



A prospective audit of blood usage post primary total knee arthroplasty

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The use of allogeneic blood is associated with many complications. A baseline audit performed in our institution in 2000 showed that 11% of patients undergoing primary total knee arthroplasty (TKA) required post-operative transfusion. Following this audit, patients undergoing primary TKA were no longer routinely cross matched, a Haemovigilance Nurse was employed in compliance with the National Blood Users Group guidelines, and post-operative cell salvage was introduced for patients with a pre-operative haemoglobin level of less than 12 g/dl. A prospective audit was then performed over a nine month period, from 1st January to 30th September 2003, to assess the impact of these changes on our transfusion practice. Data was collected on 233 patients who had primary TKA performed during the period of our prospective audit. Patients were transfused if their blood loss exceeded a pre-calculated maximal allowable loss, or based on a 48 hour post-operative haemoglobin level.

Seventeen of the 233 patients (7%) received allogeneic blood. The average amount received was two units. Pre-operative anaemia and advanced patient age were predictive for increased risk of transfusion. Thirty six per cent of patients who were given a cell saver did not collect sufficient blood for re-transfusion. Ten per cent required further transfusion with allogeneic blood.

There was no statistically significant difference in either the percentage of patients transfused or the volume of blood given to each patient between the two periods of audit. We did not find post-operative cell salvage to be an effective method of reducing allogeneic blood use.

Keywords: total knee arthroplasty; blood management; blood salvage; blood transfusion.

INTRODUCTION

The use of allogeneic blood is associated with many potential complications. These include the transmission of blood borne infection, transfusion reactions (acute haemolytic, febrile non-haemolytic, allergic, graft versus host disease), transfusion related lung injury, circulatory overload, and increased risk of prosthetic infection (1).

There is also a high financial cost (€ 223 per unit in our institution), and a reduced availability of donated blood. Hence it is necessary to be prudent with allogeneic blood transfusion.

Several procedures exist in our unit to curtail allogeneic transfusion. There is a pre-operative

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assessment clinic, which, among other functions, aims to identify and treat pre-operative anaemia. There is a facility to pre-donate autologous blood, but this is expensive (€ 444 per unit) and is generally only used when a large intra-operative blood loss is expected. We also regularly audit our use of allogeneic blood.

One such audit was performed over a six month period in 2000 to look at the transfusion requirements of 90 patients undergoing primary total knee arthroplasty. It showed that 10 of the 90 patients (11%) required post-operative allogeneic transfusion. The average amount of blood transfused was 2.3 units per patient. It also showed that the need for transfusion was related to the patient's pre-operative haemoglobin and that patients with a pre-operative haemoglobin ≥ 12 g/dl did not require transfusion with allogeneic blood. Based on these findings, changes in peri-operative transfusion practice were introduced to optimize allogeneic blood use and reduce wastage.

1. The practice of routinely cross-matching blood for patients undergoing primary knee arthroplasty was discontinued. Patients would still have a group and hold reserved.
2. A Haemovigilance Nurse was employed to monitor blood use and adverse events associated with transfusion.
3. The indication for transfusion was based on :

(i) National Blood Users' Group (NBUG) guidelines, which recommend that a young, healthy patient does not require transfusion unless his/her haemoglobin falls below 7 g/dl. This cut-off becomes 9 g/dl in a patient with cardiovascular co-morbidity. Symptomatic anaemia should be treated with transfusion, but this should consist of one unit of red cells, followed by reassessment, as opposed to the practice of automatically transfusing several units at once.

And

(ii) Reaching a pre-calculated maximal allowable blood loss (MABL) as calculated using the formula devised by Kallos and Smith (5) :

$$\text{MABL (ml)} = \frac{(\text{EBV}) \times (\text{Hct (pre)} - \text{Hct (min)})}{\text{Hct (pre)}}$$

Where : EBV = Estimated Blood Volume
(Weight in Kg \times 70),

Hct (pre) = Pre-operative haematocrit,

Hct (min) = Minimal allowable haematocrit (0.30 for men, 0.27 for women)

4. Post-operative cell salvage was introduced after in-service training of nursing staff and the establishment of protocols for its use.

The aim of our prospective audit was to determine if the above measures made an impact of decreasing our use of allogeneic blood, and to ensure our transfusion practice remained safe and cost-effective.

MATERIALS AND METHODS

Patient demographics

The hospital notes and transfusion records of 233 patients presenting for primary total knee arthroplasty between 1st January and 30th September 2003 were prospectively reviewed. There were 162 female patients and 71 male patients. Ages ranged from 36 to 91 years, with a mean age of 69 years. Because six patients had bilateral knee arthroplasties performed during the period of our audit, they were included as separate procedures, giving 239 procedures in total.

Pre-operative haemoglobin levels ranged from 9.81 g/dl to 17.1 g/dl. The average was 13.1 g/dl. Forty six patients (20%) were anaemic pre-operatively (taken as Hb < 12.5 g/dl in males, and Hb < 11.5 g/dl in females).

Surgical technique

Most (99%) operations were performed under spinal +/- epidural anaesthesia, using a pneumatic tourniquet positioned at the mid-thigh. A medial parapatellar approach was used in the majority of cases. All patients had wound drains inserted post-operatively

Cell Salvage

The postoperative cell salvage system used was the Cell-Trans™, by Summit Medical. It allows retransfusion of any amount between 100 ml and 1,200 ml of lipid filtered blood within eight hours of surgery. It cost € 125 per device, and was to be used on patients with a pre-operative haemoglobin of < 12 g/dl.

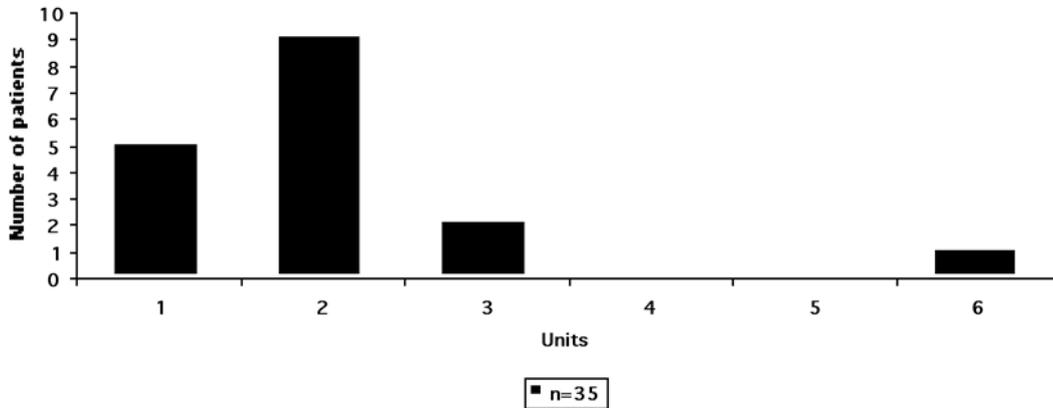


Fig. 1. — Use of allogeneic blood post primary knee arthroplasty. Includes one patient who required transfusion post haematemesis

Blood loss measurement

All patients had their post operative blood loss from their drains recorded. Haemoglobin level was checked at 48 hours post-operatively, unless blood loss had exceeded the MABL before this time.

Statistical methods

Data was analysed using the Student t-test and the Chi squared test.

RESULTS

Allogeneic transfusion

Seventeen (7%) of the 239 patients required post-operative transfusion with allogeneic blood. These included 15 female and two male patients. Ages ranged from 63 to 85 years, with a mean age of 74.8 years. Pre-operative haemoglobins in this group ranged from 9.53 g/dl to 13.8 g/dl, with an average of 11.72 g/dl. Eight patients (47%) were anaemic pre-operatively.

At 48 hours post-operatively, the average Haemoglobin drop was 4.13 g/dl.

The reason for transfusion was :

Reasons for transfusion (n = 17)

MABL exceeded	6
Symptomatic anaemia	6
Hb below NBUG guidelines	5

Thirty-five units of blood were transfused to the 17 patients (fig 1). Four of the patients who received two units of blood also received between 200 ml and 250 ml of salvaged blood.

Cell salvage

Sixty two of the 239 patients had a pre-operative haemoglobin level below 12 g/dl. Twenty-eight of these patients were supplied with a post-operative cell saver, and a further 11 patients, with a pre-operative haemoglobin of greater than 12 g/dl, were also given one. Figure 2 shows the amount of autologous blood re-transfused to the 39 patients. Sixteen patients (36%) collected only a negligible amount of blood (≤ 100 ml, which was not retransfused), and four patients (10%) required further transfusion with allogeneic blood. The average amount of blood collected in the cell saver was 248 ml.

Complications of transfusion

There were no transfusion reactions reported during the period of our audit. One patient, who had received two units of blood, developed an infected prosthesis.

DISCUSSION

Factors which predict the need for allogeneic transfusion are important to identify patients at risk. From our data, advanced patient age ($p =$

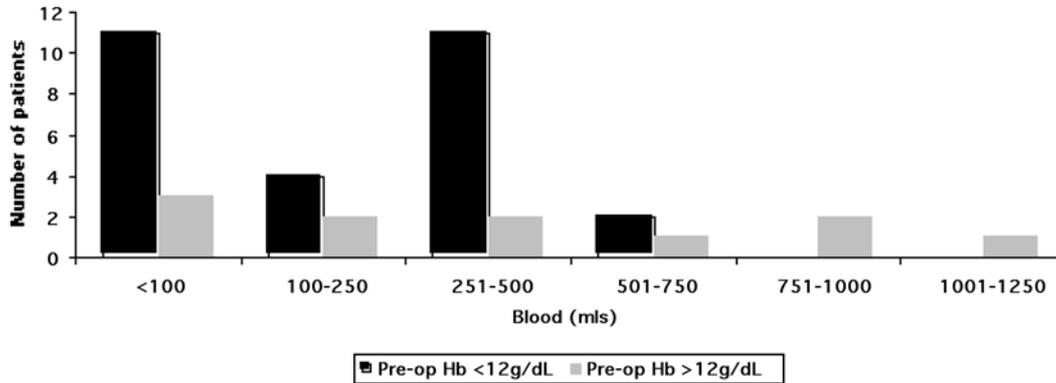


Fig. 2. — Amounts of autologous blood retransfused (Volumes less than 100 ml were not retransfused)

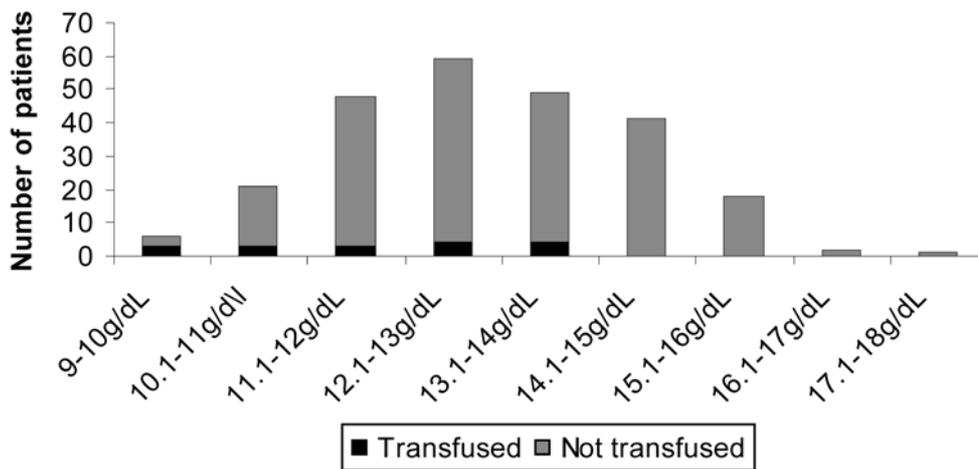


Fig. 3. — Patients with low pre-operative haemoglobin were more likely to require transfusion

0.003*) (* by Student t-test) and pre-operative anaemia ($p = 0.001^*$) (fig 3) were predictive for post-operative allogeneic blood transfusion. Patient gender was not a significant predictive factor ($p = 0.242^\dagger$) († by χ^2 test).

The indications for use of post-operative cell salvage were not always correctly followed in our study, despite staff training and protocols. However, 16 of the 39 patients (36%) who received a cell saver did not collect sufficient blood (i.e. > 100 ml) to warrant re-transfusion. Four patients (10%) required further transfusion with allogeneic blood. While there is evidence in the literature to support the use of post-operative cell salvage (3, 4, 7), Keating and Ritter (6) found no difference in

allogeneic transfusion requirements or haemoglobin drop between patients who had cell savers attached to their drains, and those who had no drain inserted following primary knee arthroplasty. The authors of this latter study did not find post-operative cell salvage to be cost effective.

The percentage of patients requiring allogeneic transfusion during our prospective audit period was 7% (a decrease from 11% in the 2000 transfusion audit). The average volume of allogeneic blood transfused to each patient was two units (also a decrease from the 2.3 units per patient in the 2000 transfusion audit). However, these differences were not statistically significant ($p = 0.492^\dagger$, $p = 0.5^*$ respectively).

In conclusion, our prospective audit showed that patients who are elderly or have a low pre-operative haemoglobin level are at increased risk of requiring post-operative allogeneic blood. The cessation of routine cross-matching of blood, close adherence to transfusion guidelines, and post-operative cell salvage did not make a significant impact on our use of allogeneic blood. Optimising pre-operative haemoglobin by treating anaemia and possible use of erythropoietin (2, 6) might prove in time to be a more fruitful strategy in reducing post-operative allogeneic blood use.

REFERENCES

1. **Bierbaum BE, Callaghan JJ, Galante JO et al.** An analysis of blood management in patients having a hip or knee arthroplasty. *J Bone Joint Surg* 1999 ; 81-A : 2-10.
2. **Hardwick ME, Morris BM, Colwell CW Jr.** Two-dose epoetin alfa reduces blood transfusions compared with autologous donation. *Clin Orthop* 2004 ; 423 : 240-244.
3. **Heddle NM, Brox WT, Klama LN et al.** A randomized trial of the efficacy of an autologous blood drainage and transfusion device in patients undergoing elective knee arthroplasty. *Transfusion* 1992 ; 32 : 742-746.
4. **Jones HW, Savage L, White C et al.** Postoperative autologous blood salvage drains : are they useful in primary uncemented hip and knee arthroplasty ? A prospective study of 186 cases. *Acta Orthop Belg* 2004 ; 70 : 466-473.
5. **Kallos T, Smith TC.** Replacement for intraoperative blood loss. *Anesthesiology* 1974 ; 41 : 293-295.
6. **Keating EM, Ritter MA.** Transfusion options in total joint arthroplasty. *J Arthroplasty* 2002 ; 17 Suppl 1 : 125-128.
7. **Majkowski RS, Currie IC, Newman JH.** Postoperative collection and reinfusion of autologous blood in total knee arthroplasty. *Ann R Coll Surg Engl* 1991 ; 73 : 381-384.