National Comparative of
Blood Transfusion Audit

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National Comparative Audit of Blood Transfusion

2016 Repeat Audit of Patient Blood Management in Adults undergoing elective, scheduled surgery

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HOSPITALS THAT AGREED TO PILOT THE FIRST ROUND OF THE AUDIT PERFORMED IN 2015

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Contents

Executive Summary

The 2015 audit of Patient Blood Management in Elective surgery demonstrated that there was considerable variation in practice across the country and highlighted areas for improvement. This audit is a component of AFFINTIE (Development & Evaluation of Audit and Feedback Interventions to Increase evidence-based Transfusion practice), an NIHR funded programme which aims to test different ways of developing and delivering feedback within the existing National Comparative Audit of Blood Transfusion Programme [(1)]. The timing of this repeat audit was dictated by the design of the AFFINTIE programme to enable analysis of the impact of the feedback interventions. The results of the AFFINITIE programme will be reported in a separate paper. In addition, since the 2015 audit, further guidance on PBM has been published in the form of the NICE Clinical Guidelines and Quality Standards [(2)].

The audit proforma used in 2015 was simplified for the repeat audit and 10 audit standards were used, looking at pre-operative, intra-operative and post-operative PBM practice. The audit was conducted on patients undergoing surgery and who received a transfusion during a 3-month period between September 2016 and November 2016.

Following data cleaning, 3266 cases were available for analysis, submitted by 156 sites across the UK. 138 of these sites also took part in the 2015 audit with 3105 cases in round 1 and 2950 cases in round 2. The commonest type of surgery in both audits was elective orthopaedics surgery followed by surgery for fractured neck of femur and then cardiac surgery.

Overall, there has been an improvement in PBM practice since 2015. This is particularly evident in areas where change in practice can be achieved more readily. For example, when comparing practice for the 138 sites participating in both rounds, there has been an improvement in the use of a restrictive approach to post-operative transfusion from 23% to 34% ($P<0.001$) and an increase in the use of a single unit transfusion approach post-operatively from 37% to 50% ($P<0.001$). Tranexamic Acid use has increased from 32% to 42% ($P<0.001$). In contrast, there has been a smaller, although still significant ($P=0.01$), improvement in the management of pre-operative anaemia with 50% managed appropriately in 2016 compared to 46% in 2015. Key barriers that need to be overcome include adequate resources to support the infrastructure to deliver effective management and a restructuring of the pre-operative pathway to allow for timely investigation and management. There are also difficulties in resolving the roles of primary and secondary care in pre-operative optimisation of anaemia, and within secondary care in setting up services to manage patients effectively. Overall, only 11% of patients receiving a post-operative transfusion had had all appropriate PBM measures attempted in 2016, compared to 7.5% in 2015 ($P=0.002$)

It is encouraging to see that there has been progress in the implementation of PBM since 2015, particularly in areas highlighted in the NICE Clinical Transfusion Guidelines and Quality Standards. Further work is required to deliver timely pre-operative anaemia management in particular and to ensure consistent implementation of all appropriate PBM measures.

Summary of recommendations

Hospital Transfusion Committee / Hospital Transfusion Team	Clinical Staff involved in the care of surgical patients
Pre-operative anaemia management	
Work with Commissioners to formalise integrated pathways and funding for the referral of patients found to be anaemic during surgical workup	Clinical staff (including GPs) should ensure that a recent haemoglobin result is available for every patient as part of their referral
Ensure that healthcare pathways are structured to enable anaemia screening and investigation/ correction before surgery.	Clinical staff should ensure that anaemia screening occurs as soon as possible after the decision to proceed (ideally at the same visit) in order to allow investigation and correction if appropriate.
	Clinical staff should ensure that blood results are reviewed in a timely fashion, and that patients with previously undetected and potentially serious anaemia are appropriately referred, including deferring non-urgent, non-cancer surgery where appropriate.
	When surgery is urgent and cannot be deferred, clinical staff should use the available time for anaemia investigation and treatment initiation (if appropriate).
	Surgeons should know whether any individual patient is anaemic or not when they undertake the consent process and discuss the patient's individual clinical risks related to blood transfusion to comply with the Montgomery ruling [3].

Hospital Transfusion Committee / Hospital Transfusion Team	Clinical Staff involved in the care of surgical patients
Transfusion Practice	
If a stable non-bleeding patient has a pre-transfusion Hb >80g/L, the transfusion laboratory staff should query the request prior to issuing blood, with support from Hospital Transfusion / PBM team to do so.	Clinical staff should only prescribe a red cell transfusion in stable, asymptomatic, non-bleeding patients who have a pre-transfusion Hb of less than 70g/L, or less than 80g/L in those with cardiovascular disease.
The team should consider how best to work with clinical trainers to ensure that induction and ongoing education programmes for clinical staff include randomised trial findings which compare the patient outcomes of different red cell transfusion strategies.	Clinical staff should record the reason for transfusion in the patient's case notes and record a justification for transfusion if the transfusion was prescribed for a patient with an Hb higher than the recommended thresholds.
For hospitals with access to electronic order comms systems, the team should consider how best to work with the IT department to design a system of decision support that encourages best practice at the time of ordering.	In stable non-bleeding patients, staff should recheck the patient's Hb after each transfused unit.
If more than one unit of red cells is being requested for routine transfusions in post-operative patients, the laboratory staff should be encouraged to challenge the request before issuing the blood, with the support of the Hospital Transfusion / PBM team. This also strengthens team working.	

Hospital Transfusion Committee / Hospital Transfusion Team	**Clinical Staff involved in the care of surgical patients**
Implementation of Patient Blood Management Measures	
The Committee should ensure that local guidelines exist regarding the use of PBM measures, including clear recommendations on the individuals or teams responsible for implementing these measures.	The theatre team, anaesthetists and surgeons should ensure that the PBM measures identified by the Hospital Transfusion / Patient Blood Management Committee are implemented as appropriate.
The Committee should ensure that the use of Tranexamic Acid (unless contraindicated) is the standard of care for surgical patients expected to have moderate or more significant blood loss.	Where available, peer data should be applied to compare individual surgical teams and encourage participation in PBM.
The Committee should identify the need for intra-operative cell salvage and resource appropriately; this would normally be used in relevant high blood loss procedures in association with Tranexamic Acid.	

Why is this audit important?

The safe and effective use of donated blood has been identified as a national priority in the UK since the inception of the "Better Blood Transfusion" initiative. This initiative emphasised supply-and-demand issues related to blood, the cost of maintaining a safe blood supply and the emergence of hitherto unknown prion diseases in donated blood. It was thus arguably "product centred" but nevertheless served to support improvements in patient care including a 20% reduction in red cell use over 10 years [4]. More recently, the paradigm has changed from a product-centred approach to one that considers optimal care for all patients who may require transfusion, the concept of "Patient Blood Management", or PBM [4].

Though rare, serious events related to blood transfusion continue to occur: the 2015 Serious Hazards of Transfusion (SHOT) group reports over 2.5 million blood component administrations in 2015, and describes 161 cases of serious morbidity and 20 deaths occurring in this cohort after timely transfusion [5]. Furthermore, donated blood is a limited resource and the donor population is under increasing demand [6]. The application of PBM has been shown to decrease the demand for donated blood, so reducing the demand on donors and increasing patient safety [6,7]. Nevertheless, in common with many other fields of medicine, transfusion medicine suffers from a continuing "research to practice gap" [1].

NHS Blood and Transplant conducts annual national comparative audits of transfusion practice – the 2015 audit of PBM (n=3897) in scheduled surgery showed substantial variability in practice which is likely beyond that which can be justified on clinical grounds or casemix alone; a finding corroborated by a national cardiothoracic audit [8]. The NHSBT audit recommended changes in practice, which included recommendations that mechanisms to identify, investigate and manage preoperative anaemia, and a single unit transfusion policy, be developed at Trust level (i.e. rather than for specific specialties or patient cohorts).

This audit is one of the audits which form part of the AFFINTIE programme. The AFFINITIE programme is an NIHR funded programme which aims to test different ways of developing and delivering feedback within the existing National Comparative Audit of Blood Transfusion Programme [1]. The timing of this repeat audit was dictated by the design of the AFFINTIE programme to enable analysis of the impact of the feedback interventions. The results of the AFFINITIE programme will be reported in a separate paper. In addition, since the 2015 audit was reported, further guidance on PBM has been published in the form of the NICE Clinical Guidelines in 2015 [2] and Quality Standards in 2016 [9]. These documents further mandate that PBM be implemented, including measures for:

- Assessment of anaemia, and treatment of pre-operative iron deficiency
- Measures to reduce intra-operative blood loss
- Single unit transfusion policies, where the patient is re-assessed after each administered unit of blood

The areas identified as *important* in the NICE documents were thus also identified as areas of *variability* in the 2015 national comparative audit. The repeat audit was designed to identify any improvements in practice since the first audit in 2015.

Purpose of the audit

As described above a disconnect exists between the evidence base and national guidelines and clinical practice across the country. The aims were to:

- Assess national practice following the report of the first audit as part of the AFFINITIE study
- Determine to what extent practice had changed compared to the 2015 audit
- Identify common areas of practice where room for improvement still exists
- Describe models of good practice (that is, areas where practice had changed for the better) to enable clinicians and managers to design their own local systems

At the time of data collection, the 2015 audit had been disseminated; the NICE transfusion guidelines [2] had been published, and the consultation period for the NICE Quality Standards [9] had passed.

As in 2015, we focused on a number of index operations; most are elective, high-volume across the NHS, and have previously been shown to account for substantial use of donated blood. We also included patients undergoing repair of femoral neck fractures. The reason for including this group was twofold: first, there is a substantial evidence base detailing the relative risks of different approaches to transfusion in these high-risk patients [10,11,12,13]. Second, on a practical level it allowed us to ascertain what opportunities there may be for PBM in acute settings, bearing in mind the additional pressures of urgency and unplanned admissions.

Audit standards and PBM algorithms

PBM standards: *

Table 1

Standard 1:	**Pre-operative anaemia optimisation** Clinical staff must ensure that patients listed for elective major blood loss surgery have an Hb measured at least 14 days preoperatively and act upon results†
Standard 2:	**Pre-operative transfusion indicated** Clinical staff should only prescribe a pre-operative transfusion in patients undergoing elective major blood loss surgery if the Hb is less than the defined Hb threshold for transfusion ‡
Standard 3:	**Pre-operative transfusion indicated only if pre-operative anaemia optimisation has been attempted** Clinical staff should only prescribe a pre-operative transfusion in patients undergoing elective major blood loss surgery if the Hb is less than the defined Hb threshold for transfusion2 and pre-operative anaemia optimisation has been attempted
Standard 4:	**Pre-operative transfusion - single unit approach** For patients receiving a pre-operative transfusion, clinical staff should prescribe one unit of red cells at a time and re-check Hb before prescribing a further unit
Standards 6a & 7a:	**Patient Blood Management in theatre and recovery** Clinical staff should attempt at least one (PBM standard 6a) or all (PBM standard 7a) appropriate patient blood management measures in patients who receive a transfusion during major blood loss surgery
Standard 8:	**Post-operative transfusion indicated** In patients who do not have active post-operative bleeding, clinical staff should only prescribe a transfusion if the Hb is less than the defined Hb threshold for transfusion[2]
Standard 9:	**Post-operative transfusion - single unit approach** For patients receiving a post-operative transfusion, clinical staff should prescribe one unit of red cells at a time and re-check the Hb before prescribing a further unit unless the patient has active bleeding
Standards 10a & 11a:	**Patient Blood Management in the post-operative period** Clinical staff should attempt at least one (PBM standard 10a) or all (PBM standard 11a) appropriate patient blood management measures in patients who receive a transfusion following major blood loss surgery

† Anaemia is defined as Hb of less than 130g/L in men less than 120g/L in women

‡ Hb less than 70g/L in patients without acute coronary ischaemia or less than 80g/L in patients with acute coronary ischaemia

Analysis of compliance with standards was undertaken using a series of algorithms as shown in Appendix B

***NB**: Standard 5 has been removed from the original list of standards used. Further explanation appears overleaf.

PBM measures

The following table illustrates the PBM measures that are appropriate to the index operations. PBM measures are the standard of care for each procedure and ideally all aspects of PBM should have been attempted unless contraindicated or optional.

Table 2

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**		**A**	**A**	**A**	**A**	**A**
Intra-operative	**A**	**A**	**A**		**A**	**A**	**A**	**A**	**A**
	B	**B**	**B**	**B**	**B**	**B**	**C**	**B**	**B**
	E	**E**	**D**			**D**	**D**	**E**	**E**
Post-operative	**A**	**A**	**A**		**A**	**A**	**A**	**A**	**A**
	B	**B**	**B**	**B**	**B**	**B**	**C**	**B**	**B**
	E	**E**	**D**			**D**	**D**	**E**	**E**
	F	**F**	**F**				**F**		

PBM Measures Key	
A	Pre-operative anaemia optimisation
B	Tranexamic Acid
C	Tranexamic Acid/aprotinin
D	Intra-operative cell salvage
E	Optional: Intra-operative cell salvage
F	Optional: Post-operative cell salvage

Differences between original 2015 audit and the current 2016 re-audit

In recognition of the considerable data collection burden on hospitals involved in the original audit the number of questions was reduced for the repeat audit. This removed most of the free-text questions, considerably slimmed down the section on antiplatelet and anticoagulation medication and only asked for details about the first post-operative transfusion episode. The intention was to retain sufficient information to enable comparability of the Patient Blood Management algorithms across the audits. Unfortunately, the trimmed down medications section did not ask about the use of aspirin, nor about whether warfarin was stopped 5 or more days before surgery. Both these aspects impact on the comparability of certain algorithms (algorithm 5 specifically and then algorithms 6,7,10 and 11 that incorporate algorithm 5). To gain measures of comparability it was decided to remove algorithm 5 and to re-work the other algorithms (now called 6a,7a,10a and 11a) without involving algorithm 5. Patients with fractured neck of femur have been removed from the algorithms PBM 6a, 7a, 10a and 11a.

How the audit was conducted

The audit was conducted on cases occurring during a 3-month period between September and November 2016.

Hospital selection and response

Those hospitals/Trusts in England, Scotland, Wales, Northern Ireland and Republic of Ireland where transfusions are administered to adult surgical patients, and who participated in the first round of the audit, were invited to take part. Those unable to take part in the first round were invited to participate in this round, if they were able. Data were submitted by Trusts as a whole and by individual hospitals. The term hospital is used throughout this report to refer to the entity engaged in the audit process at each hospital.

Case selection and quotas

Participating hospitals were asked to collect data on all consecutive cases of patients who had undergone any of the audit index operations and received a transfusion pre-operatively and/or intra-operatively and/or up to 7 days post-operatively. Up to a maximum of 70 cases per hospital were collected from patients operated on during the period 1st September 2016 to 30th November 2016. The majority of procedures were elective and scheduled, however patients undergoing surgery for fractured neck of femur were also included to ensure that meaningful numbers of cases were collected for the audit.

A list of OPCS4 codes was provided for the index operations and hospitals were asked to liaise with their Informatics Department to collect a list of patients who had undergone one of these procedures. Transfused cases were identified with reference to laboratory data.

Data entry, cleaning and validation

The audit data from the transfusion episode was entered via a web-based audit tool specifically designed for the purpose although data could be collected on a paper proforma (see Appendix A). Submitted audit data was collated by the audit Programme Manager after the closing date for data entry. Because no patient identifiable data is recorded on the web-based audit tool, hospital auditors were advised to keep an audit linkage record to assist in review of cases and validation of data. Algorithms were developed to analyse whether the standards were met using the definitions outlined below (see Appendix B). There was some post-hoc analysis of the free text answers where indicated.

Data Collection Round 2

A total of 3331 audit records were received, 65 of which (from 34 sites) were either duplicate, almost empty or ineligible and were removed from the dataset, leaving 3266 cases for analysis, submitted by 156 sites, median 19, IQR 10-31, range 1-70. Geographically: NHS England/N Ireland/Scotland/Wales: 3112 from 145 sites, median 20, IQR 10-32, range 1-65 and the Republic of Ireland: 23 from 2 sites, range 11-12. Data also came from Independent hospitals: 131 from 9 sites, median 4, range 4-70.

138 of these 156 sites also took part in the original round one of this audit with 3105 cases in round one and 2950 in this round two re-audit. A later section of this report will compare both rounds of audit for these 138 sites. The first part of this report shows results for the most recent audit, which gives the best snapshot of the current situation.

The audit period specified September to November 2016 for including operations, with 1347 records for September, 991 for October and 759 for November. Details were also received for a further 163 operations (from 22 sites) that fell outside the audit period; these were included in the analysis, with 46 in July, 109 in August and 8 in December. Also included were 6 operations for which the date of surgery was not stated.

In summary, the national results in this re-audit report are derived from all 3266 cases from 156 sites. To see which sites participated in this audit, please see Appendix C.

Overall distribution of operations audited is given in Table 3 below.

Table 3: Type of surgical procedure audited

	Previous 2015 audit	This 2016 audit
	National (3897)	National (3266)
Primary unilateral total hip replacement	16% (610)	14% (471)
Primary bilateral total hip replacement	1% (30)	1% (18)
Primary unilateral total knee replacement	9% (341)	9% (289)
Primary bilateral total knee replacement	1% (27)	1% (24)
Unilateral revision hip replacement	7% (258)	7% (233)
Unilateral revision knee replacement	2% (67)	3% (93)
Colorectal resection for any indication (open or laparoscopic)	8% (300)	7% (241)
Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infra-inguinal, femoro-popliteal or distal bypass	4% (157)	4% (141)
Primary coronary artery bypass graft (CABG)	3% (116)	3% (102)
Valve replacement +/- CABG	11% (423)	10% (339)
Simple or complex hysterectomy	9% (342)	8% (275)
Cystectomy	1% (37)	1% (34)
Nephrectomy	3% (130)	3% (103)
# neck of femur (arthroplasty)	27% (1044)	28% (901)
Procedure not stated	(15)	(2)

The distribution of types of procedure were very similar between the two rounds of audit at the national level.

Results

Overall, 3266 cases were reviewed from 156 sites. Median (IQR) age was 76 years (66-84) with age distribution shown in Table 4; 66% (2147) of patients were female and 34% male (1117). The age distribution by operation is given in Table 5.

Table 4: Patient age

	National
Age known	3265
<55	11% (360)
55-64	12% (378)
65-74	24% (777)
75-84	31% (1006)
≥85	23% (744)
Median (IQR)	76 (66-84)

Table 5: Type of procedure and age of patient

	Median (IQR) age
Primary unilateral total hip replacement	77 (68-83), n=471
Primary bilateral total hip replacement	67 (63-82), n=18
Primary unilateral total knee replacement	76 (69-82), n=289
Primary bilateral total knee replacement	72 (65-77), n=24
Unilateral revision hip replacement	76 (68-83), n=233
Unilateral revision knee replacement	72 (66-78), n=93
Colorectal resection for any indication (open or laparoscopic)	71 (57-79), n=241
Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infra-inguinal femoro-popliteal or distal bypass	71 (63-76), n=141
Primary coronary artery bypass graft	69 (62-76), n=102
Valve replacement +/- CABG	73 (65-79), n=339
Simple or complex hysterectomy	54 (47-66), n=275
Cystectomy	72 (58-77), n=34
Nephrectomy	65 (55-73), n=103
# neck of femur (arthroplasty)	86 (79-90), n=900
Procedure not stated	59, 70, n=2

Overview of PBM practice

The use of PBM and transfusion practice as assessed against the PBM algorithms in the 2016 audit is summarised in Table 6. The change in practice between round 1 and round 2 of the audit is shown in Table 7 **for the 138 sites that participated in both rounds**. Approximately 7000 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 for different procedures is shown in Table 8.

Table 6: Patient Blood Management algorithms: overall performance in 2016 audit (see further algorithm explanations in Appendix B)

Algorithm	Standard MET	Standard NOT MET	EXCLUDED	INSUFFICIENT DATA	% standard MET*
PBM1	1175	1186	901	4	50%
PBM2	14	76	3168	8	13%
PBM3	2	88	3161	15	2%
PBM4	62	123	3063	18	34%
PBM6a	572	132	2559	3	81%
PBM7a	141	563	2559	3	20%
PBM8	797	1559	860	50	34%
PBM9	903	922	1385	56	49%
PBM10a	1404	268	1584	10	84%
PBM11a	172	1496	1584	14	10%

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

Note that #NOF patients were excluded from PBM algorithms 1, 2, 3, 6a, 7a, 10a and 11a. The percentage of cases meeting each standard is formed from the ratio of cases meeting each standard divided by the total number of cases either meeting or not meeting the standard, i.e. %MET = 100X(MET/(MET+NOT MET).

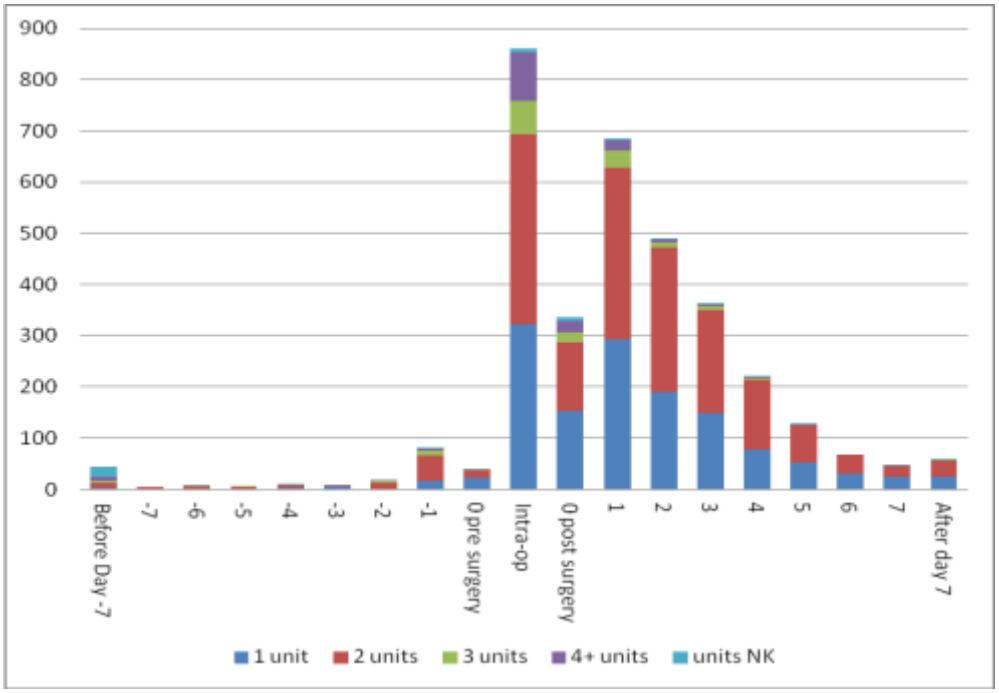
Table 7: PBM standards met in 2015 and 2016 **for the 138 sites that participated in both rounds**

		Original audit 2015	Re-audit 2016	P value (national data)
PBM1	Pre-operative anaemia management	46% (1004/2185)	50% (1062/2136)	0.01
PBM2	Pre-operative transfusion indicated	11.8% (12/102)	16.9% (14/83)	0.40
PBM3	Pre-operative transfusion indicated only if preoperative anaemia optimisation has been attempted where appropriate	1.8% (2/109)	2.4% (2/83)	>0.99
PBM4	Pre-operative transfusion - single unit transfusion policy	27% (57/213)	35% (59/168)	0.09
PBM6a	Patients having intra-operative transfusion in whom at least one PBM measure has been attempted (where appropriate)	82% (483/592)	82% (517/631)	0.88
PBM7a	Patients having intra-operative transfusion in whom all PBM measures have been attempted (where appropriate)	17% (104/605)	21% (131/631)	0.11
PBM8	Post-operative transfusion allowed (whether or not PBM measures attempted) - FIRST EPISODE	23% (503/2158)	34% (725/2137)	<0.001
PBM9	Post-operative transfusion following the single unit policy – FIRST EPISODE	37% (703/1900)	50% (837/1661)	<0.001
PBM10a	Post-operative in whom at least one PBM measure has been attempted (where appropriate)- FIRST EPISODE	84% (1233/1460)	84% (1279/1522)	0.76
PBM11a	Post-operative in whom all PBM measures have been attempted (where appropriate) FIRST EPISODE	7.5% (113/1515)	11% (162/1518)	0.002

Note that #NOF patients were excluded from PBM1, PBM2, PBM6a, PBM7a, PBM10a and PBM11a, and also for PBM3 since this uses PBM1 within the algorithm.

There has been significant improvement in the use of a more restrictive transfusion threshold and single unit approach post-operatively in particular

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



Note that Figure 1 gives the number of patients transfused before, during and after operation, stratified by the number of units received in that episode. Post-operatively we only know the number of units transfused for the first transfusion episode to the patient.

Table 8: 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	65% (306/471)	72% (13/18)	66% (192/289)	83% (20/24)	52% (121/231)	59% (55/93)	21% (51/241)
PBM2	0% (0/4)	-	0% (0/4)	0% (0/1)	33% (2/6)	0% (0/1)	25% (7/28)
PBM3	0% (0/4)	-	0% (0/4)	0% (0/1)	0% (0/6)	0% (0/1)	4% (1/28)
PBM4	25% (1/4)	-	25% (1/4)	0% (0/1)	0% (0/6)	0% (0/1)	36% (10/28)
PBM6a	93% (54/58)	100% (3/3)	92% (11/12)	-	95% (90/95)	95% (21/22)	37% (33/89)
PBM7a	50% (29/58)	0% (0/3)	42% (5/12)	-	25% (24/95)	18% (4/22)	0% (0/90)
PBM8	27% (105/386)	23% (3/13)	20% (49/241)	9% (2/23)	44% (65/148)	29% (21/72)	43% (63/145)
PBM9	45% (142/316)	10% (1/10)	42% (88/211)	36% (8/22)	46% (48/105)	32% (18/57)	56% (59/106)
PBM10a	89% (347/390)	92% (12/13)	93% (226/243)	91% (21/23)	91% (135/148)	93% (69/74)	29% (43/150)
PBM11a	0.5% (2/390)	31% (4/13)	0.4% (1/240)	35% (8/23)	24% (36/147)	22% (16/74)	3% (4/150)

	Open arterial surgery	Primary CABG	Valve replacement +/- CABG	Simple or complex hysterectomy	Cystectomy	Nephrectomy	# neck of femur (arthroplasty)
PBM1	37% (52/141)	48% (49/102)	41% (139/339)	44% (121/275)	41% (14/34)	41% (42/103)	-
PBM2	0% (0/2)	-	0% (0/6)	15% (4/27)	-	9% (1/11)	-
PBM3	0% (0/2)	-	0% (0/6)	4% (1/27)	-	0% (0/11)	-
PBM4	0% (0/2)	-	67% (4/6)	26% (7/27)	-	10% (1/10)	40% (38/96)
PBM6a	58% (31/53)	97% (32/33)	99% (155/156)	77% (86/112)	83% (10/12)	78% (46/59)	Excluded
PBM7a	0% (0/53)	30% (10/33)	27% (42/156)	18% (20/112)	17% (2/12)	9% (5/58)	Excluded
PBM8	37% (27/73)	36% (31/86)	50% (115/228)	54% (92/169)	41% (7/17)	47% (21/45)	28% (196/710)
PBM9	57% (32/56)	89% (55/62)	77% (99/129)	47% (46/98)	64% (7/11)	52% (14/27)	47% (286/615)
PBM10a	65% (49/75)	98% (84/86)	99% (237/238)	77% (130/169)	89% (16/18)	78% (35/45)	Excluded
PBM11a	0% (0/75)	34% (29/86)	28% (66/238)	0% (0/169)	0% (0/18)	13% (6/45)	Excluded

When comparing change in practice according to procedure between 2015 and 2016, improvements in pre-operative anaemia management have occurred particularly in elective orthopaedics and cardiac surgery. A more restrictive approach to red cell transfusion and the use of single unit transfusion have increased across the board.

Section A: Pre-operative Patient Blood Management (in period from listing for surgery to going to theatre)

This section describes practice as assessed against four pre-operative PBM algorithms (see algorithms in Appendix B)

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

Note that #NOF patients were excluded from the PBM1 algorithm

Preoperative assessment was performed in **85% (2010/2365)** of elective cases, excluding patients with #neck of femur, at a median (IQR) of 21 (10-49) days before surgery. Table 9 shows the median number of days between listing and surgery by procedure.

Table 9: 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	89% (418/471)	29 (16-65), n=401
Primary bilateral total hip replacement	83% (15/18)	47 (15-93), n=12
Primary unilateral total knee replacement	96% (277/289)	33 (16-79), n=271
Primary bilateral total knee replacement	96% (23/24)	38 (23-59), n=22
Unilateral revision hip replacement	79% (184/233)	28 (10-55), n=180
Unilateral revision knee replacement	83% (77/93)	40 (17-83), n=76
Colorectal resection for any indication (open or laparoscopic)	75% (180/241)	10 (6-16), n=172
Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infra-inguinal femoro-popliteal or distal bypass	77% (109/141)	16 (6-46), n=107
Primary coronary artery bypass graft	75% (76/102)	24 (8-54), n=76
Valve replacement +/- CABG	80% (271/339)	22 (9-48), n=266
Simple or complex hysterectomy	93% (255/275)	13 (7-25), n=249
Cystectomy	94% (32/34)	12 (6-20), n=30
Nephrectomy	88% (91/103)	12 (6-21), n=86
# neck of femur (arthroplasty)	11% (97/901)	1 (0-1), n=87
Procedure not stated	100% (2/2)	7, 48, n=2

Interval between listing and surgery

Overall most (76-89%) elective patients were listed several weeks (median 43 days (16-94), n=1937 excluding # neck of femur) before their operation with patients undergoing elective orthopaedic surgery having the longest interval period. Patients undergoing colorectal surgery (often for cancer) had a median 15 days before operation. (See Table 10 for more detail).

Most patients underwent operation on the day of planned procedure (80%) with only 4% occurring before the planned date and 13% being postponed for two or more days.

Table 10: 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	83% (393/471)	77 (38-129), n=393
Primary bilateral total hip replacement	89% (16/18)	80 (21-191), n=16
Primary unilateral total knee replacement	87% (251/289)	87 (50-137), n=251
Primary bilateral total knee replacement	88% (21/24)	60 (34-127), n=21
Unilateral revision hip replacement	86% (200/233)	47 (12-98), n=200
Unilateral revision knee replacement	81% (75/93)	55 (25-108), n=75
Colorectal resection for any indication (open or laparoscopic)	76% (182/241)	15 (6-27), n=182
Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infra-inguinal femoro-popliteal or distal bypass	76% (107/141)	21 (7-47), n=107
Primary coronary artery bypass graft	80% (82/102)	23 (6-56), n=82
Valve replacement +/- CABG	76% (259/339)	51 (20-95), n=259
Simple or complex hysterectomy	88% (242/275)	27 (13-56), n=242
Cystectomy	76% (26/34)	30 (17-48), n=26
Nephrectomy	81% (83/103)	22 (13-33), n=82
# neck of femur (arthroplasty)	76% (685/901)	1 (0-1), n=682
Procedure not stated	50% (1/2)	7, n=1
Total (excluding #NOF)	**82% (1938/2365)**	**43 (16-94), n=1937**

PBM standard 1: Pre-operative anaemia optimisation

Clinical staff must ensure that patients listed for elective major blood loss surgery have an Hb measured at least 14 days pre-operatively and act upon results

This standard was defined as:

- Those with anaemia who have had iron deficiency identified and treated
- Those without anaemia, or those with non-iron deficiency anaemia are not expected to be optimised but meet the standard

Nationally, in those patients having elective surgery, only **50% (1175/2361)** received appropriate pre-operative anaemia management before surgery.

National Results for those 138 sites in BOTH rounds of audit:

In those patients having elective surgery in 2015: **46% (1004/2185)** received appropriate pre-operative anaemia management before surgery.

In those patients having elective surgery in 2016: **50% (1062/2136**) received appropriate pre-operative anaemia management before surgery.

There has been an improvement in practice (P = 0.01)

Assessment of whether patients had anaemia was performed at least 14 days before surgery in **53% (1243/2365)** of elective patients who were listed. At this time, of those who had an Hb performed, **50% (396/793)** of females and **51% (228/448)** of males were anaemic. Of those with an Hb result, 17% (209) had further investigation by serum ferritin performed and in the absence of a ferritin result very few (only 4 of 1033) had a transferrin saturation performed. (See Table 11 for more detail).

Table 11: FBC results performed at least 14 days before surgery

FBC results	Median	IQR	N
Hb result, g/L: Total	122	112-133	1242
• Female	120	110-130	793
• Male	129	116-139	448
Total anaemic	50% (624/1241)		
• Females with Hb < 120 g/L	50% (396/793)		
• Males with Hb < 130 g/L	51% (228/448)		
MCV result, femtolitres	89	85-93	1231
Serum ferritin. µg/L:	84	33-192	209
Transferrin saturation test (TSAT)	15	11-22	55
Of those with an Hb result:			
• Also with a MCV result	99% (1231/1242)		
• Also with a ferritin result	17% (209/1242)		
Of those with an Hb result but with no ferritin result:			
• Also with a TSAT result	0.4% (4/1033)		

22% (705/3262) of all patients received some form of intervention for anaemia in the preoperative setting (Table 12).

Table 12: Was the patient on any of the following treatments before they had their operation?

	National
Known for	3262
• Oral iron	11% (354)
• IV iron	1% (37)
• Erythrocytosis-stimulating agent (ESA) therapy	0.2% (8)
• B12	3% (87)
• Folic Acid	5% (150)
• Red cell transfusion*	6% (207)
• None	78% (2557)

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

PBM Standard 2: Pre-operative transfusion indicated

Clinical staff should only prescribe a pre-operative transfusion in patients undergoing elective major blood loss surgery (i.e. excluding patients with fractured neck of femur) if the Hb is less than the defined Hb threshold for transfusion (70g/L in patients without acute coronary ischaemia or 80g/L in patients with acute coronary ischaemia)

A pre-operative transfusion was prescribed in **4.3% (102/2362)** patients nationally, excluding fractured neck of femur.

The pre-operative transfusion was prescribed when the Hb was less than the defined Hb threshold for transfusion in **15% (14/90)** nationally

National Results for those 138 sites in BOTH rounds of audit

2015: The pre-operative transfusion was prescribed when the Hb was less than the defined Hb threshold for transfusion in **11.8% (12/102)**

2016: The pre-operative transfusion was prescribed when the Hb was less than the defined Hb threshold for transfusion in **16.9% (14/83)**

There is no evidence of a change in practice (P = 0.4)

Further information about pre-operative transfusion practice is shown in Table 13. The majority of patients were those with either fractured neck of femur or undergoing colorectal surgery or hysterectomy.

Table 13: Pre-operative transfusion

	National
Hb result (up to 72 hours before first unit transfused): Median (IQR)	83 (74-89), n=193
Days from Transfusion of the first unit to surgery: Median (IQR)	1 (1-4), n=196
Same day as op	20% (39)
Day before op	41% (80)
2 Days before op	9% (17)
3-5 Days before op	13% (25)
6-14 Days before OP	14% (27)
Earlier	4% (8)

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

In those patients having a red cell transfusion within 14 days before surgery and also meeting the first PBM standard (of receiving some form of preoperative anaemia management before surgery) only **2% (2/90)** received the transfusion appropriately. (See Algorithm for PBM standard 3 in Appendix B).

PBM standard 4: Pre-operative transfusion – single unit approach

For patients receiving a pre-operative transfusion, clinical staff should prescribe one unit of red cells at a time and re-check Hb before prescribing a further unit

The single unit transfusion approach was followed by clinical staff in **34% (62/186)** of patients nationally.

National Results for those 138 sites in BOTH rounds of audit

2015: The single unit transfusion approach was followed by clinical staff in **27% (57/213)**

2016: The single unit transfusion approach was followed by clinical staff in **35% (59/168)**

There is borderline evidence of an improvement in practice (P = 0.09)

Looking at the 2016 data from 156 sites, it is evident that most patients received more than one unit of blood and 19% (38/199) of patients had their Hb checked between transfusions of red cells.

Table 14: Red cell units given pre-operatively

	National
Number of units (all patients)	Known for 198
One	26% (51)
Two	56% (110)
Three	12% (23)
Four or more	7% (14)
Hb recorded after each unit of red cells	19% (38/199)

Pre-operative anticoagulant and antiplatelet management

The relevant standards algorithm (PBM5) could not be worked through because of changes made to the audit tool. Any reference to use of antiplatelet agents within this section includes aspirin.

A record of any anticoagulant or antiplatelet medication prior to surgery was documented for **35% (1136/3259)** of patients, comprising 47 with *both* an anticoagulant and an anti-platelet, 345 with an anti-coagulant and 744 with an anti-platelet. **4.5% (146/3259)** were on direct oral anticoagulation and **44% (61/146)** had this stopped 5 days or more before surgery **(55% 58/105 if #NOF excluded)**. When looking at specific types of operation, antiplatelet agents were least likely to be stopped within 5 days in colorectal resection **(48%, 14/29)**, open arterial surgery **(31%, 28/89)** and #NOF **(4%, 8/211)** cases, while orthopaedic and general surgeons were more likely to cease antiplatelet agents.

Table 15: Anticoagulant and Antiplatelet agent management any time in the month leading up to surgery

	National
Patient on Anticoagulant or Antiplatelet	35% (1136/3259)
Patient on Direct Oral Anticoagulants (DOAC)	4.5% (146/3259)
Stopped 5 days or more before surgery	44% (61/140)
Patients on Warfarin	7.7% (252/3259)
Patient on Antiplatelet	24% (791/3259)
Stopped 5 days or more before surgery	41% (317/782)
Documented clinical reason for continuing:	
• Coronary artery stent within last 12 months	10
• Acute coronary syndrome	38
• Other reasons	309
• Not known	108

Table 16 gives INR results on patients on pre-operative warfarin. Anticoagulation was normalised in **64% (159/247)** of cases with the INR being greater than 1.4 in 36%.

Table 16: Pre-operative warfarin

	National
Patients on Warfarin pre-operatively	7.7% (249/3228)
INR result taken closest before surgery for those on Warfarin pre-operatively:	
• ≤1.0	21
• 1.1-1.4	138
• 1.5-1.9	42
• 2.0-2.4	18
• 2.5-2.9	16
• 3.0-3.4	6
• 3.5-4.4	3
• 4.5-5.9	2
• 6.0-7.9	-
• ≥8.0	1
Median (IQR) INR result	1.3 (1.1-1.7), n=247
Days between INR and surgery:	
• Same day as op	100
• Day before op	80
• Earlier	67
Median (IQR) days before op	1 (0-2), n=247

Pre-operative haemoglobin

The Hb was checked in most patients **(96%, 3146/3266)** in the immediate preoperative period, at a median of 2 days before operation. The percentage of patients found to be anaemic was 61% (Table 17), and broken down by procedure in Table 18.

Table 17: Pre-operative Hb taken closest before the date of surgery

	National
Hb result, g/L:	
All patients: median (IQR)	117 (104-129), n=3146
• Female: median (IQR)	116 (104-126), n=2069
• Male: median (IQR)	122 (105-136), n=1077
Total anaemic (F<120, M<130)	61% (1932/3146)
• Females with Hb<120 g/L	60% (1247/2069)
• Males with Hb<130 g/L	64% (685/1077)
Days between pre-op Hb and surgery: median (IQR)	2 (1-14), N=3104

Table 18: Anaemic patients by surgical group

TYPE OF PROCEDURE	Total anaemic (F<120, M<130)
Primary unilateral total hip replacement	50% (226/448)
Primary bilateral total hip replacement	56% (10/18)
Primary unilateral total knee replacement	60% (168/278)
Primary bilateral total knee replacement	29% (7/24)
Unilateral revision hip replacement	60% (133/221)
Unilateral revision knee replacement	55% (48/88)
Colorectal resection for any indication (open or laparoscopic)	71% (166/235)
Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, Infra-inguinal femoro-popliteal or distal bypass	57% (77/136)
Primary coronary artery bypass graft	32% (33/102)
Valve replacement +/- CABG	41% (136/334)
Simple or complex hysterectomy	57% (150/261)
Cystectomy	59% (19/32)
Nephrectomy	60% (58/96)
# neck of femur (arthroplasty)	80% (699/871)
Procedure not stated	100% (2/2)
Total	61% (1932/3146)

Section 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.

PBM6a	Patients having intra-operative transfusion in whom at least one PBM measure has been attempted (where appropriate)
PBM7a	Patients having intra-operative transfusion in whom all PBM measures have been attempted (where appropriate)

(see algorithms in Appendix B)

Nationally, clinical staff prescribed intra-operative transfusion in **26% (860/3266)** patients.

PBM 6a

Clinical staff attempted at least one appropriate PBM measure in **81% (572/704)** of patients undergoing major blood loss surgery who received an intra-operative transfusion nationally.

PBM7a

Nationally, clinical staff attempted **all** appropriate PBM measures in **20% (141/705)** of patients undergoing major blood loss surgery who received an intra-operative transfusion.

National Results for those 138 sites in BOTH rounds of audit

PBM 6a

2015: Clinical staff attempted **at least one** appropriate PBM measure in **82% (483/592)** of patients undergoing major blood loss surgery who received an intra-operative transfusion

2016: Clinical staff attempted **at least one** appropriate PBM measure in **82% (517/631)** of patients undergoing major blood loss surgery who received an intra-operative transfusion

There is no evidence of a change in practice (P = 0.88)

PBM 7a

2015: Clinical staff attempted **all** appropriate PBM measures in **17% (104/605)** of patients undergoing major blood loss surgery who received an intra-operative transfusion

2016: Clinical staff attempted **all** appropriate PBM measures in **21% (131/631)** of patients undergoing major blood loss surgery who received an intra-operative transfusion

There is no evidence of a change in practice (P = 0.11)

Hb testing was performed in **57% (487/848)** within 1 hour of intra-operative transfusion. Median (IQR) pre-transfusion Hb was **84 (75-92) g/L, n=485**. The reason for transfusion was given as 'active bleeding' in **77% (654/849)** of patients. A single unit transfusion was given to **38% (323/852)** of patients, with two units of blood given in **44% (371/852)**. The Hb level was checked in recovery in **36% (1164)** of patients and the median (IQR) value was **99 (88-109) g/L, n=1158**. Further details are given in Table 19.

Table 19: Any intra-operative transfusion with allogeneic red cells issued by the transfusion laboratory

	National
Intra-operative transfusion with allogeneic red cells issued by the transfusion laboratory	26% (860/3266)
Pre-transfusion Hb checked within 1 hour before transfusing the first unit	57% (487/848)
Pre-operative Hb result, g/L: Median (IQR)	84 (75-92), n=485
Hb taken on arrival in recovery Hb result, g/L on arrival: Median 9IQR)	36% (1164/3265) 98 (88-109), n=1158

Antifibrinolytic therapy

Data on use Tranexamic Acid is shown below:

Tranexamic acid was used in **42% (1367/3255)** of cases nationally

Cardiac surgery used Tranexamic Acid in **80% (353/440)** of cases, elective orthopaedic surgery in **61% (691/1125)** of cases and it was used in **19% (322/1688**) of the remaining known procedures. Further detail is shown in Table 20.

Table 20: Use of Tranexamic Acid by procedure

TYPE OF PROCEDURE	Tranexamic Acid used
Primary unilateral total hip replacement	63% (294/469)
Primary bilateral total hip replacement	44% (8/18)
Primary unilateral total knee replacement	51% (148/289)
Primary bilateral total knee replacement	50% (12/24)
Unilateral revision hip replacement	75% (174/232)
Unilateral revision knee replacement	59% (55/93)
Colorectal resection for any indication (open or laparoscopic)	9% (22/240)
Open arterial surgery e.g. scheduled (non-ruptured) aortic aneurysm repair, infra-inguinal femoro-popliteal or distal bypass	10% (14/140)
Primary coronary artery bypass graft	84% (86/102)
Valve replacement +/- CABG	79% (267/338)
Simple or complex hysterectomy	29% (80/275)
Cystectomy	21% (7/34)
Nephrectomy	22% (22/100)
# neck of femur (arthroplasty)	20% (177/899)
Procedure not stated	50% (1/2)
Total	42% (1367/3255)

There has been a statistically significant increase in the use of tranexamic acid when comparing the results in the 138 sites that participated in both rounds of the audit (R1 & R2). This has particularly occurred in orthopaedic surgery, urology and gynaecology (see Table 21).

Table 21 Use of Tranexamic Acid by procedure 138 SITES IN BOTH AUDITS

TYPE OF PROCEDURE	Tranexamic Acid used R1	Tranexamic Acid used R2
Primary unilateral total hip replacement	48% (210/437)	62% (259/415)
Primary bilateral total hip replacement	48% (10/21)	50% (8/16)
Primary unilateral total knee replacement	39% (100/257)	50% (134/266)
Primary bilateral total knee replacement	47% (9/19)	48% (11/23)
Unilateral revision hip replacement	62% (127/205)	75% (164/218)
Unilateral revision knee replacement	50% (25/50)	61% (51/84)
Colorectal resection for any indication (open or laparoscopic)	5% (12/236)	9% (21/224)
Open arterial surgery e.g. scheduled (non- ruptured) aortic aneurysm repair, infra-inguinal femoro-popliteal or distal bypass	7% (9/121)	9% (10/117)
Primary coronary artery bypass graft	88% (71/81)	85% (86/101)
Valve replacement +/- CABG	75% (238/317)	80% (242/301)
Simple or complex hysterectomy	16% (42/264)	31% (77/249)
Cystectomy	5% (1/21)	21% (6/28)
Nephrectomy	12% (12/97)	25% (22/87)
# neck of femur (arthroplasty)	13% (112/890)	18% (148/809)
Procedure not stated	33% (3/9)	50% (1/2)
Total	32% (981/3025)	42% (1240/2940)

National Results for those 138 sites in BOTH rounds of audit

2015: Tranexamic acid was used in **32% (981/3025)** of cases

2016: Tranexamic acid was used in **42% (1240/2940)** cases

There has been an improvement in practice (P < 0.001)

Intraoperative cell salvage (IOCS)

Cell salvage was collected in **17% (539/3261)** of cases and reinfused in **87% (468/537)** with a median (IQR) volume of **450 (241-668) mls returned, n=438**. A clinical contraindication was given in 9% of those without IOCS, but more commonly it was not used as felt to be not worthwhile (36%) or not available on the day of surgery (2%) or in the hospital (15%). No known reason was given in 37%. Overall, cardiac surgery most often used cell salvage (more than half of cases) while open arterial surgery used it in 39% of cases and revision hip surgery in orthopaedic surgery used it in 38% of cases (see Table 22). There was little change in the use of cell salvage between 2015 and 2016 (2015: 15%, 2016: 16% for the 38 sites in both rounds of audit).

Table 22: Intra-operative cell salvage and type of surgery

TYPE OF PROCEDURE	Intra-operative cell salvage (IOCS) commenced
Primary unilateral total hip replacement	6% (27/470)
Primary bilateral total hip replacement	17% (3/18)
Primary unilateral total knee replacement	6% (16/289)
Primary bilateral total knee replacement	4% (1/24)
Unilateral revision hip replacement	38% (89/233)
Unilateral revision knee replacement	11% (10/93)
Colorectal resection for any indication (open or laparoscopic)	1% (2/241)
Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, infrainguinal femoropopliteal or distal bypass	39% (54/140)
Primary coronary artery bypass graft	60% (61/102)
Valve replacement +/- CABG	69% (233/339)
Simple or complex hysterectomy	6% (17/275)
Cystectomy	26% (9/34)
Nephrectomy	6% (6/101)
# neck of femur (arthroplasty)	1% (11/900)
Procedure not stated	0% (0/2)
Total	17% (539/3261)

Near Patient testing of Haemostasis

Near patient testing of haemostasis was undertaken in **8.4% (272/3252)** of all procedures. The use in cardiac surgery formed the largest group (207) with near patient testing used in 47% of cases (see Tables 23 and 24). There has been no increase in use of near-patient testing of haemostasis since 2015.

Table 23: Near patient testing of haemostasis (cardiac patients)

	National
Near patient testing of haemostasis undertaken:	
Total (cardiac)	47% (207/440)
Primary coronary artery bypass graft	41% (42/102)
Valve replacement +/- CABG	49% (165/338)
Near patient testing options undertaken:	Known for 206
• TEG	84% (173)
• RoTEM	16% (33)

Table 24: Near patient testing of haemostasis (all patients)

	National
Near patient testing of haemostasis undertaken	8.4% (272/3252)
Near patient testing options undertaken:	Known for 265
• TEG	82% (217)
• RoTEM	18% (48)

Section 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 post-operative PBM algorithms.

PBM8	Post-operative transfusion allowed (whether or not PBM measures attempted) - FIRST EPISODE
PBM9	Post-operative transfusion following the single unit policy – FIRST EPISODE
PBM10a	Post-operative in whom at least one PBM measure has been attempted (where appropriate) - FIRST EPISODE
PBM11a	Post-operative in whom all PBM measures have been attempted (where appropriate) - FIRST EPISODE

(see algorithms in Appendix B)

Nationally, in the post-operative period at least one transfusion was prescribed by clinical staff in **74% (2396/3256)** of patients

Analysis was undertaken on the first transfusion episode. The first Hb taken the day after surgery was available in **88% (2858)** of patients with a median value of **92g/L (IQR 84-102)** (Table 25). Post-operative management of anaemia was in the most part reliant on blood transfusion; a small minority **(2.0%, 64/3252)** of patients had post-operative cell salvage. Iron therapy was given post-operatively for **16% (502/3217)** of patients (Table 26)

Table 25: First Hb (g/L) taken on day 1 *(Day 1 is the next calendar day after surgery)*

	National
Median (IQR)	92 (84-102), n=2858

Table 26: Post-operative iron by procedure

TYPE OF PROCEDURE	Post-operative iron
Primary unilateral total hip replacement	14% (66/462)
Primary bilateral total hip replacement	11% (2/18)
Primary unilateral total knee replacement	13% (37/286)
Primary bilateral total knee replacement	21% (5/24)
Unilateral revision hip replacement	12% (28/232)
Unilateral revision knee replacement	13% (12/93)
Colorectal resection for any indication (open or laparoscopic)	15% (36/236)
Open arterial surgery e.g.: scheduled (non-ruptured) aortic aneurysm repair, Infra-inguinal femoro-popliteal or distal bypass	7% (10/139)
Primary coronary artery bypass graft	12% (12/100)
Valve replacement +/- CABG	11% (37/322)
Simple or complex hysterectomy	35% (97/274)
Cystectomy	6% (2/34)
Nephrectomy	12% (12/101)
# neck of femur (arthroplasty)	16% (146/894)
Procedure not stated	0% (0/2)
Total	16% (502/3217)

Further information about the first transfusion episode is given in Table 27 overleaf:

Table 27: Details of the first post-operative transfusion episode

	Episode ONE N=2373
Days from surgery: median (IQR)	2 (1-3), n=2353
Pre-transfusion Hb*, g/L: median (IQR)	78 (74-85), n=2171
Units of red cells given: • One • Two • Three • Four or more	Known for 2355 42% (983) 53% (1241) 3% (76) 2% (55)
Hb recorded after each unit of red cells	38% (887/2333)
Patient had acute coronary ischaemia**	5.4% (127/2346)

Reason for transfusion:
• Active bleeding/Blood loss***
• An Hb <70 g/L without acute coronary syndrome
• An Hb <80 g/L with acute coronary syndrome
• Other****
  • Low BP or other haemodynamic reason
  • Hb drop
  • Blood loss - any volume recorded
  • Clinical decision and no other reason given, plus a few with underlying chronic anaemia
  • Not known
• Not known
	N=2373
	18% (428)
	9% (225)
	5% (113)
	1600
	21% (487)
	26% (609)
	4% (97)
	4% (87)
	13% (320)
	0.3% (7)

**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*

PBM standard 8: Post-operative transfusion indicated

In patients who do not have active post-operative bleeding, clinical staff should only prescribe a transfusion if the Hb is less than the defined Hb threshold for transfusion

Nationally, the first post-operative transfusion was prescribed by clinical staff for documented active bleeding or when the Hb was less than the defined Hb threshold for transfusion in **34% (797/2356)** of patients.

PBM Standard 8: National Results for those 138 sites in BOTH rounds of audit

2015: The post-operative transfusion was prescribed when the Hb was less than the defined Hb threshold for transfusion in **23% (503/2158)**

2016: The post-operative transfusion was prescribed when the Hb was less than the defined Hb threshold for transfusion in **34% (725/2137)**

There has been an improvement in practice (P < 0.001)

PBM standard 9: Post-operative transfusion – single unit approach

For patients receiving a post-operative transfusion, clinical staff should prescribe one unit of red cells at a time and re-check Hb before prescribing a further unit (unless the patient has active bleeding)

Nationally, the single unit transfusion approach was followed by clinical staff in **49% (903/1825)** of first post-operative transfusion episodes

PBM Standard 9: National Results for those 138 sites in BOTH rounds of audit

2015: The single unit approach was followed in the first post-operative episode in **37% (703/1900)**

2016: The single unit approach was followed in the first post-operative episode in **50% (837/1661)**

There has been an improvement in practice (P < 0.001)

When comparing the results for post-operative transfusion practice in the 138 sites nationally between 2015 and 2016, there has been a shift towards the use of a more restrictive transfusion threshold (23% v 34%, p<0.001) and an increased uptake in the single unit transfusion approach (37% v 50%, p<0.001)

PBM Standards 10a and 11a: Patient Blood Management in the post-operative period

Clinical staff should attempt at least one (PBM standard 10a) or all (PBM standard 11a) appropriate patient blood management measures in patients who receive a transfusion following major blood loss surgery

PBM 10a

Nationally, clinical staff attempted **at least one** appropriate PBM measure in **84% (1404/1672)** of patients undergoing major blood loss surgery who received their first post-operative transfusion

PBM11a

Nationally, clinical staff attempted **all** appropriate PBM measures in **10% (172/1668)** of patients undergoing major blood loss surgery who received their first post-operative transfusion

When comparing the results for PBM practice in the 138 sites nationally, for patients receiving at least one post-operative transfusion between 2015 and 2016, there has been an improvement in the number of patients where all appropriate PBM measures were attempted (7.5% v 11% p=0.002). There has been no improvement for patients where at least one PBM measure was attempted.

National Results for those 138 sites in BOTH rounds of audit PBM 10a

2015: Clinical staff attempted **at least one** appropriate PBM measure in **84% (1233/1460)** of patients undergoing major blood loss surgery who received at least one post-operative transfusion.

2016: Clinical staff attempted **at least one** appropriate PBM measure in **84% (1279/1522)** of patients undergoing major blood loss surgery who received at least one post-operative transfusion.
There is no evidence of a change in practice (P = 0.76)

PBM 11a
2015: Clinical staff attempted **all** appropriate PBM measures in **7.5% (113/1515)** of patients undergoing major blood loss surgery who received at least one post-operative transfusion.

2016: Clinical staff attempted **all** appropriate PBM measures in **11% (162/1518)** of patients undergoing major blood loss surgery who received at least one post-operative transfusion.

There has been an improvement in practice (P = 0.002)

Patient outcomes

Tables 28 to 30 give further information about final Hb results, rate of transfusion reactions and mortality.

Table 28: Hb on or nearest to discharge/death (*g/L)*

	National
All patients: median (IQR) Hb result g/l	100 (93-108), n=3217
Days from surgery to Hb: median (IQR)	7 (4-12), n=3169

Table 29: Adverse reaction to ANY (post-operative) transfusion

	National
ANY adverse reaction	0.6% (14/2360)

Table 30: Did the patient die during this admission?

	National
Patient died	2.9% (96/3256)
Days from surgery To date of death: median IQR) To discharge: median (IQR)	 9 (4-27), n=93 8 (6-14), n=3111

Comparative results between the two rounds of audit

138 sites took part in both rounds of the audit. These represent 138 of 190 sites in round one and 138 of 156 sites in round two, with 3105 cases from round one and 2950 cases from round two.

Most of the significant differences have been highlighted through the text where comparison is possible. Further key comparative results are shown in Tables 31, 32 and 33 below.

Table 31: BEFORE THEATRE

		Original audit 2015 (3105)	Re-audit 2016 (2950)	P value (comparing national data)
Listed for surgery (excluding #NOF)	% Yes	94% (2078/2199)	84% (1792/2140)	<0.001
	Median (IQR)	44 (14-95), n=2077	43 (16-95), n=1791	0.78
Pre-operative assessment (excluding #NOF)	% Yes	88% (1903/2164)	85% (1825/2140)	0.006
• Days before surgery	Median (IQR)	19 (8-50), n=1885	21 (10-48), N=1780	0.14
FBC results (at least 14 days before surgery)	% Yes	35% (1081/3105)	38% (1118/2950)	0.01
• Hb result	Median (IQR)	123 (112-135), n=1081	122 (112-133), n=1117	0.24*
Patient anaemic (Male <130 g/L, Female <120 g/L)	% Yes	47% (510/1081)	50% (559/1116)	0.19
• If anaemic, was ferritin checked	% Yes	19% (96/510)	23% (126/559)	0.15
Some form of intervention for anaemia preoperatively	% Yes	21% (631/3020)	22% (648/2948)	0.31
Patient on iron before operation	% Yes	11% (333/3020)	12% (355/2948)	0.22
Patient had red cell transfusion before operation	% Yes	7.7% (233/3020)	6.3%(186/2948)	0.04
• Hb result, g/L	Median (IQR)	83 (77-89), n=222	83 (74-89), n=174	0.57*
• Units of red cells given	One	20% (47/232)	28% (49/178)	
	Two	61% (142/232)	53% (95/178)	
	Three	13% (30/232)	11% (20/178)	0.23
	Four or more	5.6% (13/232)	7.9% (14/178)	
• Hb recorded after each unit	% Yes	13% (27/216)	19% (34/179)	0.09
Pre- operative Hb taken closest to surgery	Median (IQR)	117 (105-130), n=2939	117 (105-129), n=2855	0.40*
Patient anaemic (Male <130 g/L, Female <120 g/L)	% Yes	59% (1745/2937)	61% (1755/2855)	0.11

**Mann-Whitney test, otherwise Fisher's Exact test*

Table 32: IN THEATRE AND RECOVERY

		Original audit 2015 (3105)	Re-audit 2016 (2950)	P value (comparing national data)
Tranexamic acid used	% Yes	32% (981/3025)	42% (1240/2940)	<0.001
Intra-operative cell salvage commenced	% Yes	15% (441/3040)	16% (461/2945)	0.22
Near patient testing of haemostasis undertaken	% Yes	15% (441/3009)	8.5% (249/2941)	<0.001
Intra-operative transfusion with allogeneic red cells	% Yes	25% (767/3066)	26% (772/2950)	0.32
First intra-operative pre-transfusion Hb	Median (IQR)	84 (75-97), n=534	84 (75-92), n=422	0.16*
Reason for transfusion = active bleeding	% Yes	65% (479/736)	77% (585/763)	
• Units of red cells given	One	32% (233/727)	39% (300/768)	
	Two	53% (382/727)	43% (333/768)	0.005
	Three	7% (48/727)	7% (56/768)	
	Four or more	9% (64/727)	10% (79/768)	
Hb taken on arrival in recovery	% Yes	34% (1008/2997)	35% (1023/2949)	0.40
• Hb result	Median (IQR)	97 (87-109), n=988	98 (88-109), n=1019	0.53*

**Mann-Whitney test, otherwise Fisher's Exact test*

Table 33: POST-OPERATIVE

		Original audit 2015 (3105)	Re-audit 2016 (2950)	P value (comparing national data)
First Hb taken on next calendar day after surgery	Median (IQR)	91 (83-102), n=2629	91 (84-101), n=2593	0.99*
Patient given post-operative iron	% Yes	16% (477/3010)	15% (447/2909)	0.62
Hb result on or nearest to discharge/death	Median (IQR)	102 (94-110), n=2998	100 (93-108), n=2906	<0.001*
Days after surgery	Median (IQR)	7 (4-12), n=2947	7 (4-11), n=2861	0.96*
FIRST TRANSFUSION EPISODE data	% Yes	72% (2249/3105)	73% (2152/2950)	0.67
Days after surgery	Median (IQR)	2 (1-3), n=2200	2 (1-3), n=2133	0.62*
Pre-transfusion Hb within 12 hours of transfusion	Median (IQR)	79 (75-85), n=2133	78 (74-84), n=1972	0.02*
• Units of red cells given	One	31% (683/2229)	43% (913/2136)	
	Two	62% (1383/2229)	52% (1107/2136)	
	Three	5% (115/2229)	3% (67/2136)	<0.001
	Four or more	2% (48/2229)	2% (49/2136)	
• Hb recorded after each unit	% Yes	28% (618/2190)	39% (831/2114)	<0.001

**Mann-Whitney test, otherwise Fisher's Exact test*

Discussion

In this document, we present the results of the 2016 National Comparative Repeat Audit of Patient Blood Management in scheduled surgery and compare the results with those from the 2015 audit. The audit comprised 3266 cases submitted by 156 sites across all 4 countries of the United Kingdom, from independent and NHS hospitals. Patients in the audit underwent a range of elective procedures:

- Cardiovascular surgery (coronary artery bypass grafting, and open arterial surgery)
- Abdominal surgery (urological, hysterectomy, and colorectal resection)
- Orthopaedic surgery (primary and revision hip or knee arthroplasty).

In addition, we also audited practice in a cohort of patients undergoing repair of proximal femoral fractures, in order to evaluate whether PBM opportunities are being taken in the acute setting.

In each case practice was assessed against a series of standards, developed from national guidance, and expressed in standardised algorithms to enable consistent interpretation as to whether national standards were met on an individual basis. We compared practice in this audit against that described in a previous national comparative audit [14], conducted before the publication of NICE guidelines [2,9].

As was the case in the 2015 audit, we identified substantial variability (particularly between surgical specialties), as well as a gap between best evidence and routine practice. Some of this heterogeneity will undoubtedly be as result of individual patient factors which were not captured in our standard data set. However, not all the observed findings can easily be explained in this way. Consequently, recommendations for change can be made.

Pre-operative care

Although not set as an original audit standard; we have included a recommendation on consent. The ruling of the UK Supreme Court in the case of Montgomery v Lanarkshire Health Board fundamentally changed the practice of consent, shifting the focus of the consent discussion to the specific needs of each individual patient [3]. Because consent now has to be patient-specific [15] and the perioperative risks for a patient with anaemia are materially different from those of a patient without anaemia (e.g. a greater risk of needing a blood transfusion), the patient's current haemoglobin result must be available to the surgeon before the consent discussion takes place. For patients with anaemia this discussion must offer possible treatment options as well as that of delaying elective surgery if time is required to complete them.

Pre-operative anaemia remains the most important modifiable risk factor for intra- and post-operative transfusion [7, 16]. Historically, pre-operative "top-up" transfusion has been the mainstay of treatment, with patients' haemoglobin (Hb) levels being raised intentionally to normal or near-normal levels in the anticipation of operative blood loss. However, this strategy is not supported by evidence of either benefit to the patient, nor that it reduces total peri-operative transfusion requirement [6]. Systematic reviews have shown that restrictive transfusion strategies are non-inferior to liberal use of donated blood in the surgical and critical illness context [11]. Though controversy still exists around the optimal threshold in elderly patients with cardiovascular disease [13], even "liberal" therapy in reviewed trials does not aim to restore normal Hb, nor is the pre-operative elective patient physiologically stressed.

Rather than resorting to transfusion, anaemia should instead be detected in good time before planned surgery, so that its cause may be diagnosed and treated, if possible. The main treatable cause of anaemia in the surgical context is iron deficiency, which may exist either as part of the surgical problem (e.g. blood loss from gastro-intestinal cancer) or be incidental to it. The approach is similar in either case and is centred around confirmation of the diagnosis and iron therapy. Oral iron is readily available, cheap and safe.

We therefore audited the timeliness of assessment and offer of iron therapy (PBM1) and whether pre-operative transfusion was used where there was clear evidence of benefit, namely where patients' Hb levels would make transfusion indicated according to restrictive criteria (PBM2).

In elective orthopaedic surgery, the majority of patients had timely assessment of Hb and were managed appropriately (707/1126, 63%). This was not replicated in other fields, with only half the whole cohort receiving timely evaluation and appropriate treatment (1062/2136, 50%, compared to 46% in 2015 audit). Overall, the median interval between listing and surgery (elective cohort) was 43 (IQR 16-94) days, with a median of 21 (IQR 10-49) days from Hb measurement to surgery. Across the whole cohort there is thus a time period of some weeks between decision to operate and the start of assessment. Process change here could substantially increase the efficiency of PBM efforts by maximising the use of time available and decreasing the likelihood of interference with surgical pathways.

Pre-operative transfusion was uncommon (207/3262 patients, including NOF fracture). However, it was commonly given where other more appropriate PBM opportunities had been missed and where no clear evidence of benefit exists (88/90 patients who had FBC measured >14 days before surgery *and who* received pre-operative transfusion, had pre-transfusion Hb values outside our criteria). Pre-operative transfusion was also still commonly given without re-assessment after each unit (123/185, 66%) suggesting that near-normal pre-operative Hb is still aimed for, albeit somewhat less commonly than in 2015.

Intra-operative measures

Across the whole cohort, 860 patients received intra-operative transfusions, the majority for active bleeding (654/849, 77%) where the indication was recorded. Of 704 elective patients, 572 (81%) were offered at least one PBM measure, but only 141 (20%) received optimal PBM with all applicable measures, including both pre- and intra-operative steps. Median (IQR) pre-transfusion Hb was 84 (75-92) g/L and most patients received 1 or 2 units only. Taken in combination with the high prevalence of transfusion for "active bleeding", this suggests a more restrictive approach than that taken pre-operatively.

Tranexamic acid is cheap, effective [17] and with no evidence of increased risk of complications from either randomised trials [17] or large retrospective analyses [18]. The surgical population in this audit was furthermore at risk of transfusion, given that circa 7000 units of red cells were administered to the cohort. We observed a significant increase in use of tranexamic acid between 2015 and 2016 (2015: 32%, 981/3025 and 2016: 42%, 1240/2940, P<0.001). More complex and costly PBM measures, namely near-patient testing of coagulation and intra-operative cell salvage, were comparatively rarely used.

Post-operative measures

By definition, in the post-operative period, the opportunities for reducing transfusion risk are limited. Consequently, PBM in this setting is a matter of applying restrictive transfusion practice where appropriate. Across the whole cohort, we observed a small but statistically significant reduction in pre-transfusion Hb (2015: 79g/L (75-85), n=2133 and 2016: 78g/L (74-84), n=1972, p=0.02) and a clinically as well as statistically significant increase in use of a single-unit approach (2015: 37%, 703/1900 and 2016: 50%, 837/1661, p<0.001).

Interpretation

We have observed a significantly increased proportion of patients having timely assessment of Hb before planned surgery, together with at least one PBM measure being used between the 2015 and 2016 audits. We further observed increases in the use of restrictive transfusion triggers, single-unit approach, and the use of tranexamic acid.
The above observations all have in common the fact that they are achievable for each patient by one individual changing their practice in that instance. The changes are thus likely to reflect an increased awareness of PBM amongst clinicians, and increased recognition of the desirability of the PBM approach.

However, those measures that require whole-system change to achieve have shown comparatively less change between 2015 and 2016. Examples include process measures, such as the proportion of patients receiving all PBM measures applicable to them. Furthermore, measures demonstrating the efficacy or otherwise of the applied measures have remained unchanged. An example is anaemia prevalence shortly before surgery, as measure of the efficacy or otherwise of pre-operative anaemia management.

Conclusions

We conclude that there is likely increased recognition amongst clinicians caring for surgical patients of the importance of PBM, with consequent signal (though not definitive evidence) that individual practice is changing. However, there is yet limited application of PBM across surgical pathways and there remains considerable room for improvement.

Recommendations

This audit report should be presented to the Hospital Transfusion Committee and clinicians involved in the care of surgical patients. The following recommendations have been developed to drive further improvement in patient blood management implementation.

Hospital Transfusion Committee / Hospital Transfusion Team	**Clinical Staff involved in the care of surgical patients**
Pre-operative anaemia management	
Work with Commissioners to formalise integrated pathways and funding for the referral of patients found to be anaemic during surgical workup	Clinical staff (including GPs) should ensure that a recent haemoglobin result is available for every patient as part of their referral
Ensure that healthcare pathways are structured to enable anaemia screening and investigation/ correction before surgery	Clinical staff should ensure that anaemia screening occurs as soon as possible after the decision to proceed (ideally at the same visit) in order to allow investigation and correction if appropriate
	Clinical staff should ensure that blood results are reviewed in timely fashion, and that patients with previously undetected and potentially serious anaemia are appropriately referred, including deferring non-urgent non-cancer surgery where appropriate
	Even if surgery is urgent and cannot be deferred, clinical staff should use whatever time is available for anaemia investigation and treatment initiation (if appropriate)
	Surgeons should know whether any individual patient is anaemic or not when they undertake the consent process and discuss the patient's individual clinical risks related to blood transfusion to comply with the Montgomery ruling [3].

Hospital Transfusion Committee / Hospital Transfusion Team	Clinical Staff involved in the care of surgical patients
Transfusion Practice	
If a stable non-bleeding patient has a pre-transfusion Hb >80g/L, the transfusion laboratory staff should query the request prior to issuing blood, with support from Hospital Transfusion / PBM team to do so	Clinical staff should only prescribe a red cell transfusion in stable, asymptomatic, non-bleeding patients who have a pre-transfusion Hb of less than 70g/L, or less than 80g/L in those with cardiovascular disease
The team should consider how best to work with clinical trainers to ensure that induction and ongoing education programmes for clinical staff include randomised trial findings which compare the patient outcomes of different red cell transfusion strategies	Clinical staff should record the reason for transfusion in the patient's case notes and record a justification for transfusion if the transfusion was prescribed for a patient with an Hb higher than the recommended thresholds
For hospitals with access to electronic order comms systems, the team should consider how best to work with the IT department to design a system of decision support that supports best practice at the time of ordering	In stable non-bleeding patients, staff should recheck Hb after each transfused unit
If more than one unit transfusions are being requested for routine post-operative patients, the laboratory staff should be encouraged to challenge the request before issuing the blood, with the support of the Hospital Transfusion / PBM team. This also strengthens team working	

Hospital Transfusion Committee / Hospital Transfusion Team	**Clinical Staff involved in the care of surgical patients**
Implementation of Patient Blood Management Measures	
The Committee should ensure that local guidelines exist regarding the use of PBM measures, including clear recommendations on the individuals or teams responsible for implementing these measures	The theatre team, anaesthetists and surgeons should ensure that the PBM measures identified by the Hospital Transfusion / Patient Blood Management Committee are implemented as appropriate
The Committee should ensure that the use of Tranexamic Acid (unless contraindicated) is the standard of care for surgical patients expected to have moderate or more significant blood loss	Where available, peer data should be applied to compare individual surgical teams and encourage participation in PBM
The Committee should identify the need for intra-operative cell salvage and resource appropriately; this would normally be used in relevant high blood loss procedures in association with Tranexamic Acid	

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National Comparative Audit of Blood Transfusion

NHS Blood and Transplant

2015 Re-Audit of Patient Blood Management in Adults undergoing Scheduled Surgery

PATIENT AUDIT BOOKLET

Audited patient number

Site number

RCS ADVANCING SURGICAL STANDARDS

intensive care society care when it matters

Use this space to record any notes *(information written here will not be captured as part of the audit)*

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? ☐☐ ☐☐ ☐☐ Don't know ☐

Q4. For what date was the surgery scheduled? ☐☐ ☐☐ ☐☐ Don't know ☐

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 Q17***

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

☐☐ ☐☐ ☐☐

Q9. Were FBC results available in the time between listing for surgery and up to 14 days before surgery?

FBC results available?

X----------X----------X
Listing 14 days before surgery Surgery

☐ Yes ***Now go to Q10*** ☐ No ***Now go to Q17***

Q10. On what date during the time between listing for surgery and up to 14 days before surgery were the FBC results first available?

☐☐ ☐☐ ☐☐

Q11. What was the Hb result? ☐☐☐ *g/L*

Q12. What was the MCV result? ☐☐☐ *femtolitres* **OR** ☐ Not available

Q13. Was ferritin checked? ☐ Yes ***Now go to Q14*** ☐ No ***Now go to Q15***

Q14. If yes, what was the ferritin result?
(State unit of measurement as well as value, and include reference range) ***Now go to Q15***

Value	Unit of measurement

Q15. Was a transferrin saturation test done?

☐ Yes ***Now go to Q16*** ☐ No ***Now go to Q17***

Q16. What was the transferrin saturation? ☐☐ *%*

Q17. 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 Q18*** *to record details of that transfusion episode. Details of allogeneic red cell transfusion in theatre are recorded at Q39.*

NB: If you ticked Red cell transfusion at Q17, please complete questions 18 to 21. If you did not tick Red cell transfusion at Q17, DO NOT complete questions 18 to 21. Go to Q22.

Q18. What was the date and time of transfusion of the first unit?
Date ddmmyy ☐☐ ☐☐ ☐☐ *Time hh:mm* ☐☐ ☐☐

Q19. What was the pre-transfusion Hb in g/L? *(up to 72 hours before first unit transfused)*

☐☐☐ g/L OR ☐ Not done

Q20. How many units of red cells were given in all before the patient went to theatre?

☐☐

Q21. Was the Hb recorded after each unit of red cells? ☐ Yes ☐ No

Q22. 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)*

Q23. 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), If they were not on any of them, tick" None/ No record" and go to Q24.*

☐ Antiplatelet drugs
☐ DOAC *(Direct Oral Anticoagulants)*
☐ Warfarin
☐ None / No record

NB: If you ticked Antiplatelet drugs in Q23 above, then go to Q24 & Q25.
NB: If you ticked DOAC in Q23 above, then go to Q26.

Q24. If the patient was on an antiplatelet agent,
was it stopped 5 days or more before surgery? ☐ Yes ☐ No

Q25. If it was **not stopped**, give details of the documented clinical reason for continuing it:

☐ Don't know
☐ Coronary artery stent within last 12 months
☐ Acute coronary syndrome
☐ Other (please state)

Q27. What was the pre-operative Hb taken closest before the date of surgery?

☐☐☐ g/L ***Now go to Q28*** **or** ☐ Not done ***Now go to Q29***

Q28. What was the date of that Hb check? ☐☐ ☐☐ ☐☐

Q29. Was the patient on Warfarin pre-operatively?

☐ Yes ***Now go to Q30*** ☐ No ***Now go to Q32***

Q30. What was the INR result taken closest before the date of surgery? ☐☐☐☐

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

C: Patient Blood Management while in theatre and recovery

Q32. Was tranexamic acid used for this patient? ☐ Yes ☐ No

Q33. Was aprotonin used for this patient? ☐ Yes ☐ No

Q34. Was collection for intra-operative cell salvage (IOCS) commenced?

☐ Yes ***Now go to Q35*** ☐ No ***Now go to Q36***

Q35. Which of these describes the outcome of using IOCS?

☐ Collected but not reinfused due to insufficient volume

☐ Collected and reinfused – (state volume reinfused) ☐☐☐☐ mls
Now go to Q37

Q36. Why was cell salvage not commenced?

☐ IOCS is not available in this hospital

☐ 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 contraindication

☐ Don't know

Q37. Was near patient testing of haemostasis undertaken?

☐ Yes ***Now go to Q38*** ☐ No ***Now go to Q39***

Q38. Which of these near patient testing options were undertaken? *(tick either or both options)*
☐ TEG
☐ RoTEM

*Questions 39 to 45 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 Q39 and continue through to Q45. If allogeneic blood **was not** used, answer No to Q39 and go to Q46.*

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

Q39. Was there any intra-operative transfusion with allogeneic red cells issued by the transfusion laboratory?

☐ Yes ***Now go to Q40*** ☐ No ***Now go to Q44***

Q40. Was the pre-transfusion Hb checked within 1 hour before transfusing the first unit?

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

Q41. What was the first intra-operative pre-transfusion Hb?

☐☐☐ g/L

Reason for intra-operative transfusion:

Q42. Did the patient have active bleeding? ☐ Yes ☐ No

Q43. How many units of red cells were transfused intra-operatively? ☐☐
On arrival in recovery:

Q44. Was an Hb taken on arrival in recovery?

☐ Yes ***Now go to Q45*** ☐ No ***Now go to Q46***

Q45. 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)*

Q46. Was post-operative cell salvage used?

☐ Yes ***Now go to Q47*** ☐ No ***Now go to Q49***

Q47. 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)*

Q48. What was the total volume in mls of post-operative salvaged blood infused? ☐☐☐☐

Q49. What was the first Hb taken on day 1? ☐☐☐ g/L **or** ☐ Not done
(Day 1 is the next calendar day after surgery)

Q50. Was the patient given post-operative iron? ☐ Yes ☐ No

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.

Q51. Was there transfusion on any of the first seven post-operative days? *(i.e. Day 1 to day 7)*
☐ Yes ***Now go to Q52*** ☐ No ***Now go to Q53***

Q52. 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
☐ More than 5

Q53. Did the patient have an adverse reaction to ANY transfusion?

☐ Yes ☐ No

Q54. Did the patient die during this admission?

☐ Yes ***Now go to Q55*** ☐ No ***Now go to Q56***

Q55. What was the date of death? ☐☐ ☐☐ ☐☐

Q56. What was the date of discharge? ☐☐ ☐☐ ☐☐

Q57. What was the Hb on or nearest to discharge / death? ☐☐☐ *g/L* ***Now go to Q58***

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

Q58. What was the date of the Hb test? ☐☐ ☐☐ ☐☐

Please record details of the first post-operative transfusion episode (if appropriate). ***If there were no post-operative transfusions, you have finished this booklet.***

Episode 1

Q59. Date of transfusion ☐☐ ☐☐ ☐☐

Q60. What was the pre-transfusion Hb (within 12 hours of transfusion)? ☐☐☐ g/L

or ☐ Not done

Q61. How many units of red cells were given? ☐☐

Q62. Was the Hb recorded after each unit of red cells? ☐ Yes ☐ No

Q63. 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.*

Q64. What was the reason for transfusion?

☐ Active bleeding/Blood loss

**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*

Notes:

Pre-operative Anaemia optimisation

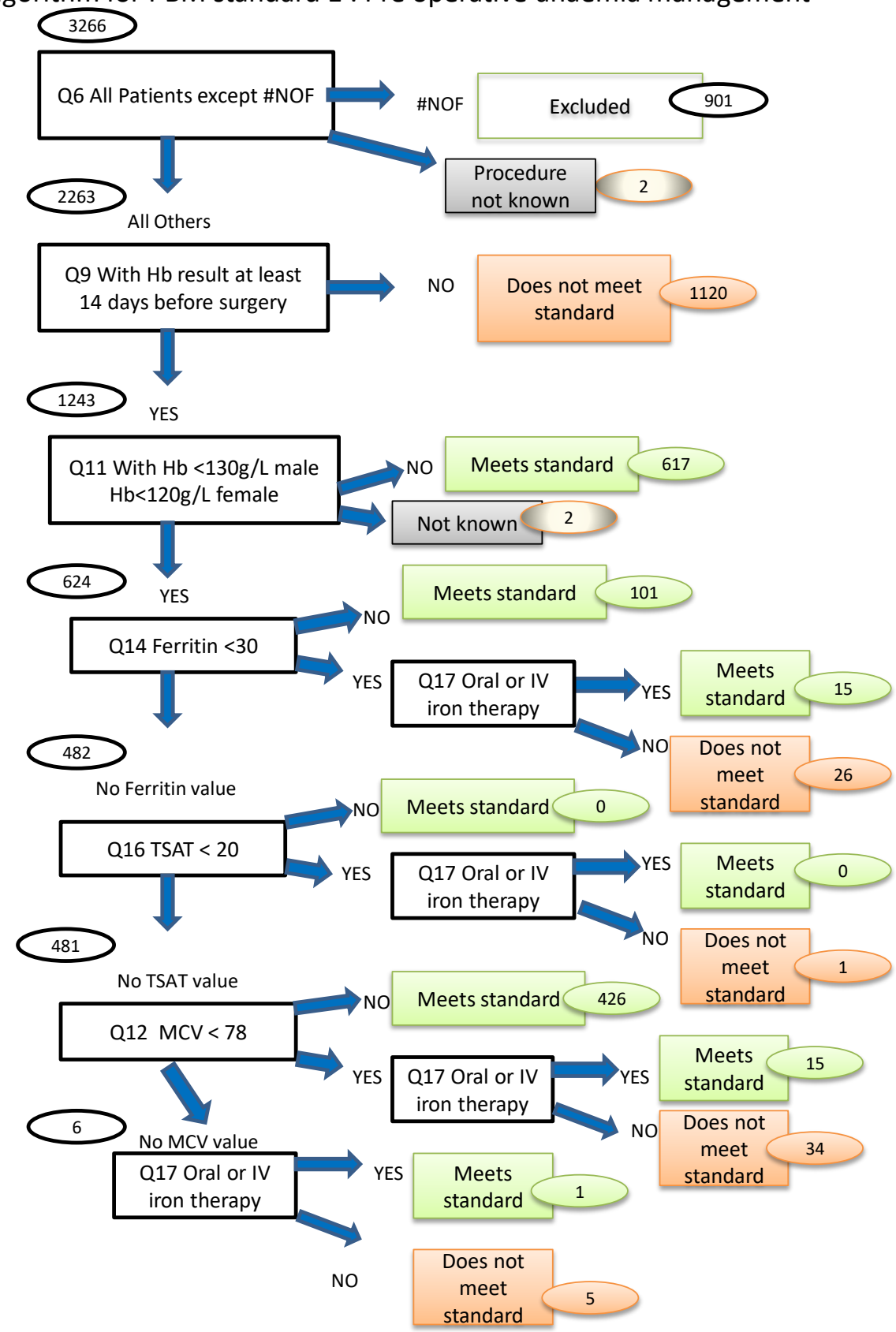
Patients with iron deficiency anaemia identified pre op and treated with IV or oral iron (anaemia defined as HB <120g/L females, < 130g/L males at least 14 days before surgery, iron deficiency defined as ferritin <30, Transferrin saturation <20% if no ferritin performed or MCV <78fl if no ferritin or 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.

Intraoperative cell salvage

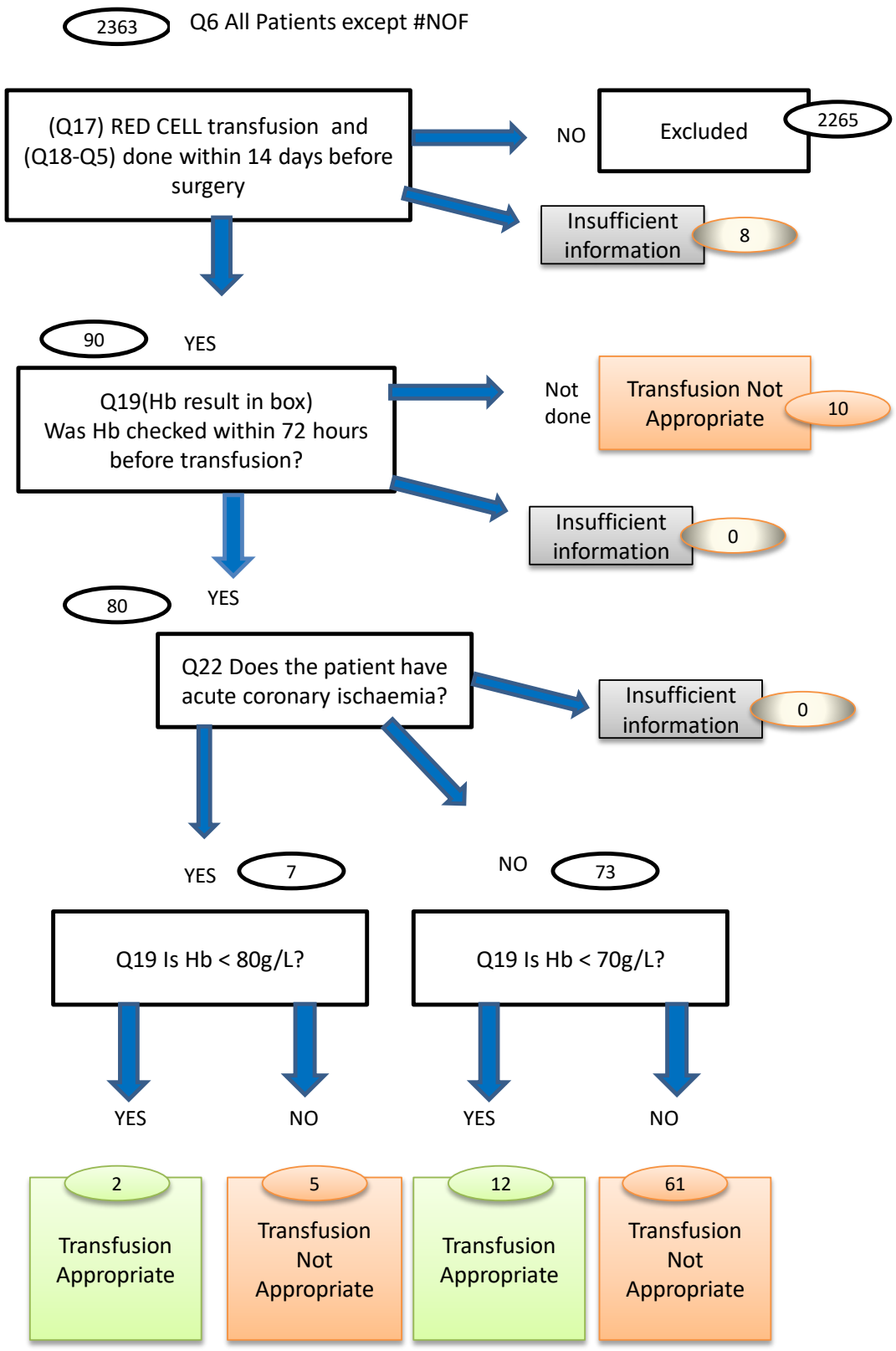
Cell salvage set up and attempt made to collect; standard is still met if not enough collected for return. Exceptions: active sepsis, malignancy, contaminated field.

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

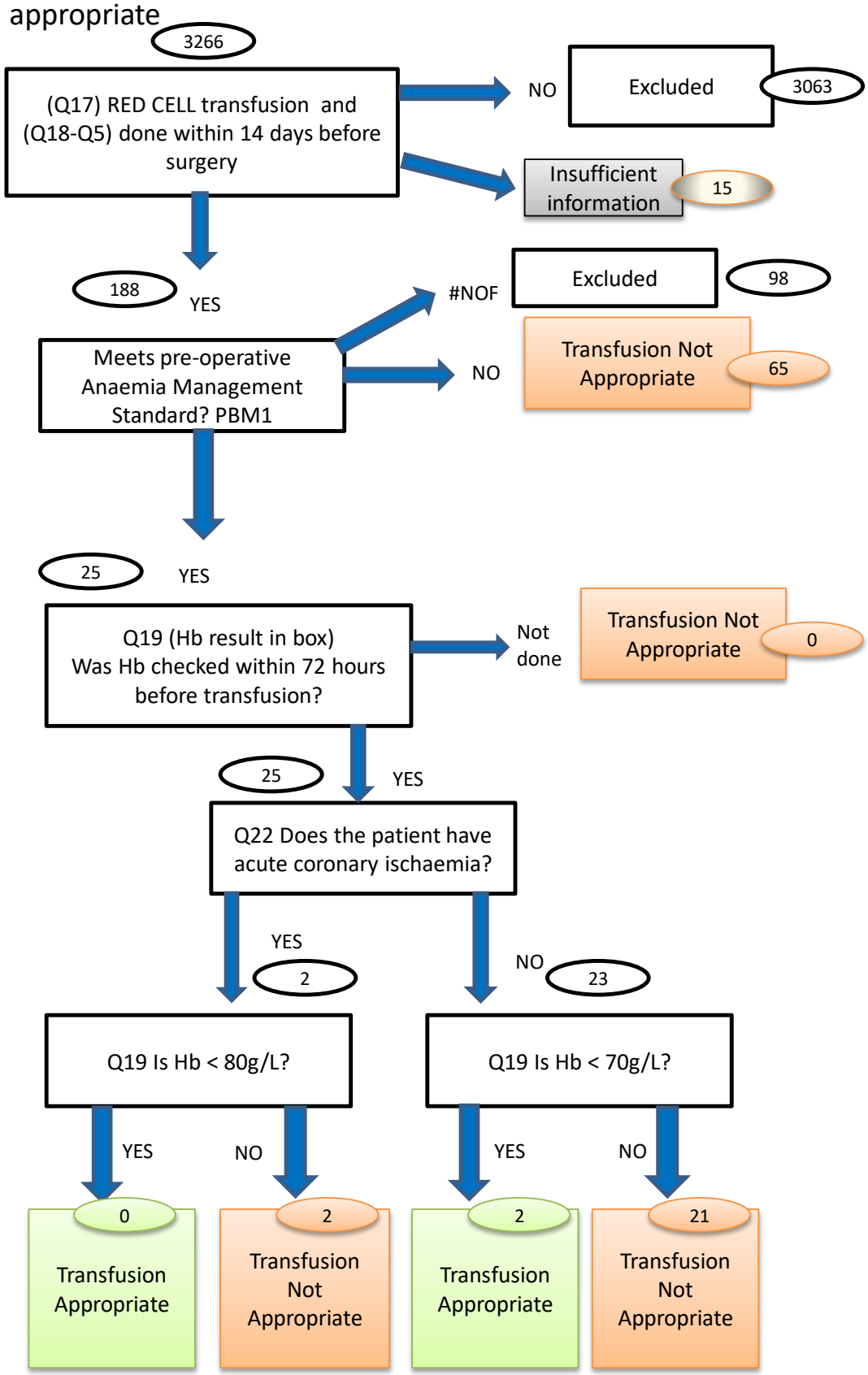
Algorithm for PBM standard 1 : Pre operative anaemia management



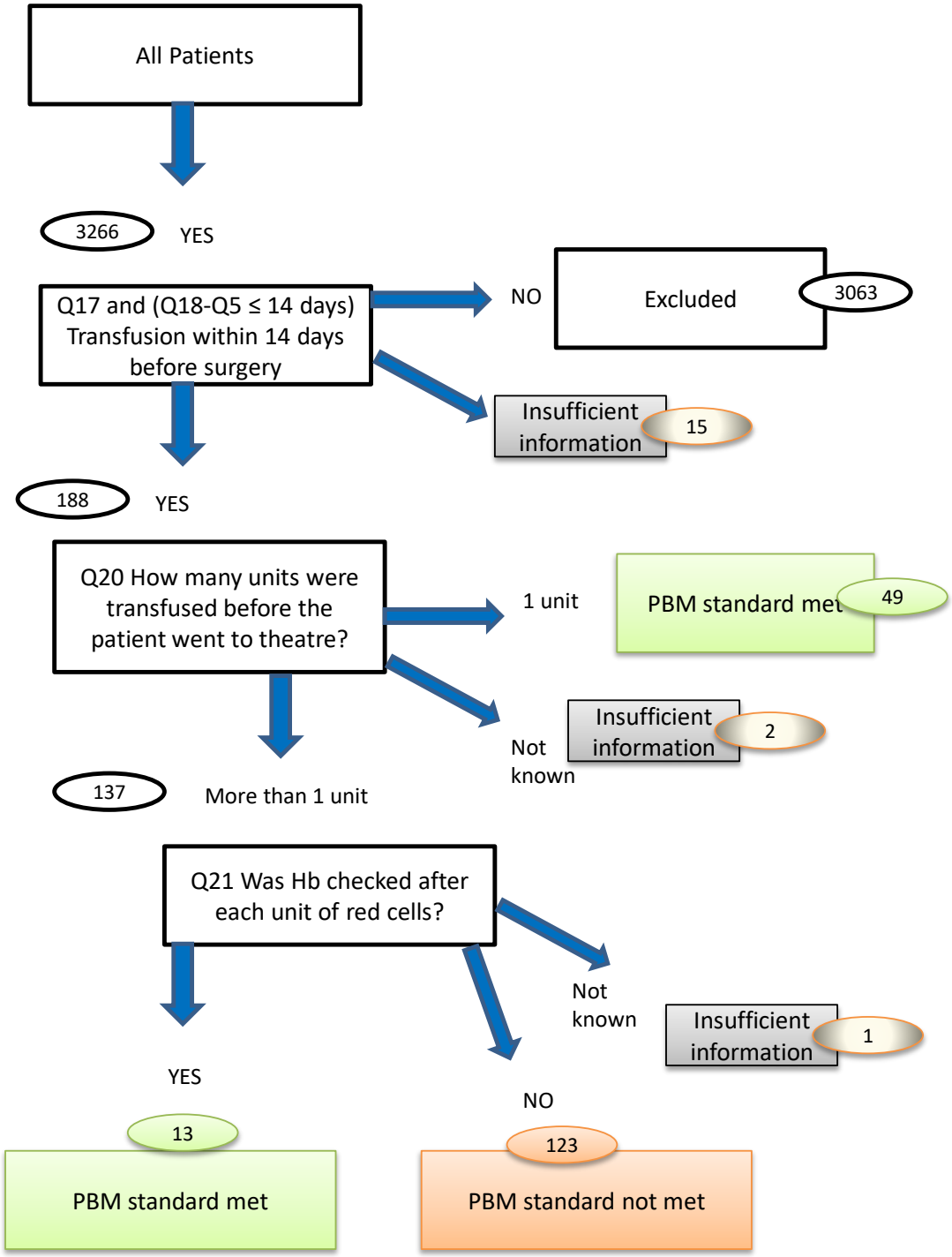
Algorithm for PBM standard 2 : Pre operative transfusion allowed



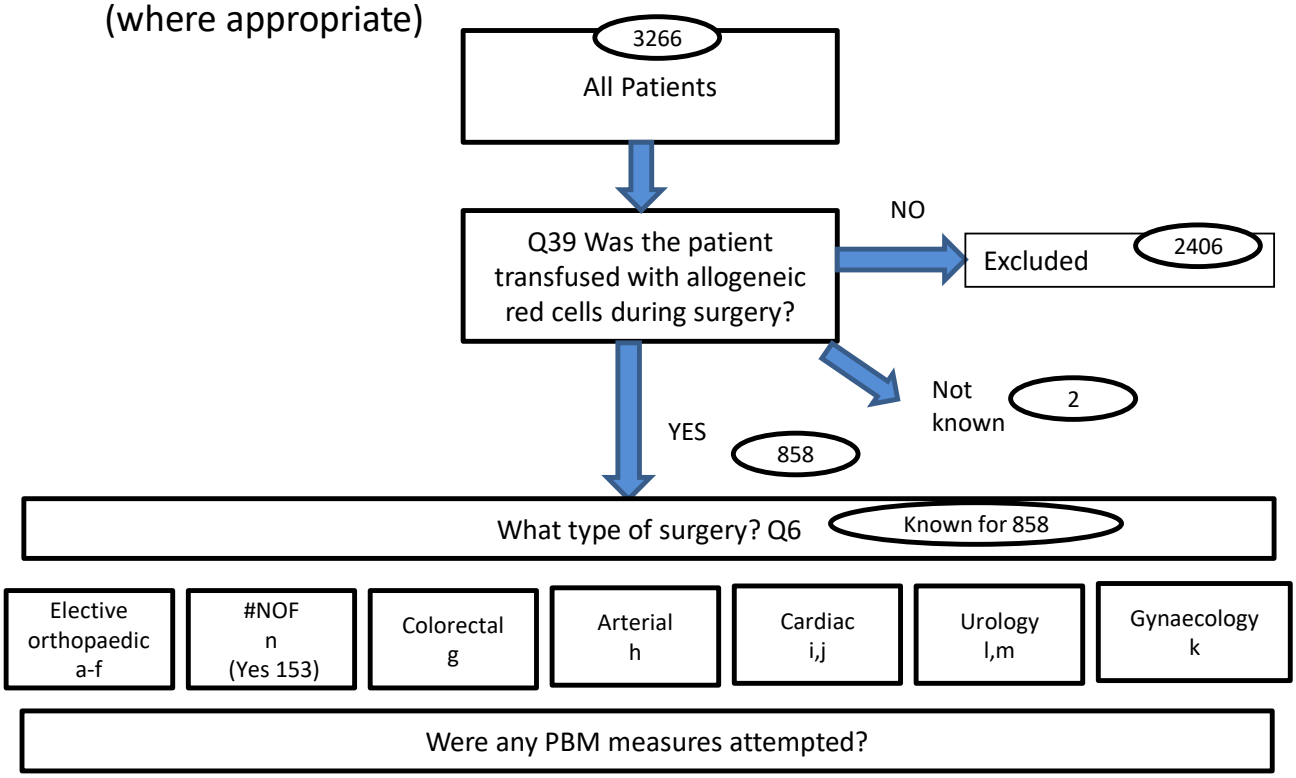
Algorithm for PBM standard 3 : Pre operative transfusion allowed only if preoperative anaemia optimisation has been attempted where appropriate



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



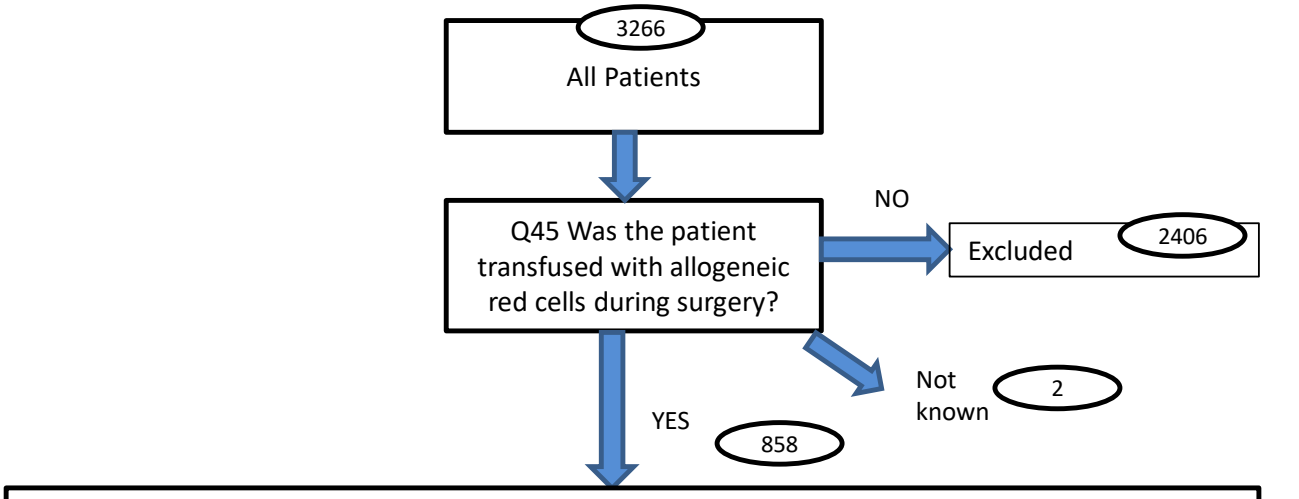
Algorithm for PBM standard 6a : Patients having Intra operative transfusion in whom at least one PBM measure has been attempted (where appropriate)



Meets pre op anaemia standard? Standard 1						
Yes / No 106 / 84	N/A	Yes / No 21 / 69	Yes / No 16 / 37	Yes / No 76 / 113	Yes / No 28 / 43	Yes / No 44 / 68
Meets TXA / Aprotonin standard? Q32=TXA or Q33=Aprotonin						
Yes / No 143 / 47	N/A	Yes / No / NK 12 / 77 / 1	Yes / No 4 / 49	Yes / No 148 / 41	Yes / No / NK 20 / 50 / 1	Yes / No 47 / 65
Meets cell salvage standard Q34yes or Q34no and Q36=reason c (Not worthwhile in this procedure as anticipated blood loss generally too low) or reason d (Not worthwhile in this procedure as anticipated blood loss generally too low)						
Yes / No 97 / 93	N/A	N/A	Yes / No 19 / 34	Yes / No 164 / 25	Yes / No / NK 37 / 33 / 1	Yes / No 49 / 63

If yes to ANY(where applicable) standard is met
If no to ALL (where applicable) standard is not met

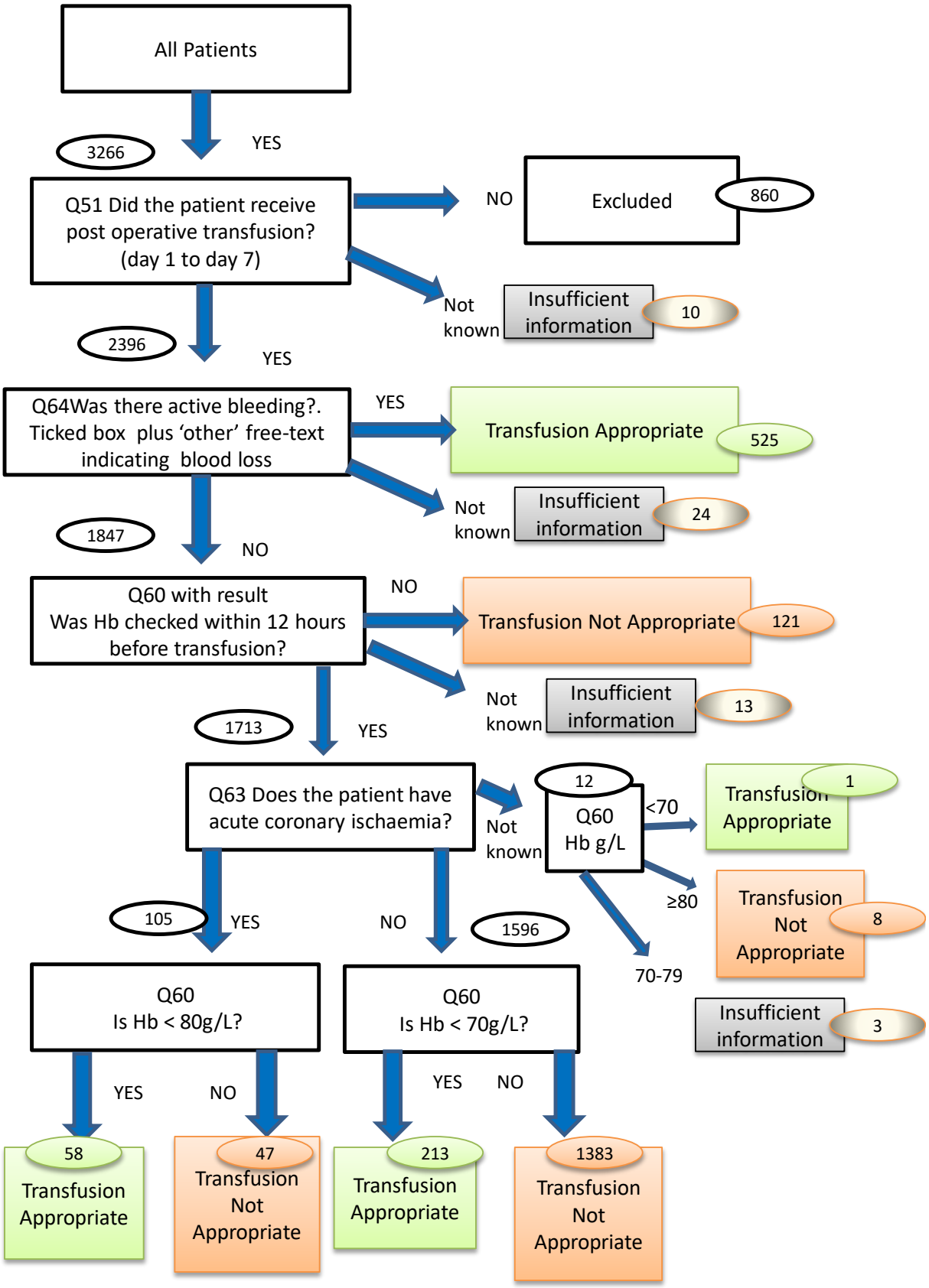
Algorithm for PBM standard 7a : Patients having Intra operative transfusion in whom all PBM measures has been attempted (where appropriate)



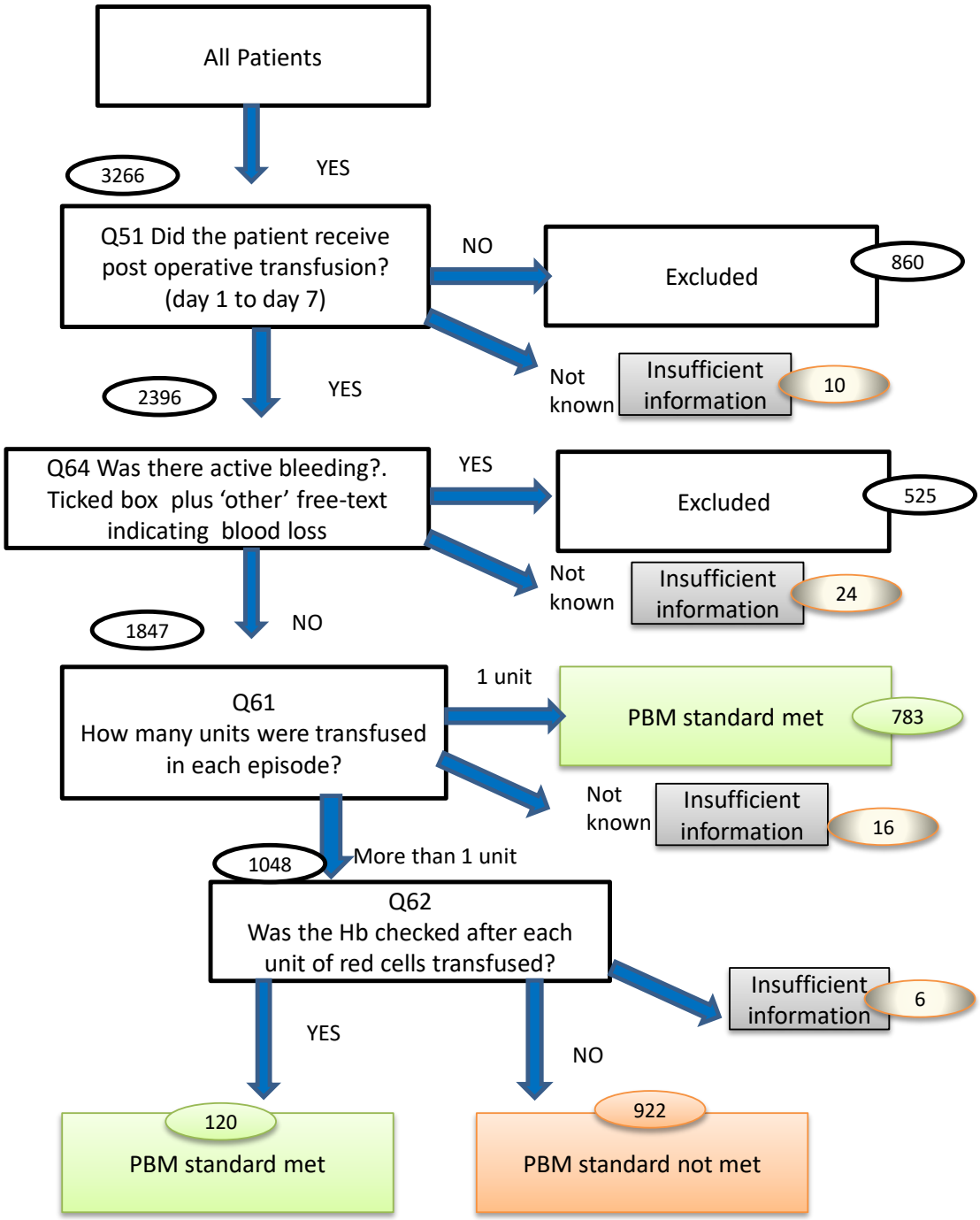
Meets pre op anaemia standard? Standard 1							
Yes /No 46 / 24	Yes /No 60 / 60	N/A	Yes / No 21 / 69	Yes / No 16 / 37	Yes / No 76 / 113	Yes / No 28 / 43	Yes / No 44 / 68
Meets TXA / Aprotonin standard? Q32=TXA or Q33=Aprotonin							
Yes /No 49 / 21	Yes /No 94 / 26	N/A	Yes / No / NK 12 / 77 / 1	Yes / No 4 / 49	Yes / No 148 / 41	Yes / No / NK 20 / 50 / 1	Yes / No 47 / 65
Meets cell salvage standard Q34yes or Q34no and Q36=reason c (Not worthwhile in this procedure as anticipated blood loss generally too low) or reason d (Not worthwhile in this procedure as anticipated blood loss generally too low)							
N/A	Yes /No 68 / 52	N/A	N/A	Yes / No 19 / 34	Yes / No 164 / 25	N/A	N/A

If yes to ALL (where applicable) standard is met
If no to ANY (where applicable) standard is not met

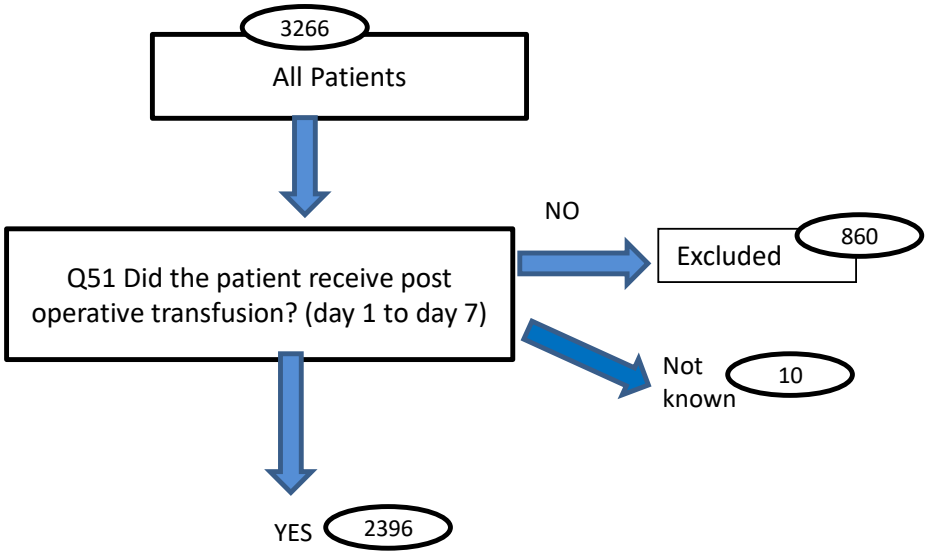
Algorithm for PBM standard 8 : Post operative transfusion allowed (whether or not PBM measures attempted) – FIRST transfusion episode



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



Algorithm for PBM standard 10a: 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 2396

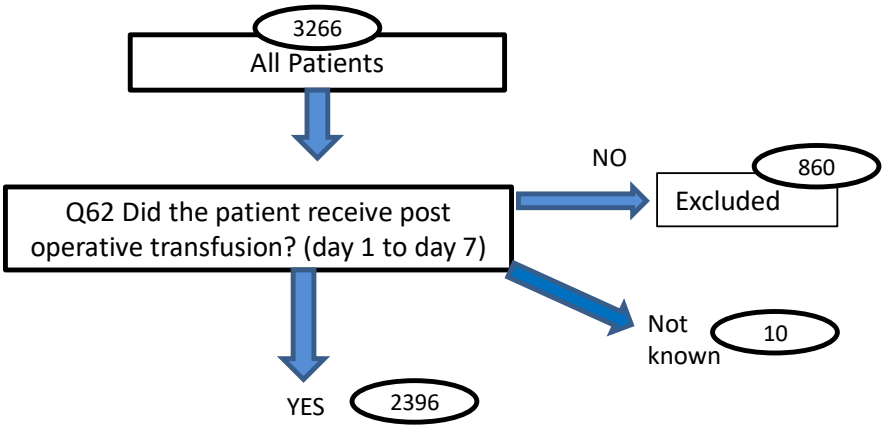
Elective orthopaedic a-f	#NOF N (Yes 724)	Colorectal g	Arterial h	Cardiac i,j	Urology l,m	Gynaecology k

Were any PBM measures attempted?

Meets pre op anaemia standard? Standard 1						
Yes /No / NK 562/ 328 / 1	NA	Yes /No 31/ 119	Yes /No 24 / 51	Yes /No 145 / 179	Yes /No 32 / 31	Yes /No 75/ 94
Meets TXA / Aprotonin standard? Q32=TXA or Q33=Aprotonin						
Yes /No / NK 531 / 359/ 1	N/A	Yes /No 16 / 134	Yes /No 7 / 68	Yes /No 273 / 51	Yes /No 12 / 51	Yes /No 51 / 118
Meets cell salvage standard Q34yes or Q34no and Q36=reason c (Not worthwhile in this procedure as anticipated blood loss generally too low) or reason d (Not worthwhile in this procedure as anticipated blood loss generally too low)						
Yes /No 441 / 450	N/A	N/A	Yes /No 36 / 39	Yes /No 256 / 68	Yes /No 34 / 29	Yes /No 66 / 103
Meets post op cell salvage standard Q46=yes						
Yes /No / NK 18 / 869 / 4	N/A	N/A	N/A	Yes /No 16 / 308	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 11a : Patients having post operative transfusion in whom all PBM measures have been attempted (where appropriate) (FIRST EPISODE)



What type of surgery?

Primary ortho a,c	Revision / bilateral ortho b,d,e,f	#NOF N (Yes 724)	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 413 / 220	Yes /No / NK 149 / 108 / 1	N/A	Yes /No 31/ 119	Yes /No 24 / 51	Yes /No 145 / 179	Yes /No 32 / 31	Yes /No 75 / 194
Meets TXA / Aprotonin standard? Q32=TXA or Q33=Aprotonin							
Yes /No 370/ 263	Yes /No / NK 161 / 96 / 1	N/A	Yes /No 16 / 134	Yes /No 7 / 68	Yes /No 273 / 51	Yes /No 12 / 51	Yes /No 51 / 118
Meets cell salvage standard Q34yes or Q34no and Q36=reason c (Not worthwhile in this procedure as anticipated blood loss generally too low) or reason d (Not worthwhile in this procedure as anticipated blood loss generally too low)							
N/A	Yes /No 140 / 118	N/A	N/A	Yes /No 36 / 39	Yes /No 256 / 68	N/A	N/A
Meets post op cell salvage standard Q55=yes							
Yes /No / NK 13 / 617 / 3	N/A	N/A	N/A	Yes /No 0 / 75	N/A	N/A	Yes /No 0 / 169

If yes to ALL (where applicable) standard is met
If no to ANY (where applicable) standard is not met

Original audit 2015	Re-audit 2016
-	Addenbrooke's Hospital
Airedale NHSFT	Airedale NHSFT
Altnagelvin Area Hospital	Altnagelvin Area Hospital
Aneurin Bevan Health Board	St. Woolos Hospital Newport, Gwent
Ashford and St Peters Hospitals NHSFT	Ashford and St Peters Hospitals NHSFT
Barnet Hospital	Barnet Hospital
Barnsley Hospital NHSFT	Barnsley Hospital NHSFT
Barts Health NHST	Barts Health NHST
Basildon and Thurrock University Hospitals NHSFT	-
Beaumont Hospital	-
-	Bedford Hospital NHST
Belfast Health and Social Care Trust	-
Betsi Cadwaladr University Health Board	Betsi Cadwaladr University Health Board
Birmingham Heartlands Hospital	-
Birmingham Women's NHSFT	Birmingham Women's NHSFT
Blackpool Victoria Hospital	-
Bon Secours Hospital Cork	-
Borders General Hospital	Borders General Hospital
Bradford Teaching Hospitals NHSFT	Bradford Teaching Hospitals NHSFT
Brighton and Sussex University Hospitals NHST	-
-	Buckinghamshire Healthcare NHST
Calderdale and Huddersfield NHSFT	Calderdale and Huddersfield NHSFT
Central Manchester University Hospitals NHSFT	Central Manchester University Hospitals NHSFT
Chase Farm Hospital	Chase Farm Hospital
-	Chelsea & Westminster Hospital
Chesterfield Royal Hospital NHSFT	Chesterfield Royal Hospital NHSFT
Colchester Hospital University NHSFT	Colchester Hospital University NHSFT
Conquest Hospital	Conquest Hospital
County Hospital (Stafford)	County Hospital (Stafford)
Craigavon Area Hospital	Craigavon Area Hospital
Croydon Health Services NHST	Croydon Health Services NHST
Darent Valley Hospital	-
Darlington Memorial Hospital	-
Derby Hospitals NHSFT	Derby Teaching Hospitals NHSFT
Derriford Hospital	Plymouth Hospitals NHST
Doncaster and Bassetlaw Hospitals NHSFT	-
Dorset County Hospital NHSFT	Dorset County Hospital NHSFT
East and North Hertfordshire NHST	East and North Hertfordshire NHST
-	East Cheshire NHST
East Lancashire Hospitals NHST	East Lancashire Hospitals NHST
Eastbourne Hospital	Eastbourne Hospital
Forth Valley Royal Hospital	Forth Valley Royal Hospital
Frimley Park Hospital	Frimley Park Hospital
Furness General Hospital	Furness General Hospital
Galway Clinic	Galway Clinic
Galway University Hospital	-
Gateshead Health NHSFT	Gateshead Health NHSFT
George Eliot Hospital NHST	George Eliot Hospital NHST
Gloucestershire Hospitals NHSFT	Gloucestershire Hospitals NHSFT
Great Western Hospitals NHSFT	Great Western Hospitals NHSFT
Guys and St Thomas' NHSFT	-
-	Hairmyres Hospital
Hammersmith Hospital	-
Hampshire Hospitals NHSFT	Hampshire Hospitals NHSFT

Harrogate and District NHSFT	Harrogate and District NHSFT
HCA International Group Hospitals	HCA International Group Hospitals
Hinchingbrooke Hospital	Hinchingbrooke Health Care NHST
Homerton University HospitalNHSFT	-
Hospital of St John & St Elizabeth	-
Hull Royal Infirmary	Hull Royal Infirmary
James Paget University Hospital	James Paget University Hospitals NHSFT
Kent & Canterbury Hospital	Kent & Canterbury Hospital
Kettering General Hospital NHSFT	Kettering General Hospital NHSFT
King Edward VIIs Hospital Sister Agnes	-
King's College HospitalNHSFT	-
King's Mill Hospital	King's Mill Hospital
Kingston Hospital	Kingston Hospital NHSFT
Lancashire Teaching Hospitals NHSFT	Lancashire Teaching Hospitals NHSFT
Liverpool Heart & Chest Hospital	Liverpool Heart & Chest Hospital
Liverpool Women's NHSFT	Liverpool Women's NHSFT
London North West Healthcare NHST	London North West Healthcare NHST
-	Luton and Dunstable University Hospital NHSFT
Maidstone Hospital	Maidstone Hospital
Medway Maritime Hospital	Medway NHSFT
Mid Cheshire Hospitals NHSFT	-
-	Mid Essex Hospital Services NHST
Milton Keynes NHSFT	Milton Keynes University Hospital NHSFT
-	Morriston Hospital
Nevill Hall Hospital	Nevill Hall Hospital
NHS Lothian	Royal Infirmary of Edinburgh
Norfolk & Norwich University Hospital	-
North Bristol NHST	North Bristol NHST
North Cumbria University Hospitals NHST	North Cumbria University Hospitals NHST
North Middlesex University Hospital	North Middlesex University Hospital NHST
North Tees and Hartlepool NHSFT	North Tees and Hartlepool NHSFT
-	Northampton General Hospital NHST
Northern Devon Healthcare NHST	Northern Devon Healthcare NHST
Northern Lincolnshire and Goole Hospitals NHSFT	Northern Lincolnshire and Goole NHSFT
Northumbria Healthcare NHSFT	Northumbria Healthcare NHSFT
Nottingham University Hospitals NHST	-
Nuffield Cheltenham Hospital	-
Nuffield Orthopaedic Centre (NHSl)	Nuffield Orthopaedic Centre (NHSl)
Oswestry Orthopaedic Hospital	The Robert Jones and Agnes Hunt Orthopaedic Hospital NHSFT
Our Lady's Hospital Navan	Our Lady's Hospital Navan
Oxford University Hospitals NHST	-
Papworth Hospital NHSFT	Papworth Hospital NHSFT
Peterborough and Stamford Hospitals NHSFT	Peterborough and Stamford Hospitals NHSFT
Poole Hospital	Poole Hospital NHSFT
Portsmouth Hospitals NHST	Portsmouth Hospitals NHST
Princess Alexandra Hospital	-
Queen Elizabeth Hospital Woolwich	Queen Elizabeth Hospital Woolwich
Queen Elizabeth The Queen Mother Hospital	Queen Elizabeth The Queen Mother Hospital
Queen's Hospital Burton	Burton Hospitals NHSFT
Queen's Hospital Romford	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 Berkshire NHSFT
Royal Bolton Hospital	Bolton NHSFT
Royal Brompton and Harefield NHSFT	Royal Brompton and Harefield NHSFT
-	Royal Cornwall Hospitals NHS Trust
Royal Devon & Exeter Hospital	Royal Devon and Exeter NHSFT
Royal Free Hospital	Royal Free Hospital
-	Royal Glamorgan Hospital
Royal Gwent Hospital	Royal Gwent Hospital
Royal Lancaster Infirmary	Royal Lancaster Infirmary
Royal National Orthopaedic Hospital NHST	Royal National Orthopaedic Hospital NHST
-	Royal Stoke University Hospital
Royal Surrey Country Hospital	Royal Surrey County Hospital NHSFT
Royal United Hospital	Royal United Hospitals Bath NHSFT
Salford Royal NHSFT	-
SalisburyNHSFT	-
Sandwell and West Birmingham Hospitals NHST	Sandwell and West Birmingham Hospitals NHST
Scarborough General Hospital	Scarborough General Hospital
Sheffield Teaching Hospitals NHSFT	Sheffield Teaching Hospitals NHSFT
South Devon Healthcare NHSFT	Torbay and South Devon NHSFT
South Infirmary Victoria University Hospital Cork	-
South Tees Hospitals NHSFT	South Tees Hospitals NHSFT
South Tyneside NHSFT	South Tyneside NHSFT
South Warwickshire NHSFT	South Warwickshire NHSFT
South West London Elective Orthopaedic Centre	-
Southampton General Hospital	University Hospital Southampton NHSFT
Southend University Hospital	-
Southport and Ormskirk Hospital NHST	Southport and Ormskirk Hospital NHST
Spire Alexandra Hospital	Spire Alexandra
Spire Bristol Hospital	-
Spire Cambridge Lea	Spire Cambridge Lea
Spire Clare Park Hospital	-
Spire Gatwick Park Hospital	Spire Gatwick Park Hospital
Spire Harpenden Hospital	-
Spire Hull & East Riding Hospital	-
Spire Little Aston Hospital	-
Spire Murrayfield Hospital Wirral	-
Spire Parkway Hospital	Spire Parkway Hospital
-	Spire Portsmouth Hospital
Spire St Anthony's Hospital	-
Spire Thames Valley Hospital	Spire Thames Valley Hospital
Spire Washington Hospital	SPIRE Washington
Spire Wellesley Hospital	-
Spire Yale Hospital	-
St. George's University Hospitals NHSFT	St. George's University Hospitals NHSFT
St. Vincent's University Hospital	-
Stockport NHSFT	Stockport NHSFT
Sunderland Royal Hospital	City Hospitals Sunderland NHSFT
Surrey and Sussex Healthcare NHST	Surrey and Sussex Healthcare NHST
Tameside Hospital NHSFT	Tameside and Glossop Integrated Care NHSFT
Taunton & Somerset Hospital	Taunton and Somerset NHSFT
The Dudley Group of Hospitals NHSFT	The Dudley Group NHSFT
The HillingdonHospitalsNHSFT	-
The Ipswich Hospital NHST	The Ipswich Hospital NHST
The Leeds Teaching Hospitals NHST	The Leeds Teaching Hospitals NHST
The Mid Yorkshire Hospitals NHST	The Mid Yorkshire Hospitals NHST
The Montefiore Hospital	-

The Newcastle upon Tyne Hospitals NHSFT	The Newcastle upon Tyne Hospitals NHSFT
The Pennine Acute Hospitals NHST	The Pennine Acute Hospitals NHST
The Queen Elizabeth Hospital King's Lynn NHSFT	The Queen Elizabeth Hospital Kings Lynn NHSFT
The Rotherham NHSFT	The Rotherham NHSFT
-	The Royal Bournemouth and Christchurch Hospitals NHSFT
The Royal Liverpool & Broadgreen University Hospitals NHST	The Royal Liverpool & Broadgreen University Hospitals NHST
The Royal Marsden NHSFT	The Royal Marsden NHSFT
The Royal Orthopaedic Hospital Birmingham	The Royal Orthopaedic Hospital NHSFT
The Royal Wolverhampton Hospitals NHST	The Royal Wolverhampton NHST
The Shrewsbury and Telford Hospital NHST	The Shrewsbury and Telford Hospital NHST
-	The Whittington Hospital NHS Trust
The Ulster Hospital	-
The York Hospital	The York Hospital
United Lincolnshire Hospitals NHST	United Lincolnshire Hospitals NHST
University College London Hospitals NHSFT	University College London Hospitals NHSFT
University Hospital Aintree	Aintree University Hospital NHSFT
University Hospital Coventry	University Hospitals Coventry and Warwickshire NHST
University Hospital Lewisham	University Hospital Lewisham
University Hospital Limerick	-
University Hospital of North Durham	University Hospital of North Durham
University Hospital of South Manchester NHS F. Trust	University Hospital of South Manchester NHSFT
University Hospitals Birmingham NHSFT	University Hospitals Birmingham NHSFT
University Hospitals Bristol NHSFT	University Hospitals Bristol NHSFT
University Hospitals of Leicester NHST	-
Walsall Healthcare NHST	Walsall Healthcare NHST
Warrington and Halton Hospitals NHSFT	Warrington and Halton Hospitals NHSFT
-	West Hertfordshire Hospitals NHST
West Middlesex University Hospital NHST	West Middlesex University Hospital
West Suffolk NHSFT	West Suffolk NHSFT
Western Sussex Hospitals NHSFT	Western Sussex Hospitals NHSFT
Westmorland General Hospital	Westmorland General Hospital
Weston Area Health NHST	Weston Area Health NHST
Wexham Park Hospital	Wexham Park Hospital
Whiston Hospital	-
William Harvey Hospital	William Harvey Hospital
-	Withybush General Hospital
Worcestershire Acute Hospitals NHST	Worcestershire Acute Hospitals NHST
Wrightington, Wigan and Leigh NHSFT	Wrightington, Wigan and Leigh NHSFT
Wye Valley NHST	Wye Valley NHST
Yeovil District Hospital NHSFT	Yeovil District Hospital NHSFT