Blood Management in Shoulder Arthroplasty

Neal Chen, MD; Mason Porramatikul, MD; David Zurakowski, PhD, Jon JP Warner, MD; Peter J. Millett, MD, MSc

Brigham and Women's Hospital

INTRODUCTION

Several studies have established a relationship between various clinical risk factors and the need for postoperative blood transfusion in hip or knee arthroplasty (1, 2). However, no study has determined the transfusion risk in shoulder arthroplasty or has established which patients are likely to benefit from predonation of autologous blood. Subsequently, a lack of guidelines has led to a tremendous waste of predonated blood.

The purpose of the current study was to identify which preoperative variables are independently associated with blood transfusion after shoulder arthroplasty. We also analyzed the preoperative autologous blood donation and transfusion practice in shoulder arthroplasty surgery at two tertiary medical centers.

MATERIALS AND METHODS

A retrospective study involving all total shoulder arthroplasties or hemiarthroplasties performed between September 30, 2001 and March 31, 2004 at two tertiary medical centers was performed. One hundred and twenty four operations met the study criteria and were included in the study group. All surgeries were performed at the authors' institutions by two attending surgeons (JPW and PJM) using the same surgical exposure and the same hemostasis techniques.

Documents analyzed included the preoperative history and physical examination, operative report, anesthesia record, nursing notes, transfusion records, blood bank records, physician's progress notes and electronic medical record. Preoperative, intraoperative, and postoperative variables were evaluated in their suitability as criteria for requiring a postoperative transfusion which included preoperative hemoglobin/ hematocrit level, gender, age, diagnosis, weight, body mass index (BMI),

Dr. Chen is a resident in the Harvard Combined Orthopaedic Residency Program

Dr. Porramatikul is a visiting fellow.

Dr. Zurakowski is a statistician, Department of Orthopaedic Surgery, Children's Hospital Boston

Dr. Warner is Chief, Partners Shoulder Service; Associate Professor of Orthopaedic Surgery; Harvard Medical School

Dr. Millett is Assistant Professor in Orthopaedic Surgery, Harvard Medical School

Address correspondence to:

Brigham & Women's Hospital
75 Francis Street
Boston, MA 02115

the presence of comorbid conditions such as hypertension, coronary artery disease, the type of operative procedure, the type of anesthesia (general, regional or combination), the operative time, the estimated blood loss, the lowest postoperative hemoglobin/ hematocrit, the number of units transfused, and whether or not autologous or allogenic blood was transfused.

Continuous variables were described using the mean and standard deviation (SD) with groups compared using the Student t-test. The Pearson chi-square and Fisher's exact test were used to assess differences in categorical data and proportions. Patients who required blood transfusion and those who did not were compared regarding preoperative variables including age, gender, weight, diagnosis, hemoglobin level, hematocrit level, comorbid conditions, preoperative medications, and type of procedure. Variables that demonstrated a significant relationship by univariate analysis were included in a multiple stepwise logistic regression analysis using backward selection to identify the significant independent predictors of transfusion. β

RESULTS

A total of 124 operations were evaluated. Mean age and weight were approximately 63 years and 85 kg, respectively. Preoperative diagnosis was primary osteoarthritis in 79 patients, secondary osteoarthritis in 36 patients and mechanical failure or loosening in 9 patients. Relatively common comorbidities included hypertension coronary artery disease, pulmonary disease, and diabetes mellitus.

One third of patients did not pre-donate autologous blood. No patient pre-donated more than 3 units of autologous blood. Overall mean operative time was about 3 hours.

Mean estimated blood for uncomplicated primary TSA was about 500 mL. Mean estimated blood for uncomplicated primary hemiarthroplasties was about 200 mL. Mean estimated blood for revision or complicated hemiarthroplasties was about 325 mL.

Transfusion Requirements

Approximately sixty percent of the 124 patients donated a total of 131 units of blood for possible autologous transfusion. One quarter of patients required a transfusion of autologous or allogenic blood, or both. Forty-eight transfusions were performed. About twenty percent of patients received autologous blood only, five percent received allogenic blood only, and two percent required a transfusion of both forms of blood. Approximately seventy five percent of the 124 patients and seventy percent of the 73 donors did not require a transfusion of either autologous or allogenic blood.

EFFECT OF AGE, WEIGHT, INITIAL HEMOGLOBIN LEVEL, AND BLOOD LOSS ON TRANSFUSION REQUIREMENTS

Preoperative hemoglobin was significantly higher in patients who did not require transfusion than those who required blood transfusion. Blood loss was significantly lower in the non-transfusion compared to the transfusion group. Patients who did not require blood transfusion weighed more on average than patients who required transfusion. Also, a higher percentage of those who required transfusion were of advancing age (>75 years). All of these associations were statistically significant.
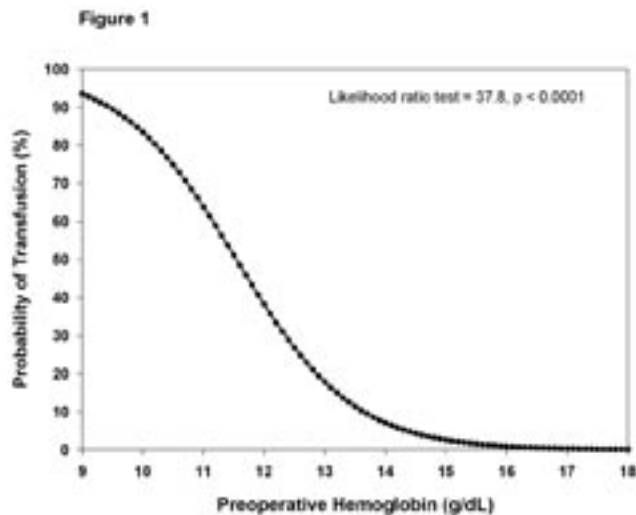
Gender, BMI, pre-operative diagnosis, comorbid conditions, use of anticoagulants or aspirin, autologous pre-donation status, type of anesthesia, operative time and decrease in hemoglobin or hematocrit did not differ significantly between the patients who had a transfusion and those who did not.

In addition, we categorized patients into three groups by their preoperative hemoglobin: There was an inverse relationship between preoperative hemoglobin and likelihood of transfusion. Statistical evidence showed a highly significant difference in the distribution of preoperative hemoglobin levels between these groups with the patients who required transfusion having higher hemoglobin levels.

Logistic regression analysis demonstrated that of the three significant predictors identified by univariate analysis (age > 75 years, weight, and preoperative hemoglobin level), preoperative hemoglobin was the only significant independent predictor of blood transfusion. The multivariate analysis indicated that weight and advancing age provided no additional information regarding the need for a transfusion beyond the information predicted by hemoglobin level.

UTILIZATION OF AUTOLOGOUS BLOOD—WASTED UNITS

About three quarters of predonated units were wasted in the primary uncomplicated total shoulder arthroplasty group and about fifty percent of units were wasted in the revision or complicated primary TSA groups.

Figure 1

Likelihood ratio test = 37.8, p < 0.0001

DISCUSSION

Previous studies have examined specific risk factors for transfusion after elective TKA and THA (1, 2). Most of the transfusion studies demonstrated an association between low preoperative hemoglobin and the need of transfusion. Advancing age, weight, female sex, higher American Society of Anesthesiologists physical status rating, cemented arthroplasty, revision surgery, and the use of low-molecular weight heparin postoperatively have also been identified as predictive factors for transfusion in knee or hip arthroplasty (1). To our knowledge, this is the first study of shoulder arthroplasty studying the preoperative clinical predictors for transfusion after total shoulder arthroplasty and hemiarthroplasty.

Clinical parameters determining the postoperative blood transfusion in shoulder arthroplasty surgery were different from those in knee and hip arthroplasty. Estimated blood loss in shoulder arthroplasty is lower than that of hip arthroplasty and equal to or greater than that of unilateral knee arthroplasty. Following THA and TKA, estimated blood loss ranges from 450-1500 ml and 180-330 ml, respectively. (1). Estimated blood loss in this current study averaged about 350mL . It should be noted that postoperative antithromboembolic prophylaxis was not routinely used after shoulder arthroplasty.

On the basis of the results obtained in this study, the univariate analysis showed a significant relationship between postoperative transfusion and the preoperative hemoglobin level, age greater than 75 years, weight and estimated blood loss. However, the multivariate analysis revealed the most significant relationship only existed with the preoperative hemoglobin level. Patients who underwent shoulder arthroplasty with a higher preoperative hemoglobin had a lower risk of being transfused. This finding supported the various studies that demonstrated a relationship between preoperative hemoglobin levels and the need for blood transfusion (1,2). However, the current study showed no relationship between transfusion requirement and gender, age, diagnosis, body mass index, the presence of comorbid conditions, the use of oral anticoagulants or aspirin, autologous pre-donation status, the type of operative procedure, the type of anesthesia and operative time.

A high percentage of the autologous units were discarded, and many patients never received any of their predonated autologous units. In short, there was a problem with overcollection. Overcollection of autologous units has been noted to be a common problem, with wastage rates of 38 percent (4) to 49 percent (5).

In our study, overall transfusion rate was approximately 25%. One quarter of predonating patients received an autologous transfusion. Nearly a third of all autologous units were wasted. In addition, a high percentage of units from the donors who had a high preoperative hemoglobin were discarded. These results demonstrated that with the practices employed on our services, shoulder arthroplasty had a much higher rate of autologous unit waste than knee or hip arthroplasty. We also found that revision or complicated primary total shoulder arthroplasty have a higher prevalence of postoperative blood transfusion

when compared with other shoulder arthroplasty procedures, although this difference was not significant statistically.

The current recommendations of the National Heart, Lung, and Blood Institute (NHLBI) is that patients pre-donate autologous blood if they have a greater than 10% chance of requiring a postoperative transfusion. Based on the results of the current study and the recommendations of the NHLBI Expert Panel on the use of autologous blood, the patient with a high preoperative hemoglobin should be advised not to pre-donate autologous blood for shoulder arthroplasty.

In summary, the results of the present study demonstrate that preoperative hemoglobin level was the strongest predictor of the blood transfusion after shoulder surgery, and patients with lower preoperative hemoglobin have the highest risk of requiring a transfusion. Given that the use of predonated autologous blood was inefficient, the present study supports the strategy of limiting pre-donation to those with a preoperative hemoglobin within a limited range. Decreasing autologous donations from shoulder arthroplasty patients affords the opportunity to improve the overall efficiency of autologous collection programs for shoulder arthroplasty procedures.

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