Cost Minimization Analysis of Preoperative Erythropoietin vs Autologous and Allogeneic Blood Donation in Total Joint Arthroplasty

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Abstract: Autologous blood donation and erythropoietin (EPO) have been shown to be effective in reducing allogeneic blood transfusion, but the cost-effectiveness of these interventions remains unclear. A cost minimization analysis was performed, comparing the total costs of allogeneic blood transfusion strategy and autologous and allogeneic blood transfusion strategy for 161 primary total hip arthroplasty (THA) and 195 total knee arthroplasty (TKA) patients. An EPO cost minimization model was constructed using a previously published algorithm for blood management after total joint arthroplasty. The least costly strategy was autologous blood donation in combination with allogeneic blood for THA and TKA patients at $856 and $892 per patient, respectively. The most costly strategy was allogeneic only at $1769 and $1352 per THA and TKA patient, respectively. The EPO strategy model predicted costs similar to the autologous and allogeneic. A strategy that combines autologous blood donation with EPO for patients who cannot donate autologous blood may provide the greatest cost savings and minimize allogeneic blood transfusion. **Keywords:** cost analysis, preoperative EPO, autologous blood donation, allogeneic blood donation, total, joint arthroplasty.

Blood transfusion is common after total joint arthroplasty. Transfusions are expensive and still carry residual albeit low risk. Although risks are considered minimal, allogeneic blood carries increased risks of disease transmission such as HIV and hepatitis C virus, transfusion reactions, and possibly immunosuppression. As a result, autologous blood donation before elective orthopedic arthroplasty procedures has become widely accepted [1-3].

There is still no consensus regarding the optimal method of minimizing allogeneic blood transfusion in total joint arthroplasty. Erythropoietin (EPO) has consistently been shown to reduce allogeneic exposure, but the cost-effectiveness of EPO in total joint arthroplasty has not been consistently demonstrated. Autologous blood donation reduces exposure to allogeneic blood but also has significant costs associated with storage and unused blood. Cost minimization analysis is a type of health care economic evaluation that considers the costs of the treatments and assumes that patient outcomes are the same or similar between the treatments [4]. A cost minimization analysis of EPO, autologous, and allogeneic blood donation may help determine which strategy is optimal.

Erythropoietin is effective in preventing allogeneic blood exposure. This has been widely studied and validated through multiple randomized clinical studies [3,5-9]. The cost-effectiveness of EPO has yet to be determined.

Properly screening total joint arthroplasty patients preoperatively using an algorithm that uses EPO and allogeneic blood may provide a less expensive blood management strategy than using a strategy that involves autologous blood donation. Pierson et al developed an effective blood-conservation algorithm that projected the patient's postoperative hemoglobin by estimating the average blood loss for total knee arthroplasty (TKA) and total hip arthroplasty (THA). Patients with estimated postoperative hemoglobin of less than 7 g/dL were given EPO. Using this algorithm, they identified patients who were at high risk for postoperative allogeneic blood transfusion and reduced exposure to allogeneic blood to 2.1%.

Very few studies have specifically studied a cost comparison between EPO, autologous blood, and allogeneic blood donation strategies. Hardwick et al prospectively randomized preoperative patients with hemoglobin 12-15 to receive either 2 doses of EPO (40 000 IU at 2 and 1 week preoperatively) or 2 U of autologous blood

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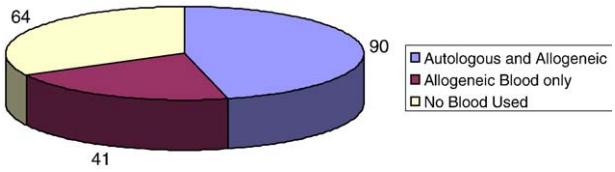

Fig. 1. Total knee arthroplasty: blood strategy by patient.

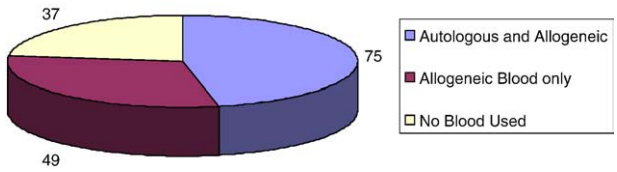

Fig. 3. Total hip arthroplasty: blood strategy by patient.

duration. The mean cost of 1 U of ABD was $391; 1 U donor specific, $569; 1 U allogeneic, $514; and one 40 000-IU EPO injection, $489. They concluded that EPO reduced the need for both allogeneic and autologous blood transfusions. However, patients had to receive 2 or more units of any blood type to equal the cost of 2 doses of EPO [2].

In this study, cost minimization analysis was performed comparing the total costs of autologous and allogeneic, allogeneic only, and EPO strategies for 161 THA and 195 TKA patients between July 2005 and May 2006. An EPO cost minimization model was constructed using the algorithm published by Pierson et al [10] for comparison.

Methods

Our Medical Center Decision Support System was used to identify patients who underwent unilateral primary THA or TKA at our institution during an 11-month period (July 1, 2005, to May 31, 2006). Revision and bilateral procedures were excluded. Clinical laboratory electronic records were used to identify hemoglobin values. Blood bank electronic records were used to determine units transfused.

Costs of allogeneic and autologous blood donation were obtained through our Medical Center Blood Bank and charge master. Costs of nursing time and administration were also included in the analysis. Cost of predonating autologous blood was dependent on where the blood was predonated.

Erythropoietin was not used in our patients. A model was constructed using a blood conservation algorithm published by Pierson et al [10] to determine projected EPO use and cost. For THA patients, this model uses preoperative hemoglobin minus expected blood loss + 1 SD (4 g/dL + 1.1 = 5.1 g/dL). For TKA patients, this model uses preoperative hemoglobin minus expected blood loss + 1 SD (3.8 g/dL + 1 = 4.8 g/dL). Patients with estimated postoperative hemoglobin of less than 7 g/dL were modeled to receive EPO. Erythropoietin costs approximately $458 per 40,000 U injection based on our institutional pharmacy. Costs such as RN administration were also included.

Results

During the 11-month period, complete clinical and cost data were available for a total of 195 unilateral primary TKR patients and 161 unilateral THR patients. The mean age of TKR and THR patients was 61.3 years and 58.5 years, respectively. The mean length of hospital stay was 4.5 days.

Preoperative Autologous Blood Donation

Among the 195 TKR patients, 90 patients predonated a total of 166 U of autologous blood, of which 82 U were transfused (Fig. 1). Among the 161 THR patients, 75 patients predonated 148 U of autologous blood, of which 110 U (74.3%) were transfused. Autologous blood was estimated to cost $300 per unit. Cost of administration was estimated to be $25 per unit. The total cost of THA patients who only used autologous blood was $40 625 among 63 patients. The total cost of TKA patients who only used autologous blood was $47 700 among 73 patients using the same cost analysis (Fig. 2).

The mean (SD) lowest hemoglobin concentration during the hospitalization was 8.4 g/dL. Both mean preoperative and discharge hemoglobin concentrations were slightly more than 10 g/dL.

Allogeneic Blood Transfusion

Among 195 TKA patients, 58 patients received 136 U of allogeneic blood. Among 161 THA patients, 61 patients received 190 U of allogeneic blood (Fig. 3). Allogeneic blood was estimated to cost $512 per unit. Cost of

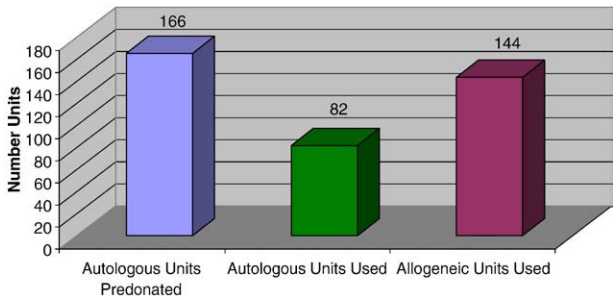

Fig. 2. Total knee arthroplasty: autologous and allogeneic units donated and used.

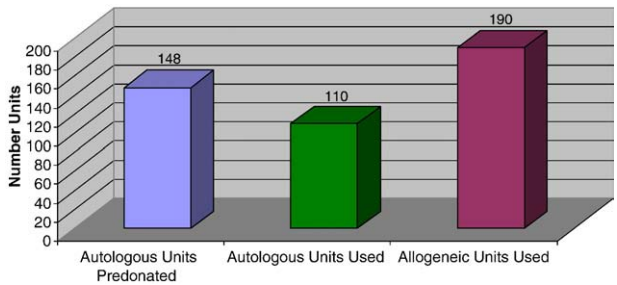

Fig. 4. Total hip arthroplasty: autologous and allogeneic units donated and used.