Post-operative red cell salvage in total knee replacement

Sarah L. Haynes, Francesco Torella, Jane A. Smith and Charles N. McCollum

Post-operative cell salvage (PCS) reduces homologous blood use after knee replacement but liberal indication for transfusion in previous studies resulted in high homologous transfusion requirements. We evaluated PCS in patients undergoing knee replacement using a restrictive transfusion trigger (Hb <8.5 g/dl). Forty patients underwent knee replacement with either PCS ($n = 20$) or with standard wound drains ($n = 20$). Blood losses and transfusion requirements were recorded prospectively. Mean (SD) post-operative blood loss with PCS was 656 (317) ml, of which 433 (197) ml were re-infused. Control blood loss was comparable at 591 (328) ml. Blood transfusion was given to only one PCS patient; 2 U, and five controls who received a total of 12 U of homologous blood.

Homologous transfusion was not necessary for most patients undergoing knee replacement when the indication for transfusion was restricted. PCS further decreased homologous blood requirements.

Editor's comment
Homologous blood replacement during and after total knee replacement surgery presents a risk to the patient. Transfusion costs are also increasing rapidly and this includes the nurse's time in setting up, running, and monitoring the process. This study demonstrates a safe and effective means of reducing the number of post-operative homologous blood transfusions due to knee replacement surgery. To help those health care professionals who do not have a research background simple explanations of the statistics are included.

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KEY WORDS: post-operative cell salvage, knee replacement, blood transfusion

Sarah L. Haynes PhD, Autologous Transfusion Co-ordinator
Francesco Torella FRCS, Research Fellow
Jane A. Smith PhD, Research Assistant
Charles N. McCollum MD FRCS, Professor of Surgery

Correspondence to:
Dr Sarah Haynes, Autologous Transfusion Co-ordinator, Academic Surgery Unit, Education and Research Centre, Wythenshawe Hospital, Southmoor Road, Manchester M23 9LT, UK.
Tel.: +161-291-5838;
Fax: +161-291-5839;
E-mail: s_haynes@fs1.with.man.ac.uk

INTRODUCTION

Autologous blood transfusion has been prioritised by the NHS Executive (Winyard 1998) and is becoming increasingly more popular among orthopaedic surgeons (Torella et al. 2001). In a recent meta-analysis, post-operative red cell salvage (PCS) reduced the need for homologous blood after total knee replacement (Huet et al. 1999). However, blood transfusion requirements remained high as the indications for transfusion were liberal. Recent evidence suggests that restrictive transfusion triggers are safe even in elderly patients or in the presence of coronary artery disease (Bracey et al. 1999, Carson et al. 1998, Hebert et al. 1999). Consequently, homologous blood is usually only given in our hospital when the haemoglobin falls below 8.5 g/dl unless there are symptoms or signs of myocardial ischemia. We conducted a pilot study to evaluate PCS in total knee replacement when the indications for blood transfusion were restricted.

METHODS

Forty consecutive patients undergoing elective total knee replacement were alternately allocated

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to either PCS or standard transfusion practice with homologous blood if required (controls). All operations were performed under tourniquet. Total drainage volumes and transfusion requirements were recorded throughout the hospital stay. In controls, standard suction drains were used and the blood discarded after measuring its volume. In PCS patients, either a Bellovac® (Astra Tech, Gloucestershire, UK, $n = 10$) or HandyVac™-ATS (Maersk Medical, Worcestershire, UK, $n = 10$) drain was used, with blood lost re-infused within 6 h of surgery only if drainage volume exceeded 200 ml. In both groups, a routine full blood count, processed by the South Manchester University Hospital Pathology Department, was performed pre-operatively and 24 h following surgery. Samples of the filtered autologous blood were also taken to assess its cellular composition.

RESULTS

PCS and control patients were well matched for mean or average age at 67 (Standard Deviation– SD 8) years in PCS and 70 (SD 8) years in the controls, and gender, with 8 men in PCS and 6 in controls. See Box 1 for an explanation of Standard Deviation. Mean pre-operative haemoglobin was 13.4 (SD 1.5) g/dl in PCS patients and 13.8 (SD 1.3) g/dl in controls. Mean post-operative blood loss with PCS was 656 (SD 317) ml, of which 433 (SD 197) ml were re-infused. Blood loss in controls was comparable at 591 (SD 328) ml. One PCS patient required transfusion of two units whereas five controls required a total of 12 U of homologous blood. Haemoglobin at 24 h was similar at 11 (SD 1.3) g/dl for PCS and 10.9 (SD 1.3) g/dl in controls. The cellular composition of the re-infused blood was similar in the two PCS systems (Table 1). There were no major complications.

Based on the results of this pilot study, a randomised trial would require only 55 patients in each treatment arm to demonstrate a statistically significant difference in exposure to homologous blood between PCS and controls (80% power, $\alpha = 0.05$, Fisher's Exact test). See Box 2 for a brief explanation of power analysis.

DISCUSSION

Homologous transfusion requirements, in this study where the indications for transfusion were restricted, were low in comparison to that pre-

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Box 1   Standard deviation (SD)

The standard deviation summarises the average amount of deviation of values from the mean. It reflects how well the mean (average) captures the typical value in a distribution. In the first instance of these results the distribution is of ages in years. The larger the typical distance or standard deviation the less well the mean reflects a set of cases, i.e., ages.

Table 1   Comparison of filtered salvaged blood

	PCS system	
	Bellovac®	HandyVac™
Hb (g/dl)	10.2 (7.8–12.1)	10.1 (9–12.7)
PCV	0.3 (0.24–0.36)	0.3 (0.26–0.38)
RBC ($\times10^{12}$/l)	3.6 (2.5–4.1)	3.375 (2.99–4.12)
Platelets ($\times10^9$/l)	38 (23.8–51.5)	26 (21.75–29.5)
WBC ($\times10^9$/l)	4.9 (3.8–6.2)	4.65 (3.9–7.8)
Lymphocytes ($\times10^9$/l)	1.3 (0.9–2)	1.1 (0.6–1.8)
Monocytes ($\times10^9$/l)	0.7 (0.4–1)	0.4 (0.3–0.7)
Eosinophils ($\times10^9$/l)	0.05 (0.05–0.12)	0.05 (0.02–0.1)
Basophils ($\times10^9$/l)	0.04 (0.03–0.1)	0.07 (0.03–0.13)
Neutrophils ($\times10^9$/l)	2.5 (1.7–2.9)	2.6 (2–4)

Values are median (Interquartile range).

Box 2   Power analysis

Power analysis is used to estimate the sample size requirements, i.e., number of patients. Fisher's Exact test is used to make this estimate when the sample size is small, total number (n) is 30 or less. Fundamentally a certain number of patients are required to ensure that the probability of wrongly rejecting the hypothesis is minimal. This study has estimated a minimum number of 55 patients in each treatment arm, that is 110 in total, if the results are to be more trustworthy. The number of patients used in this study was 40 in total.

viously reported (Heddle et al. 1993, Majkowski et al. 1991, Roberts et al. 2000, Shenolikar et al. 1997). This was largely due to the restrictive transfusion trigger routinely used in our practice. Despite this, PCS reduced the need for homologous blood transfusion yet further. This might be particularly attractive to orthopaedic surgeons in view of recent concerns about transmission of variant CJD via blood donors (Turner & Ironside 1998, Wilson et al. 2000), and the deleterious effect of homologous blood on surgical outcome (Duffy & Neal 1996, Haynes et al. 2001). Furthermore, PCS may achieve significant cost savings as the price of stored blood has risen sharply (Provan 1999). The devices we evaluated are currently priced at around £40, but replace standard low vacuum drains costing around £8–10 each. Now that stored blood costs around £100 per unit, modest reductions in homologous blood usage could finance universal adoption of PCS in knee replacement. Further savings could be achieved if the pre-operative cross-match were replaced by a simple group and save policy.

CONCLUSIONS

This pilot study suggests that there is a role for PCS in knee replacement even when transfusion requirements are low due to a restrictive blood transfusion trigger. A randomised clinical trial recruiting at least 110 patients is necessary to confirm this.

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