

Patient Blood Management as the Standard of Care

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Word count of text: 1998

Word count of abstract: 169

Learning objectives:

- 1. Recognize that there is considerable potential to improve the management of patients at risk of transfusion.**
- 2. Understand that the key issue is to improve the management of anemia.**
- 3. Propose that the implementation of Patient Blood Management measures should be *the Standard of Care*.**

Abstract

Blood transfusion is one of the commonest hospital procedures in developed countries. However, inappropriate use of blood transfusion is common, and this is of considerable concern as transfusion is known to be associated with adverse events, and is costly. Reductions in blood use have resulted from recent evidence indicating that restrictive use of RBC transfusions is associated with similar patient outcomes to liberal strategies, and from a focus on *Patient Blood Management* (PBM) which recognises the importance of conserving the patient's own blood alongside the judicious use of transfusion. A recent Consensus Conference in Frankfurt developed practice and research recommendations for PBM, but also indicated that further studies are needed to provide better evidence for PBM interventions including for improved patient outcomes and lower hospital costs as well as for reductions in blood utilization. In the meanwhile, it is of utmost importance to translate PBM guidelines into practical day-to-day recommendations and to encourage their use to make PBM 'the standard of care'.

Case Study

A 64 year old female is referred to the department of orthopedic surgery with chronic infection of a hip replacement that requires revision surgery. The patient is otherwise fit and well but has a history of myocardial infarction 3 years ago.

A full blood count is performed as soon as the patient is listed for surgery, maximising the available time for preoptimization. Hemoglobin concentration (Hb) is 9.8g/dL, so hematinics are measured. These reveal a transferrin saturation 9% (normal 16-50%), ferritin 475mcg/L (normal 12-150mcg/L) , and C-reactive protein (CRP) 34mg/L (normal <10mg/L). These results are compatible with a diagnosis of functional iron deficiency. Folate B12/folate levels are within normal range and a referral is made to gastroenterology to exclude gastrointestinal malignancy.

An intravenous iron infusion of 1g ferric carboxymaltose is administered six weeks prior to surgery, which increases the Hb to 10.8g/dL by the day of surgery.

Pretransfusion compatibility testing reveals multiple RBC antibodies. It is not possible to accurately estimate the number of donor blood units that will be required for surgery, however, blood loss greater than 1 litre is anticipated. Four compatible RBC units are identified and transported to the blood bank in advance of surgery.

Surgery is performed under spinal anesthesia. 1g intravenous tranexamic acid is administered at the start of the procedure and 1g topically to the surgical field at the end of the procedure. Intraoperative cell salvage produces 256ml (hematocrit 60%) that is reinfused during the procedure. No drains are used postoperatively. During the postoperative period, the Hb is 7.7g/dL and a single unit of donor RBCs is transfused. The Hb transfusion threshold was 8.0g/dL in line with the findings of the FOCUS trial⁸ which found that a liberal RBC transfusion policy (Hb transfusion threshold 10.0g/dL) did not reduce rates of death, inability to walk independently on 60-day follow-up or reduce in-hospital morbidity in elderly patients at high cardiovascular risk in comparison to a restrictive policy (Hb transfusion threshold 8.0g/dL). The Hb increased to 8.8g/dL. The decision to transfuse donor blood is guided by an electronic decision support tool within the electronic patient record. No further donor blood is required.

Introduction

Blood transfusion is one of the commonest hospital procedures in developed countries such as the United States and the United Kingdom (UK).¹ Over 11.3 million units of red blood cells (RBCs), 1.9 million units of platelets, and 2.7 million units of plasma were transfused to patients in the United States in 2015² and there were nearly 3 million blood donations in the UK in 2017.³ Unnecessary use of blood transfusion is common worldwide; national audits of blood transfusion in England and elsewhere suggest that there is substantial inappropriate use of transfusions of all types of blood component.^{4,5} Recent evidence indicates that strategies for the restrictive use of RBC transfusions reduces transfusions but are associated with similar patient outcomes to liberal transfusion strategies.⁶⁻¹⁰ A systematic review of 31 randomized controlled trials involving over 12,000 patients found that transfusing at a hemoglobin concentration (Hb) of between 7g/dL to 8g/dL decreased the proportion of participants exposed to RBC transfusion by 43% across a broad range of clinical specialities, but there was no difference in mortality or morbidity such as cardiac events, stroke, pneumonia, thromboembolism, or infection compared with a liberal transfusion strategy (pre-transfusion Hb 9-10g/dL).¹⁰ These data from RCTs are of considerable importance as they repudiate data from retrospective and observational studies indicating a variety of adverse outcomes associated with transfusion.¹² However, transfusions are costly and are well known to be associated with adverse events. The inclusion of the evidence for restrictive RBC transfusion in practice guidelines for transfusion^{13,14} has resulted in a worldwide reduction in the use of RBC transfusions; some hospitals are using strategies such as electronic decision support to support the implementation of restrictive RBC transfusion.¹⁵ In recent years, there has also been a focus on *Patient Blood Management* (PBM) which recognises the importance of conserving the patient's own blood alongside the judicious use of transfusion. PBM is relevant to each stage of the patient journey (see the case study above).

The Origins of Patient Blood Management

An early driver to exploring measures for blood conservation and the avoidance of blood transfusion was the need to provide modern medical and surgical care for those individuals objecting to transfusion because of their religious beliefs.¹⁵ Further interest derived from other events such as the recognition of transfusion-transmitted HCV and HIV, concerns about the transmission by transfusion of variant

Creutzfeldt-Jakob disease (vCJD) particularly in the UK, and evidence for the safety of restrictive transfusion practice beginning with the Transfusion Requirements in Critical Care (TRICC) trial published in 1999.⁷ These efforts became organized through the formation of bodies such as the National Association of Bloodless Medicine and Surgery (1996), The Network for the Advancement of Transfusion Alternatives (NATA) (1998) now the Network for the Advancement of Patient Blood Management, Haemostasis and Thrombosis, and the Society for the Advancement of Blood Management (SABM) (2000).

Definitions of Patient Blood Management

The World Health Organization (WHO) defines PBM as ‘a patient-focused, evidence-based and systematic approach to optimize the management of patients and transfusion of blood products for quality and effective patient care. It is designed to improve patient outcomes through the safe and rationale use of blood and blood products and by minimizing unnecessary exposure to blood products’.¹⁶

An alternative definition takes the focus away from transfusion and on to improving patient outcomes: ‘PBM is the timely application of evidence-based medical and surgical concepts designed to maintain haemoglobin concentration, optimize hemostasis and minimize blood loss in an effort to improve patient outcome’.¹⁷ These are sometimes termed the ‘3 Pillars’ of PBM, and each pillar is illustrated by our case study.

Renewed focus on the management of anemia rather than reducing transfusion

Anemia is very common in hospitalized patients. The main causes are blood loss, poor RBC production and hemolysis. A study by the American College of Surgeons National Surgical Quality Improvement Program involving 211 hospitals worldwide and 277,425 patients found that 30% of non-cardiac surgery patients had anemia on admission.¹⁸ There was an increased risk of 30-day mortality and 30-day morbidity in anemic compared to non-anemic patients, both in those with mild anemia and moderate-severe anemia. Similar results have been found in other studies^{19,20} and in a meta-analysis of 24 observational studies which found that preoperative anemia was associated with an increased risk of adverse outcomes including mortality.²¹

A recent retrospective study of 445,371 patients who survived after hospitalization in an integrated network of 21 hospitals found that the prevalence of

moderate anemia (Hb 7-10g/dL) at discharge from hospital increased from 20% to 25% and that RBC transfusions decreased by 28% in the same period from 2010 to 2014. The increase in anemia at hospital discharge was not associated with a rise in re-hospitalization, subsequent RBC transfusion or mortality within 6 months of discharge.²² The authors concluded that their data supported the safety of efforts to limit RBC transfusion and tolerate anemia during and after hospitalization. In an accompanying editorial, Shander and Goodnough emphasised the harms caused by anemia, and questioned the false choice between transfusion and tolerance of anemia.²³ They argued that the mindset of ‘transfusion or anemia’ risks calls for even more restrictive transfusion trials rather than focussing on the needs of the patient which are the judicious use of transfusion, with its known risks and costs, as a short-term measure to prevent tissue hypoxia and ischemia followed by specific treatments for anemia.²³

The change in Hb concentration may be more important than absolute values. A difference in Hb of 50% or greater following gastrointestinal surgery was associated with complications, especially ischemic adverse events, even if the absolute nadir level of Hb remained greater than the transfusion threshold of 70g/L.²⁴

Evidence for Patient Blood Management

Over the last 10 years, there have been many publications indicating that PBM implemented in various ways reduces the use of transfusions, but with less convincing data on improvement in clinical outcomes, as already described above.²⁵⁻²⁸

An example of such a PBM study is the one conducted in Western Australia which initiated a comprehensive health-system-wide PBM program in 2008.²⁷ It was a retrospective study of 605,046 patients admitted to four major adult tertiary-care hospitals between July 2008 and June 2014. Comparing final year with baseline, units of RBCs, fresh frozen plasma (FFP), and platelets transfused per admission decreased by 41%, representing a saving of over US\$18 million. Mean pre-transfusion Hb decreased 7.9 g/dL to 7.3 g/dL, and anemic elective surgery admissions decreased from 20.8% to 14.4%. Single-unit RBC transfusions increased from 33.3% to 63.7%. There were risk-adjusted reductions in hospital mortality (odds ratio [OR], 0.72; 95% confidence interval [CI], 0.67-0.77; $p < 0.001$), length of stay (incidence rate ratio, 0.85; 95% CI, 0.84-0.87; $p < 0.001$), hospital acquired infections (OR, 0.79; 95% CI,

0.73-0.86; $p < 0.001$), and acute myocardial infarction/stroke (OR, 0.69; 95% CI, 0.58-0.82; $p < 0.001$).

Several national bodies and international groups of experts have produced recommendations for PBM.²⁹⁻³³ The most ambitious of these initiatives was the Consensus Conference held in Frankfurt in April 2018.³⁴

Frankfurt Consensus Conference on Patient Blood Management (2018)³⁴

The Consensus Conference was held in Frankfurt in April 2018 and was based on a considerable amount of preparatory work in conducting systematic reviews before the conference and presentations and discussion at the conference focussing on 17 PICO (population/intervention/comparison/outcome) questions for RBC transfusion in adult patients (Table 1). The questions encompassed preoperative anemia (3 questions), RBC transfusion thresholds (11 questions), and implementation of PBM programs (3 questions). MEDLINE, EMBASE, Cochrane Library, and the Transfusion Evidence Library were searched for relevant literature through to January 2018. Meta-analyses were conducted by 3 panels including clinical and scientific experts, nurses, patient representatives and methodologists using the GRADE methodology³⁵ and the Evidence-to-Decision (EtD) framework³⁶ to develop clinical recommendations.

17,607 literature citations were identified to be associated with the 17 PICO questions, including 145 studies, of which 63 were randomized clinical trials with 23,143 patients, and 82 were observational studies with >4 million patients. The recommendations are shown in Table 2. For preoperative anemia, 4 clinical and 3 research recommendations were developed, including the strong recommendation to detect and manage anemia sufficiently early before major elective surgery. For RBC transfusion thresholds, 4 clinical and 6 research recommendations were developed, including two strong clinical recommendations for critically ill, but clinically stable intensive care patients with or without septic shock (recommended threshold for RBC transfusion, Hb <7 g/dL) as well as for patients undergoing cardiac surgery (recommended threshold for RBC transfusion, Hb <7.5 g/dL). For the implementation of PBM programs, 2 clinical and 3 research recommendations were developed, including recommendations to implement comprehensive PBM programs and to use electronic decision support systems to improve appropriate RBC utilization. These recommendations should be adopted for current clinical practice (see case study).

The quality of evidence for the majority of questions considered at the Consensus Conference apart from RBC transfusion thresholds was moderate to very low. This limited the number of strong recommendations for many of the key questions for PBM and supports the need for additional research and a consensus for clinically meaningful endpoints for multicenter trials. Research recommendations were made for priority questions in areas with limited evidence (Table 3).

The vast majority of clinical PBM implementation trials were observational, and only focussed on the number of units of RBC transfused rather than clinical outcomes such as patient survival and adverse events. There was concern about bias due to concurrent interventions or practice evolution that might have occurred during the study period in the reports of these studies as well as the lack of information about how well the PBM interventions of interest were actually implemented in practice. The assessment of reduction in ‘inappropriate transfusion’ i.e. transfusions given outside current guidelines was often not addressed. Health economic evaluations were lacking to provide robust data on the cost savings, which were primarily in reduced blood usage, compared to the costs of the interventions. While there was evidence for reduction in RBC use resulting from PBM implementation, there was inadequate evidence for reduction of platelet and plasma usage.

Standards for Patient Blood Management

As already indicated in this review, several national bodies and international groups of experts have produced recommendations for PBM.²⁸⁻³³ A different challenge is to develop ‘standards’ for PBM to encourage the measurement of key parameters and facilitate the identification of opportunities for improvement. The Joint Commission developed performance measures for PBM in collaboration with the University of Pittsburgh (Table 4).³⁷ The AABB followed this by developing Standards for PBM in 2014, updating them in 2018³⁸, and establishing PBM certification in partnership with The Joint Commission. At the time of writing, 6 centers have achieved PBM certification and it is expected that 30 centers will have done so by the end of 2020.

The AABB standards cover all aspects of PBM including the optimization of erythropoiesis, minimization of blood loss and management of anaemia including the appropriate indications for transfusion. Organizational issues are also encompassed including management oversight and support, adequate staffing, equipment and

information systems, policies and procedures for clinical care, documentation, and responding to non-conformances and adverse events.³⁸

Patient Blood Management as the *Standard of Care*

Despite the worldwide recognition of the value of PBM, there is still some way to go in terms of its widespread adoption to become ‘the Standard of Care. A recent survey of hospitals in England found poor compliance with PBM standards developed by the National Institute for Health and Care Excellence (NICE) (Table 5).³⁹ Comprehensive PBM implementation is challenging as it encompasses patients with a wide range of clinical conditions undergoing many different procedures and therapies, and involves many clinical settings and many types of healthcare professionals.

PBM activities require co-ordination, arguably but not necessarily best led by a transfusion medicine specialist. The support of hospital managers is essential to ensure that sufficient resources are made available and that any organizational problems which might interfere with a comprehensive PBM program are overcome. PBM requires input from multiple medical specialties that may include hematology, anesthesiology, surgery, and gastroenterology, as illustrated by the case study. Efforts to raise awareness about PBM include the ‘Choosing Wisely’ campaigns of the AABB⁴⁰ and the American Society of Hematology⁴¹ which are intended to encourage clinicians to rethink their engrained culture of liberal transfusion practice and prompt patients to question why they are being prescribed blood.

Implementing Patient Blood Management

Our case study illustrates the implementation of PBM. Preoperative anemia is diagnosed and treated at the earliest opportunity prior to elective surgery. Intraoperatively, antifibrinolytic medication is administered to reduce blood loss and cell salvage allows a unit of autologous RBCs to be reinfused. There is evidence that spinal anesthesia may reduce blood loss. Conventional suction drains are avoided as these may increase blood loss. Postoperatively, the recommended transfusion threshold of 8.0g/dL is followed and only a single unit of donor RBCs is required, supported by an electronic decision support tool.

Conclusions

It is recognised that further studies are needed to provide better evidence for the whole range of PBM interventions including evidence for improved patient outcomes and lower hospital costs as well as for reductions in blood utilization. More research also needs to be undertaken to understand how best to employ educational efforts and other methods such as electronic clinical decision support systems⁴² to support the implementation of PBM interventions. However, while these studies are conducted, it is of utmost importance to translate PBM guidelines into practical day-to-day recommendations and to encourage their use. The output in terms of practice and research recommendations from the recent PBM Consensus Conference in Frankfurt is a further step on the path to making PBM ‘the Standard of Care’.

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Table 1: 17
Frankfurt Consensus Conference on Patient Blood Management (2018)³⁴

PICO questions

<u>Preoperative anemia</u>
PICO 1 – ADVERSE EVENTS: In elective surgery patients [population], is preoperative anemia [intervention/risk factor] a risk factor for adverse clinical or economic outcome [outcomes] compared to no preoperative anemia [comparison]?
[PICO 2 – DEFINITION: In elective surgery patients [population], should a specific hemoglobin (Hb) cut-off [index test] versus another Hb cut-off [comparator test] be used to diagnose preoperative anemia [outcome]?] was not answered due to lack in evidence
PICO 3 – MANAGEMENT: In elective surgery patients with preoperative anemia [population], is the use of red blood cell transfusion or iron supplementation and/or erythrocyte stimulating agents [intervention] effective to improve clinical and economic outcomes [outcomes] compared to no intervention/placebo/standard of care [comparison]?
<u>Red blood cell concentrate (RBC) transfusion thresholds</u>
PICO 4 – ADULT INTENSIVE CARE PATIENTS: In critically ill, but clinically stable adult intensive care patients [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?
PICO 5 – ORTHOPAEDIC AND NON-CARDIAC SURGERY: In elderly high risk (cardiovascular) patients undergoing orthopaedic or non-cardiac surgery [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?
PICO 6 – ACUTE GASTROINTESTINAL BLEEDING: In patients with an acute gastrointestinal bleeding [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?
PICO 7 – CORONARY HEART DISEASE: In patients with symptomatic coronary heart disease [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?
PICO 8 – SEPTIC SHOCK: In patients with septic shock [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?
PICO 9 – CARDIAC SURGERY: In patients undergoing cardiac surgery [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?
PICO 10 – ADULT HAEMATOLOGICAL PATIENTS: In adult haematological patients [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?

PICO 11 – ADULT PATIENTS WITH SOLID TUMOURS: In adult patients with solid tumours [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?

PICO 12 – ACUTE CENTRAL NERVOUS SYSTEM INJURY: In patients with acute central nervous system (CNS) injury [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?

PICO 13 – CEREBRAL PERFUSION DISORDERS: In patients with cerebral perfusion disorders [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?

PICO 14 – ACUTE BLEEDING: In patients with acute bleeding [population], is the use of a restrictive transfusion threshold [intervention] effective to reduce mortality and improve other clinical outcomes [outcomes] compared to a liberal transfusion threshold [comparison]?

Implementation of patient blood management (PBM) programs

PICO 15 – EFFECTIVENESS OF PBM IMPLEMENTATION: Is a PBM program [intervention] effective to improve clinical and economic outcomes [outcomes] compared to no PBM program [comparison]?

PICO 16 – PBM PROMOTIONAL TOOLS: BEHAVIOURAL INTERVENTIONS: Is a specific behavioural intervention to promote the implementation of a PBM program [intervention] more effective to improve clinical and economic outcomes [outcomes] compared to no/another behavioural intervention [comparison]?

PICO 17 – PBM PROMOTIONAL TOOLS: DECISION SUPPORT SYSTEMS: Is a specific decision support system to promote the implementation of a PBM program [intervention] more effective to improve clinical and economic outcomes [outcomes] compared to no intervention or another decision support system/behavioural intervention [comparison]?

Table 2: 10
Frankfurt Consensus Conference on Patient Blood Management (2018)³⁴

CLINICAL RECOMMENDATIONS

Preoperative anemia

Clinical recommendation (CR)	Level of evidence
CR 1: Detection and management of preoperative anemia early enough before major elective surgery	strong recommendation, low certainty in the evidence of effects
CR 2: Use of iron supplementation in adult preoperative elective surgery patients with iron-deficient anemia in order to reduce red blood cell transfusion rate	conditional recommendation, moderate certainty in the evidence of effects
CR 3: DO NOT use erythropoiesis-stimulating agents (ESA) routinely in general adult preoperative elective surgery patients with anemia	conditional recommendation, low certainty in the evidence of effects
CR 4: Consider short-acting erythropoietins in addition to iron supplementation in adult preoperative elective major orthopedic surgery patients with hemoglobin levels < 13 g/dL in order to reduce transfusion rates	conditional recommendation, low certainty in the evidence of effects

Red blood cell (RBC) transfusion thresholds

Clinical recommendation (CR)	Level of evidence
CR 5: Restrictive RBC transfusion threshold (Hb <7 g/dL) in critically ill, but clinically stable intensive care patients	strong recommendation, moderate certainty in the evidence of effects
CR 6: Restrictive RBC transfusion threshold (Hb <7.5 g/dL) in cardiac surgery patients	strong recommendation, moderate certainty in the evidence of effects
CR 7: Restrictive transfusion threshold (Hb <8 g/dL) in patients with hip fracture and cardiovascular disease or other risk factors	conditional recommendation, moderate certainty in the evidence of effects
CR 8: Restrictive transfusion threshold (Hb 7-8 g/dL) in hemodynamically stable patients with acute gastrointestinal (GI) bleeding	conditional recommendation, low certainty in the evidence of effects

Implementation of PBM programs

Clinical recommendation (CR)	Level of evidence
CR 9: Implementation of PBM programs to improve appropriate RBC utilization	conditional recommendation, low certainty in the evidence of effects
CR 10: Computerized/electronic decision support systems in order to improve appropriate RBC utilization	conditional recommendation, low

	certainty in the evidence of effects
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Table 3: 12 Frankfurt Consensus Conference on Patient Blood Management (2018)³⁴

RESEARCH RECOMMENDATIONS

<u>Preoperative anemia</u>
R 1: Since published studies show major differences in the hemoglobin values (Hb) used for the definition of preoperative anemia, the expert panel recommends to identify optimal Hb thresholds in different patient groups as well as adequate cut-off values.
R 2: The expert panel suggests to address the effects of iron supplementation in non-anaemic, but iron-deficient patients scheduled for major surgery.
R 3: The expert panel recommends to investigate the use of short-acting erythropoietins + iron supplementation in adult preoperative elective surgery patients with focus on long term (un)desirable effects, optimal dose, type of surgery, particular in cancer surgery, co-presence of iron deficiency, and cost effectiveness.
<u>Red blood cell concentrate (RBC) transfusion threshold</u>
R 4: The expert panel recommends further research re. restrictive RBC transfusion thresholds for hemodynamically stable patients with acute upper or lower GI bleeding. The panel does not recommend further research in hemodynamically unstable patients with acute major bleeding.
R 5-9: The expert panel suggests further research on RBC transfusion support in patients with hematological and oncological diseases, coronary heart diseases, non-cardiac/non-orthopedic surgery or brain injury.
Rx (no evidence): No further research on Hb thresholds in acutely bleeding patients.
<u>Implementation of PBM programs</u>
R 10-12: The expert panel suggests further research on the impact of PBM programs on a) adverse events and patient-important outcomes, b) compliance, adherence and acceptability and c) cost-effectiveness. Reproducible definitions and outcome parameters have to be defined beforehand to evaluate the sustainability of PBM programs.

Table 4. Performance measures for PBM.³⁷

TABLE 4. Final measure set*		Measure	Comments
Number	Measure name		
PBM-01	Transfusion consent	<i>N</i> : Patients with a signed consent who received information about the risks, benefits, and alternatives before the initial blood transfusion or the initial transfusion was deemed a medical emergency. <i>D</i> : Patients who received a transfusion of RBCs, PLTs, or plasma. <i>N</i> : Number of RBC units (bags) with pretransfusion Hb or Hct result and clinical indication documented. <i>D</i> : Number of transfused RBC units evaluated. <i>N</i> : Number of plasma units (bags) with pretransfusion laboratory testing and clinical indication documented. <i>D</i> : Number of transfused plasma units evaluated. <i>N</i> : Number of PLT doses with pretransfusion PLT testing and clinical indication documented. <i>D</i> : Number of transfused PLT doses evaluated. <i>N</i> : Number of transfused blood units/doses (bags) with documentation for all of the following: • Patient identification and transfusion order (or blood identification number) confirmed before the initiation of transfusion • Date and time of transfusion • Blood pressure, pulse, and temperature recorded before, during, and after transfusion. <i>D</i> : Number of transfused RBC, plasma, and PLT units/doses (bags) evaluated. <i>N</i> : Patients with documentation of preoperative anemia screening 14-45 days before anesthesia start date. <i>D</i> : Selected elective surgical patients. <i>N</i> : Patients with documentation of preoperative type and screen or type and crossmatch completed before anesthesia start time. <i>D</i> : Selected elective surgical patients.	Include all patients Include all patients Include all patients Include all patients Include all patients Include all patients Elective orthopedic and hysterectomy surgeries; patients >18 years of age Elective cardiac, orthopedic, and hysterectomy surgeries; patients >18 years of age
PBM-02	RBC transfusion indication		
PBM-03	Plasma transfusion indication		
PBM-04	PLT transfusion indication		
PBM-05	Blood administration documentation		
PBM-06	Preoperative anemia screening		
PBM-07	Preoperative blood type screening and antibody testing		

* http://www.jointcommission.org/patient_blood_management_performance_measures_project/
D = denominator; N = numerator.

Table 5. Hospitals in England responding to a survey asking if they have data to indicate compliance with NICE Quality Standards for Blood Transfusion*. If so, did they provide the data and what was the mean level of compliance against the quality standards

NICE Quality Standards	QS1pre	QS1post	QS2	QS3	QS4
Sites <i>having</i> compliance data (% of Trusts)	26 (23%)	17(15%)	31 (28%)	38 (34%)	40 (36%)
Sites <i>providing</i> Compliance Data (n)	4	2	12	15	19
Mean Level of Compliance (%)	61% (30-100%)	40% (10-69%)	69% (0-100%)	55% (20-78%)	53% (0-100%)

*NICE Quality Standards for Blood Transfusion (2016)³⁹

QS1. People with iron deficiency anaemia are offered iron supplementation before (QS1 pre) and after surgery (QS1 post)

QS2. Adults who having surgery and expected to have moderate blood loss are offered tranexamic acid

QS3. People who receive a red cell transfusion are clinically reassessed and have their Hb checked after each unit

QS4. People who may have or who have had a transfusion are given verbal and written information about the benefits and risks of transfusion