



National comparative audit of blood use in elective primary unilateral total hip replacement surgery in the UK

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ABSTRACT

INTRODUCTION Blood is a scarce and expensive product. Although it may be life-saving, in recent years there has been an increased emphasis on the potential hazards of transfusion as well as evidence supporting the use of lower transfusion thresholds. Orthopaedic surgery accounts for some 10% of transfused red blood cells and evidence suggests that there is considerable variation in transfusion practice.

PATIENTS AND METHODS NHS Blood and Transplant, in collaboration with the Royal College of Physicians, undertook a national audit on transfusion practice. Each hospital was asked to provide information relating to 40 consecutive patients undergoing elective, primary unilateral total hip replacement surgery. The results were compared to indicators and standards.

RESULTS Information was analysed relating to 7465 operations performed in 223 hospitals. Almost all hospitals had a system for referring abnormal pre-operative blood results to a doctor and 73% performed a group-and-save rather than a cross-match before surgery. Of hospitals, 47% had a transfusion policy. In 73%, the policy recommended a transfusion threshold at a haemoglobin concentration of 8 g/dl or less. There was a wide variation in transfusion rate among hospitals. Of patients, 15% had a haemoglobin concentration less than 12 g/dl recorded in the 28 days before surgery and 57% of these patients were transfused compared to 20% with higher pre-operative values. Of those who were transfused, 7% were given a single unit and 67% two units. Of patients transfused two or more units during days 1–14 after surgery, 65% had a post transfusion haemoglobin concentration of 10 g/dl or more.

CONCLUSIONS Pre-operative anaemia, lack of availability of transfusion protocols and use of different thresholds for transfusion may have contributed to the wide variation in transfusion rate. Effective measures to identify and correct pre-operative anaemia may decrease the need for transfusion. A consistent, evidence-based, transfusion threshold should be used and transfusion of more than one unit should only be given if essential to maintain haemoglobin concentrations above this threshold.

KEYWORDS

Orthopaedic surgery – Blood transfusion – Total hip replacement

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Blood transfusions may be beneficial and life-saving in particular clinical situations. However, they are not without risk.^{1–5} In the UK, blood donation is voluntary and only 4% of those eligible give blood. Blood is thus a limited resource and liable to shortages at times of peak demand. Orthopaedic surgery accounts for 10% of red cells used in hospitals with total hip replacement (THR) accounting for 4.6%.⁶ Studies have shown a wide variation in transfusion

practice in elective hip arthroplasty.^{7,8} A UK survey reported that surgeons used a higher mean transfusion threshold than anaesthetists and were also more likely to transfuse two or more units.⁹ However, the use of protocols and algorithms has demonstrated that less blood can be safely given to fewer patients in the peri-operative period.^{10–14} A pre-operative haemoglobin of less than 12 g/dl increases the likelihood of transfusion 3-fold.¹⁵

NHS Blood & Transplant (NHSBT), in collaboration with the Royal College of Physicians, carry out a series of 'National Comparative Audits' on transfusion practice, endorsed by the Care Quality Commission. These audits evaluate the safety of transfusion and appropriateness of use of blood and blood products. The aim of this prospective 'National Comparative Audit of Blood Use in Elective Primary Unilateral Total Hip Replacement Surgery in UK' was to measure hospital transfusion practice against two performance indicators and four practice standards. A customised feedback sent to hospitals enabled them to review their performance indicators and compliance with practice standards. The audit report highlights deficiencies in practice nationally and makes recommendations to improve transfusion practice.

Patients and Methods

For national comparative audits, the issue of obtaining ethical approval does not arise, since they are carried out as part of a programme supported by the Chief Medical Officer; as audits, they serve to assess if healthcare professionals are managing patients in accordance with good practice. Patient treatment does not vary, nor is it influenced by the audit design, during the audit period, so patient outcome is not influenced, thus the ethical considerations are addressed. Similarly, the need for patient consent is removed by the *NHS Code of Practice* (2003), which allows for information relating to a patient to be used for clinical audit purposes, but in the main addresses the issue of patient identifiable data. National Comparative Audits do not collect patient identifiable data.

The audit was designed and managed by a project group comprising healthcare and audit professionals. It was piloted in 22 hospitals from England, Wales and Northern Ireland. The audit collected information about the management of individual patients and, via an organisational questionnaire, about service delivery provisions to understand the context in which care is provided.

All NHS Trusts and independent hospitals in England were invited to participate. Trusts and hospitals in Wales, Northern Ireland and Scotland were invited to participate via nominated contacts within the blood services in those countries. A letter about the audit was sent from the clinical audit lead of the NHSBT to the chief executive, medical director and clinical audit manager in each English NHS Trust. Electronic copies of this letter were sent via email to Trust transfusion laboratory managers, transfusion practitioners, and consultant haematologists with responsibility for blood transfusion. A similar letter was sent to managers of independent hospitals. Non-responders were sent a reminder letter in August 2006 and the audit clinical lead telephoned the medical directors of trusts who did not respond to the follow-up letter.

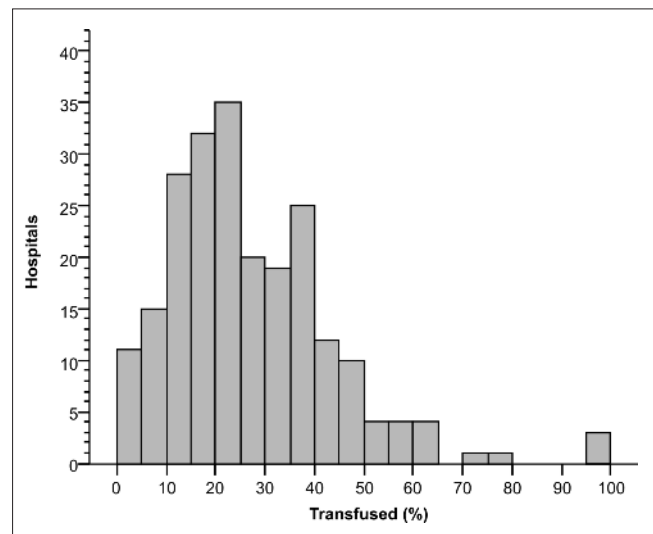


Figure 1 Variation among hospitals in the average percentage of patients transfused.

Information was requested about pre-operative assessment, the management of patients and hospital policies. For each hospital, the target sample was 40 consecutive patients undergoing elective, primary unilateral THR. Data could be collected prospectively or on a recent retrospective basis depending on operational preferences. Data on transfusion and full blood count values was required for the period of 28 days pre-operatively to 14 days postoperatively. Data entry was made directly into a purpose-designed audit tool web-page. The audit tool was piloted on paper in March 2006 by 22 hospitals representing a mix of district general hospitals and large university hospitals. A short technical pilot of electronic data capture was undertaken in August 2006. The main audit began in October 2006.

Transfusion practice was measured against two performance indicators and four practice standards.

Performance indicators

1. Percentage of patients transfused.
2. Average number of red cell units transfused per procedure.

Practice standards for audit

1. Hospitals have effective means of assessing a patient's anaemia prior to surgery and take appropriate corrective action when necessary.¹⁶
2. Patients assessed in the pre-assessment clinic have their anaemia managed effectively.¹⁶
3. Postoperatively, all patients who are asymptomatic are not transfused unless their pretransfusion haemoglobin (Hb) concentration is < 8 g/dl.¹⁷

4. Patients who are transfused two or more units of red blood cells and whose post transfusion Hb is above 10 g/dl, may have been transfused excessively.¹⁸

A customised feedback was sent to each hospital so that they could review and compare their performance and compliance with other hospitals.

Results

A total of 223 hospitals submitted data on 7552 operations performed between January 2006 and March 2007, 86% from June to December 2006. Fourteen cases were excluded as the surgery date was unknown and a further 73 from 53 hospitals because of duplication of records leaving 7465 cases for analysis. A median of 40 (interquartile range, 28–40) cases was submitted by each hospital.

Organisational audit

Of hospitals that responded, 47% (91 of 195) had a transfusion policy. In 19% (17 of 91) of hospitals, the policy recommended an Hb transfusion trigger of < 8 g/dl, in 54% (49 of 91) it was 8 g/dl, in 9% (8 of 91) the trigger was > 8 g/dl and in 14% (13 of 91) a range was stated, typically 7–9 g/dl. The transfusion trigger was not reported by four hospitals. Some method of intra-operative or postoperative cell salvage was available in 61% (122 of 199) of the hospitals who responded. Of 196 responses, 91% stated that there was a system for stopping anti-platelet medication before surgery.

Almost all hospitals had a pre-operative assessment clinic (202 of 203 responses), the facilities for taking a full blood count (198 of 199 responses) and a system for referring abnormal results to a doctor (183 of 192 responses). In 73% (146 of 199) of hospitals, a group-and-save was the preferred method when ordering blood for primary, elective unilateral THR. The other hospitals reported that a group-and-cross-match was performed.

In 69% (134 of 194) of the responding hospitals, the orthopaedic directorate was represented on the hospital transfusion committee (HTC). However 34% (45 of 134) of these hospitals stated that no one from the orthopaedic directorate had attended the HTC in the previous 12 months.

A median of 184 (interquartile range, 102–313) primary elective unilateral THRs were reported as being performed in the previous year by the 180 hospitals who responded.

Clinical audit

Nationally, 25% (1823 of 7465) of patients were transfused within 28 days before surgery to 14 days afterwards and the transfusion rate among hospitals varied between 0–100% (Fig. 1).

The mean age was 69 years (SD 11 years), and 38% (2779 of 7364) were male. An ASA score¹⁹ was recorded for 84% (6238 of 7465) of patients of whom 19% (1175 of 6238)

Table 1 Patients categorised according to pre-operative haemoglobin

Pre-operative Hb (g/dl)	Number	%
< 8.0	1	0
8.0–8.9	15	0.2
9.0–9.9	62	1
10.0–10.9	159	2
11.0–11.9	558	7
12.0–12.9	1138	15
13.0–13.9	1542	21
14.0–14.9	1093	15
≥ 15.0	669	9
No pre-surgery Hb value recorded	2177	29
Pre-surgery transfusion	51	1
Total	7465	100

were judged to be ASA grade I, 62% ($n = 3868$) ASA grade II and 18% ($n = 1145$) ASA grade III. A further 0.8% ($n = 50$) patients were recorded as ASA grade IV.

The pre-operative assessment records indicated 22% (1613 of 7406) of patients were on antiplatelet drugs. The time before surgery for stopping the drugs was recorded for 41% ($n = 664$). The median time for stopping these drugs was 7 days before surgery (interquartile range, 5–8 days).

A Hb value from the 28 days before surgery was recorded for 71% (5237 of 7414) of patients and 15% of these patients (795 of 5237) had recorded Hb value of < 12g/dl (Table 1).

Consultants performed 5135 of 7404 hip replacements (69%) where the grade of surgeon was reported. The median duration of surgery was 97 min (inter-quartile range, 75–120 min). The type of anaesthetic is given in Table 2, in which the percentages add up to more than 100% as combinations may be given.

Table 2 Number of patients in relation to anaesthetic techniques

Anaesthetic technique	Number	%
General anaesthetic	3743	51
Spinal (intrathecal)	4350	59
Epidural	730	10
Nerve block	945	13
Sedation	1401	19

Table 3 Distribution of patients in relation to intra- and postoperative blood loss

	Postoperative blood loss (ml)				
	< 500	500 – < 1000	1000 – < 1500	≥ 1500	Not known
Intra-operative blood loss (ml)					
< 500	487 (6.5)	121 (1.6)	10 (< 1)	1 (< 1)	651 (8.7%)
500 – < 1000	525 (7.0)	131 (1.8)	15 (< 1)	3 (< 1)	478 (6.4%)
1000 – < 1500	106 (1.4)	25 (< 1)	4 (< 1)	4 (< 1)	109 (1.5%)
≥ 1500	37 (< 1)	18 (< 1)	3 (< 1)	1 (< 1)	49 (< 1%)
Not known	1785 (23.9)	462 (6.2)	32 (< 1)	2 (< 1)	2406 (32.2%)

The volume of intra-operative blood loss was reported for 2778 (37%) of the patients and postoperative blood loss for 3772 (51%). Table 3 shows details of intra-operative and postoperative blood loss.

In the period from 28 days before surgery until 14 days postoperatively, transfusion data were available on 7341 patients of whom 1823 (25%) were transfused. Information

about transfusion was recorded on 790 of the patients with a pre-operative Hb < 12 g/dl and 454 (57%) of these patients were transfused. This compares with 869 out of 4409 patients (20%) of patients with a Hb value of ≥ 12 g/dl. There were 51 transfusions before surgery (from 41 hospitals), 156 during surgery (90 hospitals) and 452 after surgery but on the day of the operation (158 hospitals). Overall, 1330 patients were transfused during days 1–14 after surgery some of whom also had earlier transfusions. Of these, 1167 (88%) had a postoperative pretransfusion Hb tested of whom 604 (52%) were < 8 g/dl. The percentage of patients transfused increased with the duration of surgery (Table 4.)

The number of units transfused was recorded for 1803 (99%) of the 1823 transfused patients (Table 5). Two-thirds of those transfused received two units of blood and 27% received three or more units.

The number of units transfused was known for 1314 of 1330 patients transfused during days 1–14 after surgery. Of these, 17% (229) received one unit, 70% (922) were given two units and 12% (163) were transfused with three or more units. Of those transfused exactly two units, 64%, (511 of 801) had a post transfusion Hb level of 10 g/dl or more, as did 69% (98 of 143) of patients who were transfused three or more units.

Table 4 Duration of surgery and percentage of patients transfused

Duration (min)	Number	Transfused (n)	Transfused (%)
< 60	683	133	19
60–89	1984	396	20
90–119	2332	570	24
120–179	1890	577	31
≥ 180	272	106	39
Not known	180	41	23

Table 5 Transfused patients categorised according to number of units of blood administered per patient

Units transfused	Number	%
1	119	7
2	1203	67
3	278	15
4	140	8
5	32	2
6	20	1
≥ 7	11	0.6

Discussion

In this audit, transfusion practice in THR surgery was measured against two performance indicators and four practice standards. Based on the national findings, recommendations were made to improve transfusion practice. Nationally, 25% were transfused and this is a significant improvement compared to the transfusion rate of 51% in a similar study in 2000.²⁰ However, the audit demonstrated continued wide variation in the transfusion rate (0–100%) among hospitals (Fig. 1).

Pre-operative anaemia, availability of protocols for transfusion and use of different haemoglobin threshold for

transfusion were some of the contributory factors for wide variation in the transfusion rate.

Although virtually all hospitals stated in the organisational audit that they have a mechanism for identifying and correcting anaemia pre-operatively, it was disappointing to find in the audit that, nationally, 29% of patients did not have a Hb estimation pre-operatively and 15% went for surgery with an Hb less than 12 g/dl. Nationally, the transfusion rate for patients with an Hb < 12.0 g/dl was almost three times higher than for patients with an Hb \geq 12 g/dl. On the basis of these findings, the following recommendations were made. In order to minimise the likelihood of a patient receiving donor blood transfusion, pre-operative anaemia should be corrected as far as possible. Hospitals should have a written policy for identification and management of anaemia in pre-assessment clinics. Surgeons seeing patients at initial consultation and general practitioners referring patients for surgery should take measures to optimise the haemoglobin.

In a national audit of elective orthopaedic surgery in the US, 35% of patients at pre-admission testing were found to have a Hb concentration < 13 g/dl.²¹ Of 1142 elective admission to a single Scottish hospital, 19.6% were anaemic, defined as males < 13 g/dl and females < 11.5 g/dl, 7.1% had a Hb value < 11 g/dl and 1.6% < 10 g/dl.²² Of anaemic admissions, 65% had normochromic normocytic indices, consistent with anaemia of chronic disease. In addition, 23% had hypochromic indices that may have responded to iron therapy alone. Of the anaemic admissions, 42% were transfused peri-operatively with homologous blood.

Morbidity and mortality after surgery are significantly associated with the presence of pre-operative anaemia.²³ A panel of multidisciplinary physicians recommended that elective surgical patients should have a Hb value determined a minimum of 30 days before scheduled surgical procedures allowing time for treatment before surgery.²¹ Unexplained anaemia should be a reason to defer elective surgery pending an evaluation of the causes. They concluded that the implementation of a clinical care pathway for anaemia management in the elective surgical patient could improve patient outcome.

A package of interventions and careful attention to detail has been shown to decrease the need for peri-operative transfusion.^{7,24,25} Pre-operative interventions, including oral iron and erythropoietin, can increase Hb concentrations, prevent anaemia and decrease the need for peri-operative blood transfusion.^{26–28} Other useful interventions include taking patients off non-selective, non-steroidal anti-inflammatory drugs,^{29,30} as well as antiplatelet medication.³¹ Intra-operative antithrombotic agents, such as tranexamic acid, may decrease blood loss.³² Intra-operative hypothermia is associated with increased blood loss³³ and aggressive peri-operative warming may be beneficial.³⁴

Intra-operatively and during the immediate postoperative period (up to 24 h after surgery), the indication for transfusion is more likely to be blood loss or signs and symptoms of anaemia, rather than the haemoglobin concentration. Transfusions given during these periods were excluded in auditing pretransfusion Hb against the nationally recommended Hb threshold for transfusion of 8 g/dl.

A total of 1330 patients were transfused in the postoperative period 24 h after surgery to day 14. Of these, 88% (1167) had a pre-transfusion Hb carried out and 48% (563) were transfused at a Hb threshold of 8 g/dl and above. More than 80% of patients whose ASA score was recorded, belonged to ASA Class I or II suggesting that this group of patients were in reasonably good health. It is likely that many of these patients were asymptomatic, unlikely to be bleeding at the time and a significant number may have been transfused unnecessarily.

Although there is some data to suggest that postoperative rehabilitation is improved in patients with higher Hb values,^{35–37} there is strong evidence to suggest that lower transfusion thresholds are safe. A large, randomised study in critical care patients found that a transfusion threshold of 7 g/dl was not associated with increased mortality compared to a threshold of 10 g/dl.³⁸ Indeed, subgroup analysis suggested that younger and less sick patients had a better outcome with the lower transfusion threshold. Studies in orthopaedic patients suggest that there is no benefit in transfusing elderly patients with hip fractures if the Hb value is above 8 g/dl³⁹ and that a transfusion trigger of 8 g/dl is not associated with increased postoperative myocardial ischaemia compared to a trigger of 10 g/dl.⁴⁰

This audit showed that over half the hospitals did not have a policy for transfusing a stable postoperative patient based on the Hb concentration. In those hospitals where a transfusion policy was in place, only 19% recommended a haemoglobin transfusion threshold < 8 g/dl. Although it is unlikely that a universal haemoglobin trigger would be acceptable for all transfusions, available clinical evidence should enable anaesthetists, surgeons and clinicians involved in transfusion medicine to develop an acceptable protocol for peri-operative transfusion. The use of such algorithms, some suggesting a transfusion threshold as low as 7 g/dl in asymptomatic patients,¹² will ensure a consistent evidence-based approach to peri-operative transfusion.

The audit report to hospitals recommended that every hospital should have a transfusion policy to guide transfusion in the peri-operative period based upon symptoms, haemoglobin concentration and estimated blood loss. The report also recommended that trusts should ensure that prescribers are made aware that, in the postoperative period, patients who are asymptomatic and not bleeding should be transfused only when the haemoglobin falls below 8 g/dl.

*Better Blood Transfusion*⁵ recommends that HTC membership should include representatives from clinical areas

where blood transfusions are frequently used. Orthopaedic surgery uses a high percentage of red blood cells issued to hospitals.^{6,41} Our audit showed that most HTC's have representation from the Orthopaedic Directorate, although attendance was often poor. We recommend that nationally orthopaedic representation at HTC's should be improved and more consistent attendance encouraged.

In the past, single-unit red cell transfusions were discouraged even though supporting evidence was lacking. Increased awareness of hazards of transfusion, decreasing blood supply and the emphasis on reducing inappropriate transfusions has led to the acceptance of one unit transfusions. Although single unit transfusions are not suitable for acute haemorrhage or severe anaemia, the British Orthopaedic Association recommends that it is appropriate to use one unit transfusions to exceed the transfusion threshold if necessary in the postoperative period.¹⁸ The potential impact of single-unit transfusions is greatest when combined with a restrictive transfusion threshold. Strict adherence to a threshold of 8 g/dl and a single-unit transfusion strategy resulted in 1.51 mean red blood cell units saved for patients who underwent hip or knee arthroplasty.⁴² In our audit of the patients who were transfused in the postoperative period, 17% ($n = 229$) received one unit, 70% ($n = 922$) received two units and 12% ($n = 30$) had three or more units. Of patients, 64% were transfused exactly two units and 69% of those transfused three or more units had a post transfusion Hb level of 10 g/dl or more. On the basis that each unit of red cells will increase the Hb by 1 g/dl in a 70-kg patient who is not bleeding, those patients who had a post transfusion Hb over 10 g/dl would still have had a post transfusion Hb above the transfusion threshold if they received one unit less and, therefore, may have been over transfused. The audit report recommended that single-unit transfusions may be appropriate and that hospitals should review the number of units transfused against the patients post-transfusion Hb at regular intervals.

It may be difficult to assess the amount of blood loss but consideration of lost circulating volume may be useful in guiding transfusion management. A 30% loss of blood volume, around 1500 ml in a 70-kg adult, can usually be managed with crystalloid or colloid solutions alone.⁴⁵ Intra-operative blood loss was recorded only in 37% of cases and may reflect the unreliability of the methods available for recording blood loss in theatre.

Blood is a scarce and expensive resource and should be used sparingly and appropriately. Pre-operative preparation is important and includes attention to the medication the patient is taking as well as active steps to ensure that patients are not anaemic. Intra-operative surgical and anaesthetic management can affect the amount of blood loss and this should be a consideration for those caring for the patient. Blood salvage techniques may also be beneficial. Agreed protocols should be developed and applied consistently.

Although transfusion practice in elective orthopaedic surgery was audited, the recommendations made are applicable to other types of elective surgery when blood transfusion may be required.

Conclusions

Patients who are anaemic pre-operatively are three times more likely to receive a red cell transfusion peri-operatively. In order to minimise red cell transfusion, it is important identify and start correcting the anaemia at least 4 weeks before surgery. The use of protocols will ensure a consistent evidence-based approach to peri-operative transfusion and it is not necessary to transfuse patients who are asymptomatic, not bleeding and have a haemoglobin level of greater than 8 g/dl. Single-unit transfusions may be appropriate and hospitals should review the number of units transfused against patients post-transfusion Hb at regular intervals.

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