ***Now go to Q66***

Q65. What type of blood caused the reaction? ☐ Autologous ☐ Allogeneic

Q65a. Please supply details:

Date	Was the transfusion Pre-op, Intra-op or Post-op?	SHOT category

Q66. Did the patient die during this admission?

☐ Yes ***Now go to Q67*** ☐ No ***Now go to Q68***

Q67. What was the date of death? ☐☐ ☐☐ ☐☐

Q68. What was the date of discharge? ☐☐ ☐☐ ☐☐

Q69. What was the Hb on or nearest to discharge / death? ☐☐☐ *g/L* ***Now go to Q70***

or ☐ Not done ***Go to Episode 1 if there was post-operative transfusion with allogeneic blood***

Q70. What was the date of the Hb test? ☐☐ ☐☐ ☐☐

Please record details of each post-operative transfusion episode:

Episodes 1 to 5

a) Date of transfusion ☐☐ ☐☐ ☐☐

b) Time of transfusion ☐☐ ☐☐

c) Who made the decision to transfuse?

d) What was the pre transfusion Hb (within 12 hours of transfusion)? ☐☐☐ g/L

e) How many units of red cells were given? ☐☐

f) Was the Hb recorded after each unit of red cells? ☐ Yes ☐ No

g) Did the patient have acute coronary ischaemia? ☐ Yes ☐ No

***Definition of acute coronary ischaemia: STEMI (ST segment elevated myocardial infarction), NSTEMI (Non ST segment elevation myocardial infarction) unstable angina) within last 14 days.*

h) What was the reason for transfusion?

☐ Active bleeding

**Active post operative bleeding defined as bleeding causing systolic Hb <90mmHg, and or heart rate >110bpm, and or return to theatre because of bleeding and or activation of major haemorrhage pathway.*

☐ An Hb <70 g/L without acute coronary syndrome

☐ An Hb <80 g/L with acute coronary syndrome

☐ Other, please state

Appendix B – Audit standards and PBM algorithms

(Rules that define likely appropriate transfusion)

Scheduled Surgical procedures:

- Primary unilateral total hip replacement
- Primary bilateral total hip replacement
- Primary unilateral total knee replacement
- Primary bilateral total knee replacement
- Unilateral revision hip replacement
- Unilateral revision knee replacement
- Colorectal resection for any indication (open or laparoscopic)
- Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass)
- Primary coronary artery bypass graft
- Valve replacement +/- CABG
- Simple or complex hysterectomy
- Cystectomy
- Nephrectomy
- # neck of femur (arthroplasty)

Definition of likely appropriate transfusions in scheduled surgical patients

***see over for definition of PBM measures**

Pre operative patients (transfusion within 14 days)

- Patients with Hb <70g/L with no acute coronary ischaemia* in whom pre op anaemia optimisation has been attempted where possible
- Patients with Hb <70g/L with no acute coronary ischaemia* and no pre op anaemia optimisation attempted
- Patients with Hb <80g/L and acute coronary ischaemia in whom in whom pre op anaemia optimisation has been attempted where possible
- Patients with Hb <80g/L and acute coronary ischaemia and no pre op anaemia optimisation attempted
- Patients should be given 1 unit at a time with an Hb check before a further unit

** definition of acute coronary ischaemia: STEMI (ST segment elevated myocardial infarction), NSTEMI (Non ST segment elevation myocardial infarction), unstable angina within the last 14 days*

Intra operative patients

- Patients in whom PBM measures have been used (all relevant for this type of surgery).
- Patients in whom one or some PBM measures have been attempted
  Patients with active bleeding

**Active intra operative bleeding = significant blood loss with haemodynamic instability (pre and post transfusion Hb and number of units transfused will also be used to judge appropriateness of transfusion)

Post operative patients

- Patients in whom PBM measures have been used (all relevant for this type of surgery).
- Patients in whom one or some PBM measures have been attempted
- Patients with active bleeding
- Patients with Hb <70g/L without active bleeding and without acute coronary. Patients with Hb <80g/L and acute coronary ischaemia but without active bleeding. In patients without active bleeding, transfusions should be given 1 unit at a time with an Hb check before a further unit is transfused.

***Active post operative bleeding = patients with bleeding and or systolic BP <90mmHg and or heart rate >110 bpm, and or return to theatre due to bleeding and or activation of the major haemorrhage pathway

**definition of acute coronary ischaemia: STEMI (ST segment elevated myocardial infarction), NSTEMI (Non ST segment elevation myocardial infarction), unstable angina*

PBM measures - This is the standard of care for each defined scheduled surgical procedure and ideally all aspects of PBM should have been attempted unless contraindicated or optional in order to meet this standard.

Timing of transfusion	Procedure								
	Primary unilateral / bilateral total hip replacement	Primary unilateral / bilateral and revision total knee replacement	Unilateral revision hip replacement	Surgery for #NOF	Colorectal resection for any indication	Open arterial surgery	• Primary coronary artery bypass graft • Valve replacement +/- CABG	Urological surgery: Cystectomy Nephrectomy	Simple or complex hysterectomy
Pre operative	**A**	**A**	**A**	**C**	**A**	**A**	**A**	**A**	**A**
	B	**B**	**B**		**B**	**B**	**B**	**B**	**B**
Intra operative	**A**	**A**	**A**	**D**	**A**	**A**	**A**	**A**	**A**
	D	**D**	**D**		**D**	**D**	**E**	**D**	**D**
	G		**F**			**F**	**F**	**G**	**G**
Post operative	**A**	**A**	**A**	**D**	**A**	**A**	**A**	**A**	**A**
	D	**D**	**D**		**D**	**D**	**E**	**D**	**D**
	G	**H**	**F**			**F**	**F**	**G**	**G**
	H		**H**				**H**		

PBM Measures Key	
A	Pre-operative anaemia optimisation
B	Pre-operative management of patients on anticoagulants and antiplatelet agents
C	Pre-operative management of patients on oral anticoagulants
D	Tranexamic acid
E	Tranexamic acid / aprotonin
F	Intra-operative cell salvage
G	Optional: Intra-operative cell salvage
H	Optional: Post-operative cell salvage

Notes:

Pre operative Anaemia optimisation

Patients with iron deficiency anaemia identified pre op and treated with IV or oral iron (anaemia defined as HB <120g/L females, < 130g/L males at least 14 days before surgery, iron deficiency defined as ferritin <30, Transferrin saturation <20% if no ferritin performed or MCV <78fl if no ferritin or transferrin saturation performed). There is no expectation for optimisation of other forms of anaemia or for optimisation of anaemia in patients with fractured neck of femur

Pre operative management of patients on anticoagulants and antiplatelet agents

Patients on oral anticoagulants (e.g. warfarin or novel oral anticoagulants as listed in the audit tool) must have the oral anticoagulant discontinued at least 5 days pre operatively. Patients on antiplatelet agents (dual antiplatelet therapy, clopidogrel, ticagrelor, prasugrel*) must have the drug(s) discontinued at least 5 days pre operatively unless there are good clinical reasons for continuation, that is coronary artery stent within last 12 months, active ischaemic heart disease in patients undergoing bypass surgery. *It is acceptable to continue low dose aspirin therapy perioperatively

For fractured neck of femur patients on warfarin: anticoagulation should be managed so that INR is <1.5 on day of or day before surgery

Intraoperative cell salvage

Cell salvage set up and attempt made to collect; standard is still met if not enough collected for return. Exceptions: active sepsis, malignancy, contaminated field

Post operative cell salvage has been listed as optional – can be washed red cells or reinfused shed blood

Appendix C – Sites that participated in the audit

Airedale NHS Foundation Trust
Altnagelvin Area Hospital
Ashford and St Peters Hospitals NHS Foundation Trust
Barnet Hospital
Barnsley Hospital NHS Foundation Trust
Barts Health NHS Trust
Basildon and Thurrock University Hospitals NHS Foundation Trust
Beaumont Hospital
Belfast Health and Social Care Trust
Betsi Cadwaladr University Health Board
Birmingham Heartlands Hospital
Birmingham Women's NHS Foundation Trust
Blackpool Victoria Hospital
Bon Secours Hospital Cork
Borders General Hospital
Bradford Teaching Hospitals NHS Foundation Trust
Brighton and Sussex University Hospitals NHS Trust
Calderdale and Huddersfield NHS Foundation Trust
Central Manchester University Hospitals NHS Foundation Trust
Chase Farm Hospital
Chelsea and Westminster Hospital NHS Foundation Trust
Chesterfield Royal Hospital NHS Foundation Trust
Colchester Hospital University NHS Foundation Trust
Conquest Hospital
County Hospital (Stafford)
Craigavon Area Hospital
Croydon Health Services NHS Trust
Darent Valley Hospital
Darlington Memorial Hospital
Derby Hospitals NHS Foundation Trust
Derriford Hospital
Doncaster and Bassetlaw Hospitals NHS Foundation Trust
Doncaster and Bassetlaw Hospitals NHS Foundation Trust
Dorset County Hospital NHS Foundation Trust
East and North Hertfordshire NHS Trust
East Lancashire Hospitals NHS Trust
Eastbourne Hospital
Forth Valley Royal Hospital
Frimley Park Hospital
Furness General Hospital
Galway Clinic

Galway University Hospital
Gateshead Health NHS Foundation Trust
George Eliot Hospital NHS Trust
Gloucestershire Hospitals NHS Foundation Trust
Great Western Hospitals NHS Foundation Trust
Guys and St Thomas' NHS Foundation Trust
Hammersmith Hospital
Hampshire Hospitals NHS Foundation Trust
Harrogate and District NHS Foundation Trust
HCA International Group Hospitals
Hinchingbrooke Hospital
Homerton University Hospital NHS Foundation Trust
Hospital of St John & St Elizabeth
Hull Royal Infirmary
James Paget University Hospital
Kent & Canterbury Hospital
Kettering General Hospital NHS Foundation Trust
King Edward VIIs Hospital Sister Agnes
King's College Hospital NHS Foundation Trust
King's Mill Hospital
Kingston Hospital
Lancashire Teaching Hospitals NHS Foundation Trust
Liverpool Heart & Chest Hospital
Liverpool Women's NHS Foundation Trust
London North West Healthcare NHS Trust
Maidstone Hospital
Medway Maritime Hospital
Mid Cheshire Hospitals NHS Foundation Trust
Mid Essex Hospital Services NHS Trust
Milton Keynes NHS Foundation Trust
Nevill Hall Hospital
NHS Lothian
Norfolk & Norwich University Hospital
North Bristol NHS Trust
North Cumbria University Hospitals NHS Trust
North Middlesex University Hospital
North Tees and Hartlepool NHS Foundation Trust
Northern Devon Healthcare NHS Trust
Northern Lincolnshire and Goole Hospitals NHS Foundation Trust
Northumbria Healthcare NHS Foundation Trust
Nottingham University Hospitals NHS Trust
Nuffield Cheltenham Hospital
Nuffield Orthopaedic Centre (NHSl)
Oswestry Orthopaedic Hospital

Our Lady's Hospital Navan
Oxford University Hospitals NHS Trust
Papworth Hospital NHS Foundation Trust
Peterborough and Stamford Hospitals NHS Foundation Trust
Poole Hospital
Portsmouth Hospitals NHS Trust
Princess Alexandra Hospital
Queen Elizabeth Hospital Woolwich
Queen Elizabeth The Queen Mother Hospital
Queen's Hospital Burton
Queen's Hospital Romford
Ramsay Ashtead Hospital
Ramsay Duchy
Ramsay Euxton Hall Hospital
Ramsay Fitzwilliam Hospital
Ramsay Oaklands Hospital
Ramsay Park Hill Hospital
Ramsay Springfield Hospital
Ramsay West Midlands
Royal Berkshire Hospital
Royal Bolton Hospital
Royal Brompton and Harefield NHS Foundation Trust
Royal Devon & Exeter Hospital
Royal Free Hospital
Royal Gwent Hospital
Royal Lancaster Infirmary
Royal National Orthopaedic Hospital NHS Trust
Royal Surrey Country Hospital
Royal United Hospital
Salford Royal NHS Foundation Trust
Salisbury NHS Foundation Trust
Sandwell and West Birmingham Hospitals NHS Trust
Scarborough General Hospital
Sheffield Teaching Hospitals NHS Foundation Trust
Torbay and South Devon NHS Foundation Trust
South Infirmary Victoria University Hospital Cork
South Tees Hospitals NHS Foundation Trust
South Tyneside NHS Foundation Trust
South Warwickshire NHS Foundation Trust
South West London Elective Orthopaedic Centre
Southampton General Hospital
Southend University Hospital
Southport and Ormskirk Hospital NHS Trust
Spire Alexandra Hospital

Spire Bristol Hospital
Spire Cambridge Lea
Spire Clare Park Hospital
Spire Gatwick Park Hospital
Spire Harpenden Hospital
Spire Hull & East Riding Hospital
Spire Leicester Hospital
Spire Little Aston Hospital
Spire Murrayfield Hospital Wirral
Spire Parkway Hospital
Spire South Bank Hospital - Hospital
Spire St Anthony's Hospital
Spire Thames Valley Hospital
Spire Washington Hospital
Spire Wellesley Hospital
Spire Yale Hospital
St Mary's Hospital, Paddington
St. George's University Hospitals NHS Foundation Trust
St. Vincent's University Hospital
St. Woolos Hospital
Stockport NHS Foundation Trust
Sunderland Royal Hospital
Surrey and Sussex Healthcare NHS Trust
Tameside Hospital NHS Foundation Trust
Taunton & Somerset Hospital
The Dudley Group of Hospitals 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 Montefiore Hospital
The Newcastle upon Tyne Hospitals NHS Foundation Trust
The Pennine Acute Hospitals NHS Trust
The Queen Elizabeth Hospital King's Lynn NHS Foundation Trust
The Rotherham NHS Foundation Trust
The Royal Bournemouth & Christchurch Hospitals NHS Foundation Trust
The Royal Liverpool and Broadgreen University Hospitals NHS Trust
The Royal Marsden NHS Foundation Trust
The Royal Orthopaedic Hospital Birmingham
The Royal Wolverhampton Hospitals NHS Trust
The Shrewsbury and Telford Hospital NHS Trust
The Ulster Hospital
The York Hospital
United Lincolnshire Hospitals NHS Trust

University College London Hospitals NHS Foundation Trust
University Hospital Aintree
University Hospital Coventry
University Hospital Lewisham
University Hospital Limerick
University Hospital of North Durham
University Hospital of South Manchester NHS F. Trust
University Hospitals Birmingham NHS Foundation Trust
University Hospitals Bristol NHS Foundation Trust
University Hospitals of Leicester NHS Trust
Walsall Healthcare NHS Trust
Warrington and Halton Hospitals NHS Foundation Trust
West Hertfordshire Hospitals NHS Trust
West Middlesex University Hospital NHS Trust
West Suffolk NHS Foundation Trust
Western Sussex Hospitals NHS Foundation Trust
Westmorland General Hospital
Weston Area Health NHS Trust
Wexham Park Hospital
Whiston Hospital
William Harvey Hospital
Worcestershire Acute Hospitals NHS Trust
Wrightington, Wigan and Leigh NHS Foundation Trust
Wye Valley NHS Trust
Yeovil District Hospital NHS Foundation Trust

Appendix D – Additional audit information

Patient demographics

Table D1: Type of procedure & age of patient

TYPE OF PROCEDURE and age of patient	Median (IQR) age
• Primary unilateral total hip replacement	77 (67-83), n=608
• Primary bilateral total hip replacement	74 (66-85), n=30
• Primary unilateral total knee replacement	76 (68-82), n=339
• Primary bilateral total knee replacement	71 (60-82), n=27
• Unilateral revision hip replacement	75 (67-82), n=258
• Unilateral revision knee replacement	73 (65-79), n=67
• Colorectal resection for any indication (open or laparoscopic)	71 (61-79), n=300
• Open arterial surgery e.g.scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	73 (65-78), n=157
• Primary coronary artery bypass graft	69 (63-76), n=116
• Valve replacement +/- CABG	73 (66-79), n=423
• Simple or complex hysterectomy	51 (44-65), n=340
• Cystectomy	68 (59-78), n=37
• Nephrectomy	68 (57-74), n=130
• # neck of femur (arthroplasty)	86 (80-91), n=1044
Procedure not stated	78 (73-86), n=15

Table D2: Days from scheduled to actual surgery (excluding # neck of femur)

	National	Your site
Known	2634	
Before scheduled	2% (54)	
Same day	77% (2032)	
Day after scheduled	3% (84)	
≥2days after scheduled	18% (464)	

Table D3: Pre-operative assessment excluding # neck of femur

	National	Your site
Known	2818	
Pre-operative assessment	87% (2446)	**% ()**

Table D4: Days from pre-operative assessment to surgery, excluding # neck of femur

	National	Your site
Median (IQR)	19(8-48), n=2420/2446	**Median: ,**

Table D5: Who is responsible for reviewing results of investigations taken at the pre-operative assessment? (excluding # neck of femur)

	National (2446)	Your site
Doctor	35% (844)	
Nurse	52% (1278)	
Not known	13% (324)	
Type of Doctor: (n=844)*		
• Consultant- Anaesthetics & critical care	34% (289)	
• Consultant - Other specialty	17% (146)	
• Consultant - Specialty not known	7% (62)	
• Senior trainee - Anaesthetics & critical care	3% (22)	
• Senior trainee - Other specialty	2% (20)	
• Senior trainee - Specialty not known	11% (93)	
• Junior trainee - Anaesthetics & critical care	1% (8)	
• Junior trainee - Other specialty	6% (52)	
• Junior trainee - Specialty not known	4% (32)	
• Grade NK - Anaesthetics & critical care	8% (70)	
• Grade NK - Other specialty	1% (12)	
• Grade NK - Specialty not known	5% (38)	

*These categories were formed from free-text stated by auditors

Table D6: Who is responsible for reviewing results of investigations taken at the pre-operative assessment? (excluding # neck of femur), broken down by procedure

	Who is responsible for reviewing results of investigations at pre-operative assessment			
TYPE OF PROCEDURE	Doctor	Nurse	Not known	Total
• Primary unilateral total hip replacement	196	279	58	533
• Primary bilateral total hip replacement	7	14	4	25
• Primary unilateral total knee replacement	90	206	33	329
• Primary bilateral total knee replacement	6	17	4	27
• Unilateral revision hip replacement	71	116	24	211
• Unilateral revision knee replacement	21	34	3	58
• Colorectal resection for any indication (open or laparoscopic)	74	125	45	244
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	50	45	19	114
• Primary coronary artery bypass graft	61	29	7	97
• Valve replacement +/- CABG	151	141	45	337
• Simple or complex hysterectomy	75	182	58	315
• Cystectomy	5	19	4	28
• Nephrectomy	33	66	19	118
• # neck of femur (arthroplasty)	163	8	21	192
Procedure not stated	4	5	1	10
Total	**1007**	**1286**	**345**	**2638**

Table D7: If the pre operative assessment took place less than 4 weeks before surgery what was the reason? (excluding # neck of femur)

	National	Your site
Pre-operative assessment within 0-28 days before surgery:	63% (1527/2420)	% (/)
Reason:*		
• Emergency Trauma	1% (12)	
• Cancer surgery	12% (187)	
• Other urgent	17% (260)	
• Waiting list initiative	1% (11)	
• Routine practice	21% (326)	
• Other non-urgent	0.4% (6)	
• No reason given/not known	47% (725)	

*These categories were formed from free-text stated by auditors

Table D8: Reason why pre-op assessment took place less than 4 weeks before surgery

TYPE OF PROCEDURE	If pre operative assessment took place < 4 weeks before surgery what was the reason?							Total
	Emergency trauma	Cancer surgery	Other urgent	Waiting list initiative	Routine practice	Other non-urgent	No reason given/not known	
Primary unilateral total hip replacement	7	4	28	5	101	-	149	294
Primary bilateral total hip replacement	-	-	-	-	4	-	6	10
Primary unilateral total knee replacement	-	1	3	3	49	1	108	165
Primary bilateral total knee replacement	-	-	-	-	5	-	9	14
Unilateral revision hip replacement	3	-	29	-	32	3	60	127
Unilateral revision knee replacement	1	-	11	-	10	1	15	38
Colorectal resection for any indication (open or laparoscopic)	-	74	30	-	20	-	71	195
Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	-	-	33	-	5	-	29	67
Primary coronary artery bypass graft	-	-	43	-	2	-	23	68
Valve replacement +/- CABG	-	1	43	1	36	1	102	184
Simple or complex hysterectomy	-	67	23	2	45	-	104	241
Cystectomy	-	7	2	-	8	-	6	23
Nephrectomy	-	33	12	-	9	-	40	94
# neck of femur (arthroplasty)	176	-	-	-	-	-	8	184
Procedure not stated	1	-	3	-	-	-	3	7
Total	188	187	260	11	326	6	733	1711

Table D9: FBC results

FBC results	Median	IQR	N	Your site median, n
Hb result, g/L:	124	112-135	1407	,
MCH result, picograms:	29.8	27-9-31.2	1302	,
MCV result, femolitres	89	85-93	1377	,
Ferritin:	68	27-140	205	,
Transferrin saturation test (TSAT)	20	12-31	48	,

Table D10: FBC results

	National	Your site
Hb result, g/L:		
Female: median (IQR)	121 (111-130), n=896	,
Male: median (IQR)	131 (117-143), n=506	,
Females with Hb<120 g/L	46% (411/896)	
Males with Hb<130 g/L	48% (244/506)	
Of those with an Hb result:		
Also with a MCV result	98% (1308/1407)	
Also with a Ferritin result	15% (205/1407)	
Of those with an Hb result but with no Ferritin result:		
Also with a TSAT result	0.4% (5/1202)	

Table D11: Days from Transfusion of the first unit to surgery

	National	Your site
Median (IQR)	1 (1-2), n=278	**Median:**
Same day as op	19% (53)	
Day before op	45% (124)	
2 Days before op	13% (37)	
3-5 Days before op	11% (31)	
6-14 Days before OP	6% (18)	
Earlier	5% (15)	

Table D12: Who made the decision to transfuse (N=279)*

	National
• Consultant- Anaesthetics & critical care	8% (23)
• Consultant - Other specialty	24% (66)
• Consultant - Specialty not known	9% (24)
• Senior trainee - Anaesthetics & critical care	1% (3)
• Senior trainee - Other specialty	10% (29)
• Senior trainee - Specialty not known	4% (10)
• Junior trainee - Anaesthetics & critical care	-
• Junior trainee - Other specialty	12% (33)
• Junior trainee - Specialty not known	10% (27)
• Grade NK - Anaesthetics & critical care	4% (10)
• Grade NK - Other specialty	6% (16)
• Nurse	0.4% (1)
• Grade NK - Specialty not known	13% (37)

**These categories were formed from free-text stated by auditors*

Table D13: Pre-transfusion Hb result, g/L *(up to 72 hours before first unit transfused)*

	National	Your site
Median (IQR)	82 (76-89), n=267	**Median: ,**

Table D14: Hb recorded after each unit of red cells

	National
Recorded	15% (38/259)

Table D15: Cessation of drugs broken down by procedure

TYPE OF PROCEDURE	On anti-coagulant	Stopped anticoagulant	Stopped at least 5 days before Op
• Primary unilateral total hip replacement	46	43	25/39
• Primary bilateral total hip replacement	3	3	0/2
• Primary unilateral total knee replacement	25	22	13/19
• Primary bilateral total knee replacement	-	-	-
• Unilateral revision hip replacement	31	29	13/27
• Unilateral revision knee replacement	7	7	5/7
• Colorectal resection for any indication (open or laparoscopic)	22	21	13/18
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	17	16	11/15
• Primary coronary artery bypass graft	9	9	5/7
• Valve replacement +/- CABG	79	65	42/56
• Simple or complex hysterectomy	8	7	4/6
• Cystectomy	2	2	0/1
• Nephrectomy	9	7	5/7
• # neck of femur (arthroplasty)	103	84	3/83
Procedure not stated	-	-	-
Total	361	315	139/287

Table D16: Specific drug

	National
Apixaban:	
On drug	0.4% (15/3890)
Stopped drug	87% (13/15)
Stopped at least 5 days pre-op	33% (4/12)
Median (IQR) days stopped pre-op	3 (1-8), n=12
Dabigatran:	
On drug	0.4% (14/3890)
Stopped drug	100% (14/14)
Stopped at least 5 days pre-op	43% (6/14)
Median (IQR) days stopped pre-op	4 (2-7), n=14
Rivaroxaban:	
On drug	1.0% (38/3890)
Stopped drug	89% (34/38)
Stopped at least 5 days pre-op	19% (6/31)
Median (IQR) days stopped pre-op	2 (1-4), n=31
Warfarin:	
On drug	7.5% (293/3890)
Stopped drug	87% (254/293)
Stopped at least 5 days pre-op	53% (122/230)
Median (IQR) days stopped pre-op	5 (2-6), n=230
Other anticoagulant:*	
On drug	<0.1% (2/3890)
Stopped drug	50% (1/2)
Stopped at least 5 days pre-op	100% (1/1)

**these drugs were not stated*

Table D17: Stopping the use of anti-platelets

TYPE OF PROCEDURE	On anti-platelet	Stopped antiplatelet	Stopped at least 5 days before Op
• Primary unilateral total hip replacement	33	31	22/28
• Primary bilateral total hip replacement	2	1	1/1
• Primary unilateral total knee replacement	13	12	8/9
• Primary bilateral total knee replacement	-	-	-
• Unilateral revision hip replacement	15	14	7/13
• Unilateral revision knee replacement	4	4	2/3
• Colorectal resection for any indication (open or laparoscopic)	13	12	11/12
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	42	23	17/23
• Primary coronary artery bypass graft	42	34	25/32
• Valve replacement +/- CABG	66	56	36/54
• Simple or complex hysterectomy	6	4	3/3
• Cystectomy	-	-	-
• Nephrectomy	11	11	8/9
• # neck of femur (arthroplasty)	114	75	7/72
Procedure not stated	2	2	2/2
Total	363	281	149/261

Table D18: Specific therapy

	National
Clopidogrel:	
On drug	8.7% (337/3890)
Stopped drug	76% (255/337)
Stopped at least 5 days pre-op	54% (129/238)
Median (IQR) days stopped pre-op	5 (1-7), n=238
Prasugrel:	
On drug	<0.1% (2/3890)
Stopped drug	100% (2/2)
Stopped at least 5 days pre-op	100% (2/2)
Median (IQR) days stopped pre-op	Days 6 & 8 before surgery
Ticagrelor:	
On drug	0.7% (29/3890)
Stopped drug	93% (27/29)
Stopped at least 5 days pre-op	85% (22/26)
Median (IQR) days stopped pre-op	8 (6-11), n=26
Other antiplatelet:*	
On drug	17% (654/3890)
Stopped drug	46% (297/652)
Stopped at least 5 days pre-op	35% (98/278)
Median (IQR) days stopped pre-op	2 (1-6), n=278

**All of these were aspirin*

Table D19: Reasons for not stopping antiplatelet agents

	National
Clopidogrel:	N=82
Coronary artery stent within last 12 months	-
Acute coronary syndrome	10
Emergency surgery	24
Other*	38
Don't know	34
Prasugrel:	N=0
Ticagrelor:	N=2
Coronary artery stent within last 12 months	1
Acute coronary syndrome	-
Other	-
Don't know	1

**Other includes cardiac or vascular surgery (9), surgeon request (1), not known (2)*

Table D20: Why was cell salvage not commenced? (N=3305)

	National	Your site
IOCS was not available on the day of surgery	7% (229)	
Not worthwhile in this procedure as anticipated blood loss generally too low	40% (1320)	0
Not considered in this procedure because of contaminated field	2% (76)	0
Not considered in this procedure because of sepsis	1% (36)	0
Not considered in this procedure because of malignancy	7% (237)	0
Other reasons*	37% (1228)	
Cell salvage not available in the hospital	374	0
Miscellaneous clinical reasons	228	0
Reason not recorded	626	0
Not known	5% (179)	0

**These categories were formed from free-text stated by auditors*

Table D21: Making the decision to transfuse

	National	Your site
Any intra-operative transfusion	25% (982/3851)	% (/)
Who made the decision to transfuse:*		
• Consultant- Anaesthetics & critical care	55% (539)	
• Consultant - Other specialty	3% (31)	
• Consultant - Specialty not known	2% (16)	
• Senior trainee - Anaesthetics & critical care	7% (64)	
• Senior trainee - Other specialty	1% (9)	
• Senior trainee - Specialty not known	1% (11)	
• Junior trainee - Anaesthetics & critical care	1% (9)	
• Junior trainee - Other specialty	0.4% (4)	
• Junior trainee - Specialty not known	0.3% (3)	
• Grade NK - Anaesthetics & critical care	21% (209)	
• Grade NK - Other specialty	4% (38)	
• Grade NK - Specialty not known	5% (49)	

**These categories were formed from free-text stated by auditors*

Table D22: Any intra-operative transfusion with allogeneic red cells issued by the transfusion laboratory

TYPE OF PROCEDURE	Any intra-operative transfusion with allogeneic red cells issued by the transfusion laboratory	Pre-transfusion Hb checked within 1 hour before transfusing the first unit	(if checked <1 hr) MEDIAN First intra-operative pre-transfusion Hb
• Primary unilateral total hip replacement	13% (78/601)	59% (42/71)	86, n=40
• Primary bilateral total hip replacement	23% (7/30)	71% (5/7)	84, n=5
• Primary unilateral total knee replacement	4% (13/337)	75% (9/12)	94, n=9
• Primary bilateral total knee replacement	4% (1/27)	0% (0/1)	-
• Unilateral revision hip replacement	34% (86/254)	69% (55/80)	90, n=53
• Unilateral revision knee replacement	15% (10/67)	50% (4/8)	82, n=4
• Colorectal resection for any indication (open or laparoscopic)	39% (116/296)	64% (65/102)	83, n=63
• Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	41% (62/152)	72% (43/60)	84, n=43
• Primary coronary artery bypass graft	39% (45/115)	93% (38/41)	76, n=36
• Valve replacement +/- CABG	44% (184/419)	89% (150/168)	79, n=146
• Simple or complex hysterectomy	34% (114/339)	59% (59/100)	83, n=56
• Cystectomy	36% (13/36)	80% (8/10)	84, n=8
• Nephrectomy	53% (69/130)	70% (46/66)	83, n=43
• # neck of femur (arthroplasty)	17% (180/1034)	62% (104/168)	82, n=95
Procedure not stated	29% (4/14)	75% (3/4)	77, n=3
Total	25% (982/3851)	70% (631/898)	83, n=604

Table D23: Post-operative cell salvage

	National	Your site
Post-operative cell salvage used*	1.9% (70/3782)	% (/)
Which post-op cell salvage technique(s) was/were used:		
• Reinfused shed blood	51/67	
• Washed red cells	15/68	
• Other	1/68	
Total volume in mls of post-operative salvaged blood infused: median (IQR)		
• median (IQR)	300 (200-500), n=46	

* *Primary unilateral total knee replacement (N=34), Valve replacement +/- CABG (N=12), Primary unilateral total hip replacement (N=8), Unilateral revision hip replacement (N=7), other procedures (N=9).*

Table D24: Post-operative iron

	National	Your site
Patient given post-operative iron	17% (630/3782)	% (/)
Given orally	609/619	
Given as IV	10/619	

Additional demographic data

Table D25: Patient age (computed as 2015 minus year of birth)

	National	Your site
Age known	3891	
<55	12% (449)	
55-64	10% (403)	
65-74	23% (908)	
75-84	30% (1182)	
≥85	24% (949)	
Median (IQR)	76 (66-84)	**Median:**

Table D26: Gender

	National	Your site
Gender known	3873	
Female	65% (2519)	
Male	35% (1354)	

Median (IQR) age for Females: 77 (66-85) years, n=2515
Median (IQR) age for Males: 75 (67-83) years, n=1353
Median (IQR) age for Gender NK: 72 (50-84), n=23

Additional Pre-operative data

Table D27: Days from listing to actual surgery

	National	Your site
Median (IQR)	42 (13-93), n=2675	**Median: ,**

Table D28: Pre-op assessment, by procedure

TYPE OF PROCEDURE	% (N) with pre-operative assessment	Days between assessment and surgery: Median (IQR)
• Primary unilateral total hip replacement	90% (533/595)	25 (13-59), n=529
• Primary bilateral total hip replacement	83% (25/30)	32 (15-93), n=24
• Primary unilateral total knee replacement	98% (329/337)	28 (15-76), n=325
• Primary bilateral total knee replacement	100% (27/27)	26 (13-47), n=27
• Unilateral revision hip replacement	82% (211/257)	22 (10-48), n=211
• Unilateral revision knee replacement	88% (58/66)	20 (7-39), n=57
• Colorectal resection for any indication (open or laparoscopic)	82% (244/296)	11 (6-21), n=240
• Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	73% (114/156)	19 (6-62), n=111
• Primary coronary artery bypass graft	84% (97/115)	8 (1-42), n=95
• Valve replacement +/- CABG	80% (337/422)	21 (7-61), n=333
• Simple or complex hysterectomy	93% (315/340)	13 (7-28), n=313
• Cystectomy	80% (28/35)	15 (9-26), n=28
• Nephrectomy	91% (118/130)	13 (7-23), n=117
• # neck of femur (arthroplasty)	19% (192/1031)	0 (0-1), n=188
Procedure not stated	83% (10/12)	9 (2-36), n=10

Table D29: days from transfusion to surgery broken down by procedure

TYPE OF PROCEDURE Key: A-Same day B-Day before C-2 days before D-3-5 days before E- 6-14 days before F-Earlier G- Unknown	A	B	C	D	E	F	G	N of cases
• Primary unilateral total hip replacement	2	7	4	1	1	-	-	15
• Primary bilateral total hip replacement	-	-	-	-	-	-	-	0
• Primary unilateral total knee replacement	-	-	1	-	-	-	-	1
• Primary bilateral total knee replacement	-	-	-	-	-	-	-	0
• Unilateral revision hip replacement	1	4	1	1	2	-	-	9
• Unilateral revision knee replacement	-	-	1	1	-	1	-	3
• Colorectal resection for any indication (open or laparoscopic)	7	21	4	7	4	4	1	48
• Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	-	7	-	3	1	-	-	11
• Primary coronary artery bypass graft	-	-	1	-	-	-	-	1
• Valve replacement +/- CABG	-	2	2	-	-	1	-	5
• Simple or complex hysterectomy	5	12	7	3	5	7	-	39
• Cystectomy	-	1	2	1	-	-	-	4
• Nephrectomy	2	3	2	4	3	1	-	15
• # neck of femur (arthroplasty)	35	67	12	10	2	1	-	127
Procedure not stated	1	-	-	-	-	-	-	1
Total	53	124	37	31	18	15	1	279

Table D30: Did the (transfused) patient have acute coronary ischaemia?

	National	Your site
Acute coronary ischaemia	6% (16/260)	% (/)

This was defined as STEMI (ST segment elevated myocardial infarction); NSTEMI (Non ST segment elevation myocardial infarction); Unstable angina within last 14 days)

Table D31: Record of any anticoagulant or antiplatelet medication prior to surgery (excluding aspirin).

	National	Your site
Record*	18% (710/3890)	% (/)

*This excludes any mention of aspirin

Additional Intra-operative data

Table D32: Haemostatic agents or sealants

	National	Your site
Haemostatic agents or sealants used	5.3% (200/3802)	% (/)
What was used:*		
• Fibrin 7 thrombin sealants	72	
• Surgical adhesives & absorbable haemostatic dressings	61	
• Both the above	3	
• Not stated	5	

*These categories were formed from free-text stated by auditors

Table D33: Agents or sealants used, per procedure

TYPE OF PROCEDURE	Haemostatic agents or sealants used
• Primary unilateral total hip replacement	1% (6/587)
• Primary bilateral total hip replacement	0% (0/30)
• Primary unilateral total knee replacement	2% (6/335)
• Primary bilateral total knee replacement	11% (3/27)
• Unilateral revision hip replacement	2% (6/256)
• Unilateral revision knee replacement	0% (0/66)
• Colorectal resection for any indication (open or laparoscopic)	4% (12/288)
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	7% (11/152)
• Primary coronary artery bypass graft	24% (28/115)
• Valve replacement +/- CABG	17% (69/418)
• Simple or complex hysterectomy	10% (33/332)
• Cystectomy	3% (1/32)
• Nephrectomy	16% (21/129)
• # neck of femur (arthroplasty)	0.4% (4/1024)
Procedure not stated	0% (0/11)
Total	5% (200/3802)

Table D34: IOCS

TYPE OF PROCEDURE	intra-operative cell salvage (IOCS) commenced
• Primary unilateral total hip replacement	4% (25/591)
• Primary bilateral total hip replacement	13% (4/30)
• Primary unilateral total knee replacement	8% (26/335)
• Primary bilateral total knee replacement	7% (2/27)
• Unilateral revision hip replacement	24% (62/256)
• Unilateral revision knee replacement	5% (3/66)
• Colorectal resection for any indication (open or laparoscopic)	0% (0/294)
• Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	42% (64/154)
• Primary coronary artery bypass graft	63% (72/115)
• Valve replacement +/- CABG	55% (229/420)
• Simple or complex hysterectomy	4% (13/337)
• Cystectomy	6% (2/35)
• Nephrectomy	8% (10/130)
• # neck of femur (arthroplasty)	1% (6/1025)
Procedure not stated	27% (3/11)
Total	14% (521/3826)

Table D35: Near patient testing of haemostasis

	National	Your site
Near patient testing of haemostasis undertaken	15% (579/3778)	% (/0)
Near patient testing options undertaken:	Known for 572	
• TEG	35% (199)	
• RoTEM	6% (36)	
• Platelet function testing	2% (12)	
• Activated Clotting Time	69% (396)	
• Other*	15% (85)	

Table D36: NPT for cardiac procedures

TYPE OF PROCEDURE	Near patient testing of haemostasis undertaken
• Primary coronary artery bypass graft	94% (108/115)
• Valve replacement +/- CABG	88% (354/402)
Total	89% (462/517)

Table D37: Pre-transfusion Hb checked within 1 hour before transfusing the first unit N=982

	National	Your site
Pre-transfusion Hb checked	70% (631/898)	% (/)
How was it checked:		
• Laboratory Hb from FBC sample	43	
• Hb from blood gas analyser	405	
• Hb from 'Masimo'	1	
• Hb from Haemocue	167	
• Not known	8	

Table D38: (If checked < 1 hour) First intra-operative pre-transfusion Hb, g/L

	National	Your site
Median (IQR)	83 (75-95), n=604	%
		N=

Reason for intra-operative transfusion

Table D39: Active bleeding

	National	Your site
Patient had active bleeding	65% (615/944)	% (/)
Estimated blood loss (EBL) in mls:		
Median (IQR)	1184 (644-1940), n=406	
If patient did not have active bleeding why were they transfused:*		
• Low BP or other hemodynamic reason	35	
• Hb drop	167	
• Blood loss - any volume recorded	16	
• Not known	111	

**These categories were formed from free-text stated by auditors*

Table D40: Active bleeding by procedure

TYPE OF PROCEDURE	Patient had active bleeding
• Primary unilateral total hip replacement	62% (46/74)
• Primary bilateral total hip replacement	43% (3/7)
• Primary unilateral total knee replacement	46% (6/13)
• Primary bilateral total knee replacement	100% (1/1)
• Unilateral revision hip replacement	84% (72/86)
• Unilateral revision knee replacement	100% (10/10)
• Colorectal resection for any indication (open or laparoscopic)	65% (73/112)
• Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	83% (50/60)
• Primary coronary artery bypass graft	61% (25/41)
• Valve replacement +/- CABG	49% (83/169)
• Simple or complex hysterectomy	84% (93/111)
• Cystectomy	90% (9/10)
• Nephrectomy	90% (60/67)
• # neck of femur (arthroplasty)	49% (81/166)
Procedure not stated	75% (3/4)
Total	66% (615/931)

On arrival in recovery

Table D41: Hb taken on arrival in recovery

	National	Your site
Hb taken on arrival in recovery	35% (1306/3775)	% (/)
Median (IQR)	97 (87-109), n=1277	Median: ,

Table D42: Complications of surgery N=3755

	National	Your site
• No complications noted	78% (2938)	% (/)
• Return to theatre	5.2% (195)	
• VTE	0.5% (19)	
• Wound infection	2.5% (92)	
• Positive blood culture	0.5% (18)	
Any of the above 4 complications	8.0% (301)	
• Others	16% (603)	

Additional post-operative data

Table D43: First Hb (g/L) taken on day 1 *(Day 1 is the next calendar day after surgery)*

	National	Your site
Median (IQR)	91 (83-102), n=3312	Median: ,

Table D44: Post-operative iron by procedure

TYPE OF PROCEDURE	Post-operative iron
• Primary unilateral total hip replacement	17% (100/579)
• Primary bilateral total hip replacement	13% (4/30)
• Primary unilateral total knee replacement	15% (48/330)
• Primary bilateral total knee replacement	22% (6/27)
• Unilateral revision hip replacement	11% (28/252)
• Unilateral revision knee replacement	21% (14/66)
• Colorectal resection for any indication (open or laparoscopic)	12% (35/289)
• Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	11% (16/151)
• Primary coronary artery bypass graft	11% (12/112)
• Valve replacement +/- CABG	11% (46/417)
• Simple or complex hysterectomy	39% (131/338)
• Cystectomy	3% (1/35)
• Nephrectomy	13% (17/129)
• # neck of femur (arthroplasty)	17% (170/1016)
Procedure not stated	18% (2/11)
Total	17% (630/3782)

Table D45: Complications of surgery

TYPE OF PROCEDURE	Return to theatre	VTE	Wound infection	Positive Blood culture	Any of these 4 complications	Total cases
• Primary unilateral total hip replacement	7	4	11	1	3.4% (20)	581
• Primary bilateral total hip replacement	-	-	-	-	-	29
• Primary unilateral total knee replacement	1	5	6	-	3.7% (12)	328
• Primary bilateral total knee replacement	-	-	-	-	-	26
• Unilateral revision hip replacement	6	1	11	1	6.5% (16)	245
• Unilateral revision knee replacement	2	-	4	-	9.1% (6)	66
• Colorectal resection for any indication (open or laparoscopic)	35	-	15	4	18% (53)	289
• Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	20	-	8	2	18% (28)	152
• Primary coronary artery bypass graft	13	-	4	2	16% (18)	112
• Valve replacement +/- CABG	43	-	5	2	12% (48)	411
• Simple or complex hysterectomy	42	-	6	-	14% (48)	332
• Cystectomy	5	-	1	-	14% (5)	35
• Nephrectomy	7	-	3	1	8.6% (11)	128
• # neck of femur (arthroplasty)	14	9	18	5	3.6% (36)	1012
Procedure not stated	-	-	-	-	-	9
Total	195	19	92	18	8.0% (301)	3755

Table D46: Did the patient die during this admission?

	National	Your site
Patient died	3.6% (138/3874)	% (/)
Days from surgery		
To date of death: median IQR)	12 (6-24), n=138	Median: ,
To discharge: median (IQR)	8 (6-14), n=3670	Median:,

Table D47: Hb on or nearest to discharge/death (*g/L)*

	National	Your site
All patients: median (IQR)	102 (94-109), n=3764	Median: ,
Days from surgery to Hb: median (IQR)	7 (4-12), n=3703	Median:,

Table D48: Adverse reaction to ANY (post-operative) transfusion

	National	Your site
ANY adverse reaction	0.9% (23/2683)	% (/)
Type of blood that caused the reaction:		
• Autologous	-	
• Allogeneic	11	
• Not known	12	
N=30 reactions from 23 cases		
Days from surgery: median (IQR)	2 (2-4), range 0-7, n=29	