Audit

An economic justification for autologous blood re-infusion in primary total knee replacement surgery

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Introduction: To justify economically the use of autologous blood re-infusion after total knee replacement surgery compared with vacuum drains. To determine if the patients using autologous re-infusion units have a reduced allogenic blood transfusion requirement and hospital stay.

Patients and Methods: Prospectively, 50 patients undergoing primary unilateral total knee replacements with autologous re-infusion units were studied. They were matched for age, sex, type of prosthesis and the month in which surgery took place to a second group undergoing the same surgery with vacuum drains. The results for the second group were obtained retrospectively from the notes. The outcome measures were the need for allogenic blood transfusion and length of postoperative hospital stay.

Results: The use of re-infusion units reduced the need for postoperative allogenic blood transfusion from 28% to 4% in total knee replacement surgery. The cost of using re-infusion units was the same as vacuum drains. Overall, the autologous re-infusion patients were discharged 2 days earlier (99% confidence interval).

Conclusions: Re-infusion units are no more expensive than vacuum drains. In addition, autologous blood has many clinical benefits compared to allogenic blood. Re-infusion may shorten the hospital stay for patients undergoing total knee replacement surgery.

Key words: Total knee replacement – Autologous – Allogenic – Blood transfusion

Traditionally, postoperative blood loss during total knee replacement surgery was collected in vacuum drains; it was not recycled. More recently, autologous re-infusion units have become available to recycle this 'lost' blood. Recycling of previously discarded blood decreases the need for postoperative allogenic blood transfusions. The clinical benefits of autologous versus allogenic blood transfusions have been well documented. Primarily, this study set out to quantify the increased financial costs, if any, of using autologous re-infusion after total knee replacement surgery compared with traditional practices.

The data collected were also used to determine if the autologous re-infusion units resulted in a reduced number of postoperative allogenic blood transfusions and if the patients using autologous re-infusion units had a reduced postoperative hospital stay.

There are four main methods of autologous transfusion – pre-deposit, haemodilution, intra-operative cell salvage and postoperative cell salvage. Of the four techniques, postoperative cell salvage is the least complicated. It does not require patients to be 'bled' pre-operatively, sometimes on numerous occasions, or require the storage and

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identification of collected blood products. As the majority of the blood loss in a total knee replacement is after surgery, postoperative blood cell salvage is the most logical method for this procedure. Many devices available for postoperative cell salvage involve adding citrate or heparin to the collected blood and the use of pumps or moving parts to process and deliver the blood back to the patient. These make the process cumbersome. The method of cell salvage used in this study requires no additives to the salvaged blood and has no pumps or moving parts. In our view, this results in the most simple and effective method of autologous blood collection and re-infusion in total knee replacement patients.

It is well recognised that it is important to reduce the number of allogenic blood transfusions to conserve this increasingly expensive resource¹ and reduce the risk of allogenic transfusion-related problems.^{2,3} Clinical trials have shown that, in general, autologous transfusion can improve clinical outcome as compared with allogenic transfusion.⁴ More specifically, studies have also shown the clinical benefits of re-infusing salvaged autologous blood in total knee replacements.⁵⁻⁷ Our aim was to quantify the costs of re-infusing salvaged blood after total knee replacement.

Patients and Methods

A total of 50 consecutive patients (group 2) who had total knee replacement with re-infusion units were compared against a control group (group 1). This group consisted of 50 patients who had their total knee replacement one year earlier when vacuum drains were being used postoperatively. The re-infusion group were studied prospectively and the data for group 1 were collected retrospectively from the notes. Ideally, a randomised, controlled trial would have been the best way of quantify any economic differences between the two groups but given that the autologous re-infusion of salvaged blood has many clinical benefits and was already considered to be 'best-practice', we felt this method would give us the economical justifications for the units we required without denying patients the benefits of the re-infused blood.

The patients were matched for age, sex, type of prosthesis and the month in which surgery took place. All patients were operated on by the same four consultant orthopaedic surgeons and were cared for on the same postoperative ward, with the same rehabilitation facilities and physiotherapy services. All patients had a haemoglobin of 10 g/dl or greater prior to surgery.

The indications for postoperative allogenic blood transfusion were the same in both groups. Patients were transfused if they were symptomatic due to a low haemoglobin or had haemoglobin of less than 8 g/dl.

For the two groups, the following were compared: (i) costings; (ii) whether or not an allogenic blood transfusion was required postoperatively; and (iii) length of hospital stay.

Equipment

The autologous re-infusion unit used was the ABTrans™ system.⁷ This was chosen because it was found to be the simplest and most effective unit of its type during trials at the Weston General Hospital. The unit has no moving parts and is not much larger or heavier than a traditional vacuum drain. It consists of a self-contained, sterile, closed system that passes blood through a micro-aggregate filter. The filter avoids extra washing of the blood as well as processing and the need for anticoagulation. Provided the bleeding is not too rapid, the blood undergoes a process of defibrinogenation within the knee joint, a natural process that eliminates the effect of clotting factors in the drained blood. The drains are opened 20 min postoperatively. The blood is drained directly into a collecting bag and then immediately infused back into the patient.

Costings

For group 1 patients, the cost of two vacuum drains was £17.00; for the group 2 patients, the cost of the re-infusion drains was £60.45.^{7,8} Both groups were group and saved only. The difference in cost between the groups, with no allogenic transfusions, is £43.45 per patient. The number of patients in group 1 who required allogenic blood transfusion was compared with the number in the group 2 re-infusion patients. The decision to transfuse was made by the team caring for the patients using the criteria given above.

Results

In group 1, 28% (14/50) of the patients required allogenic blood transfusions as compared with only 4% (2/50) of the group 2 re-infusion patients. The criteria for transfusion were followed in all the patients receiving an allogenic transfusion. The cost of a two-unit transfusion at the time of this study was £166.86. Hence, the total cost for group 1 was £3297.00 ($50 \times £19.23 + 14 \times £166.86$). The cost for group 2 was £3467.72 ($50 \times £62.68 + 2 \times £166.86$).

Patients using the re-infusion system had a shorter average postoperative stay in hospital. The average stay for a group 1 patient was 11 days and for a group 2 patient 9 days. Null hypothesis and standard variance tables show that the length of stay of the two groups was significantly different with a 99% confidence interval.

As each group was operated on by the same four surgeons in the same theatres and cared for in the same

specialist postoperative ward, it is assumed that each group received comparable care.

Discussion

The clinical benefits of re-infusing autologous blood, compared with allogenic transfusions, are well documented. They include the prevention of transmission of blood borne infection (including hepatitis B and C and possibly Creutzfeldt-Jacob disease^{10,11}) and of cross matching and transfusion errors. However safe the process is made, none of these problems can be entirely eliminated using allogenic blood transfusions. Autologous re-infusion also enables the conservation of increasingly expensive allogenic blood supplies.² This will become increasingly important especially if donor testing is introduced for Creutzfeldt-Jacob disease which, it is estimated, could reduce the number of active donors by as much as 50%.¹ Over half of all red cell concentrates are used in elective surgical procedures.¹⁴ It, therefore, seems logical that one of the best methods to reduce the use of increasingly scarce blood is by developing methods for reducing the use of elective allogenic transfusions. Finally, re-infusion units like the one used in this study can also overcome religious objections to transfusion as the blood remains connected to the patient at all times. These benefits mean that the use of simple re-infusion units can be justified on clinical grounds alone. However, in today's NHS procedures have to be justified economically.

In this study, the use of re-infusion units reduced the need for postoperative allogenic blood transfusion from 28% to 4% in primary total knee replacement surgery. The total cost for group 1 patients was £3297 and for group 2 patients £3467. Therefore, economically the two groups are comparable. However, such a comparison does not take into account the clinical benefits of re-infusion versus allogenic transfusion, such as a reduced infection risk and transfusion reactions or the possible benefit of an earlier discharge in the re-infusion group. These are difficult to quantify financially.

Universal guidelines for blood transfusions and pre-operative cross-matching of blood in primary unilateral total knee replacement are not yet available.¹⁰ Trusts vary depending on their maximum blood-ordering schedule (MBOS), but it is common practice to cross-match 2 units of blood per total knee replacement patient. If this practice was applied to this study, a saving of £116 per patient undergoing total knee replacement would be made using the re-infusion units. Keeping a patient in hospital with no treatment costs a minimum of £200 a day.⁸ This includes basic care from staff, food and a hospital bed. Taking into account the 2-day difference in hospital stay between the two groups, a potential saving of a further £400 per person

undergoing a total knee replacement in the re-infusion group could be made.

The results of this study leave many unanswered questions. Did autologous re-infusion patients go home earlier than those who received allogenic blood? Could it be that they were just operated on one year later and things had changed? Possibly. However, the likely major variables (*i.e.* surgeons, nursing staff, physiotherapists, ward and rehabilitation programmes) were constant for the two groups. Therefore, this is unlikely to explain fully the differences in discharge times. Other possible reasons for the difference could be, first, group 2 patients were re-infused with their own blood faster postoperatively than group 1 patients who had to wait for postoperative haemoglobin checks. Second, group 2 patients, unlike those in group 1, received much of their lost blood back postoperatively even when their haemoglobin was greater than 8 g/dl. Finally, there is uncertainty as to whether any blood autoimmunity reactions occurred in transfused group 1 patients causing adverse effects; these did not occur if autologous blood was used. A recent study has suggested that blood transfusions increase mortality in critically ill patients who are transfused for anaemia.¹² Of the ITU patients transfused in the study, 18.5% died within 28 days of transfusion compared with 10.1% in the non-transfusion group. This difference was shown to be statistically significant. The reason for the difference is not clear but the paper suggests that immunosuppression caused by the transfusion may play a role. If this is true in critically ill patients, it seems likely the same process(s) may also affect elective surgery patients receiving allogenic transfusions postoperatively.

The results of this study led to speculation as to whether other operations would benefit from autologous re-infusion. Consequently, the autologous re-infusion units used in this study are now being used for total hip replacement surgery at Weston General Hospital. Total hip replacements use up to 4.6% of all blood transfused.¹ This equates to 11% of all blood used in surgical patients for both elective and emergency procedures. The same benefits may be more difficult to prove as most of the blood is lost intra-operatively in total hip replacement compared with postoperatively in total knee replacements.

This study has many limitations. The sample size is small, the numbers are discrete and the two groups of patients were operated on one year apart. However, the results are shown to be statistically significant with 99% confidence intervals. Therefore, it is felt that the limitations do not completely invalidate the findings.

Conclusions

Despite its limitations, this is a valuable study. The system used allows the recycling of a patient's own blood in a

very cheap and simple manner leading to dramatic reduction in the use of an increasingly expensive and potentially dangerous commodity. Re-infusion compared with allogenic transfusion has many clinical benefits for the patient. These include the prevention of transfusion reactions, blood-borne infections and auto-immunity reactions as well as a reduction in post-transfusion immunosuppression. In addition, this study suggests autologous re-infusion may shorten hospital stay for patients undergoing a total knee replacement. Finally, the study shows the use of re-infusion units in total knee replacements can be justified economically.

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