A Point Score System for Predicting the Likelihood of Blood Transfusion After Shoulder and Elbow Arthroplasty

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ABSTRACT

Objective: To determine a point score system for predicting the likelihood of blood transfusion after Shoulder and elbow arthroplasty.

Methods: The current study represents a retrospective analysis of all shoulder and elbow arthroplasties performed at the Manor Teaching Hospital United Kingdom by the senior surgeon/Author from Jan 2010 to Dec 2014. A database of 183 patients that underwent elective surgery at a teaching hospital was used for analysis to determine potential variables that was predictive of blood transfusion. The predictor variables evaluated included type of arthroplasty (shoulder vs. elbow, primary vs. revision, trauma vs. arthritis.) and age, sex, and medical co morbidity. The outcome variable was allogeneic blood transfusion.

Results: The record of 124 patients were reviewed. Females were 91(73.3%) and males 33(26.6%). The average age was 72 years (Range 39-91 years). There were 57(45%) primary arthroplasty surgeries involving the shoulder, 5 (4%) were shoulder revision surgery, 5 (4%) Delta shoulders for rotator cuff problems and one(0.7%) excision arthroplasty. Shoulder arthroplasty due to trauma was done in 30(24.1%) cases. There were 15 (12%) primary elbow replacements,11(8.7%) revision elbows and 4(3.2%) patients had elbow arthroplasty for trauma. One(0.8%) patient had Polaris hemi Arthroplasty for metastasis in shoulder and one(0.8%) patient had total elbow replacement for metastasis. Pre-operative Haemoglobin ranged from 9.4G/dl to 17.9G/dl (average 12.7) and post-operative Haemoglobin 6.8G/dl to 14.3G/dl (average 10.6). Blood transfusion (100 units) was done in 53(42%) patients. The average number of transfusion per patient was 1.88 (Range 1 – 4 units) with 28(65.1%) transfusions in arthroplasties for trauma,12(75%) transfusions in revision arthroplasties and 13(10%) patients with other procedures. The two most important variables which were highly significant were revision and trauma ($p < 0.001$), while age was not very significant at all.

Conclusion: It is possible to predict patients undergoing upper limb arthroplasty that will need postoperative blood transfusion Shoulder and elbow arthroplasty in trauma and revision cases are strong predictor of blood transfusion.

Key words: Arthroplasty, Autologous blood, Transfusion, Scoring System

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INTRODUCTION

Since the early 80's the infectious risks associated with allogeneic blood transfusion have become a major medical and social issue, as a consequence there has been an increase in the use of alternatives. These alternatives include perioperative blood salvage acute normovolaemic haemodilution and autologous blood donation.[1] Despite development of these alternatives, the overall use of blood components has been declining.[2]The reason being fear of transmissible infections, high threshold for transfusing blood in non-emergency situations.[3-5] Given the high cost of these alternatives it would be desirable to predict which patient would be most likely benefit from this procedure. At present there is a point score system to predict the likelihood for blood transfusion for lower limb arthroplasty.[1] To the authors knowledge this is the first study to score the likelihood in upper limb arthroplasty.

METHODS

This study was a retrospective Cohort analysis of all shoulder and elbow arthroplasties performed at the Manor Teaching Hospital United Kingdom by the senior surgeon/Author from Jan 2010 to Dec 2014. A database of 183 patients that underwent elective surgery at a teaching hospital was used for analysis to determine potential variables that was predictive of blood transfusion. The predictor variables evaluated included type of arthroplasty (shoulder vs. elbow, primary vs. revision, trauma vs. arthritis.) and age, sex, and medical co morbidity. The outcome variable was allogeneic blood transfusion. The authors from experience were aware that revision and trauma were the patients that needed transfusion in some cases however the study was not exploratory but a method to confirm the experience. Data was analysed with SPSS(version 22) and the Binomial linear logistic regression. The data represented in tables where necessary.

RESULTS

A total of 183 patients were in the database. But 124 patients had complete records. Females were 91(73.3%) and males 33(26.6%). The average age was 72 years (range 39-91 years). A total of 43(34.6%) patients had arthroplasty following trauma including 30(69.7%) shoulder arthroplasties with 28(93.3%) having cemented arthroplasty and 2(6.6%) had Polaris uncemented arthroplasty. Elbow arthroplasty for trauma was done in 4(3.2%) cases. One(0.8%) patient had Polaris hemi Arthroplasty for metastasis in shoulder and one(0.8%) patient had total elbow replacement for metastasis. There were 57(45%) primary arthroplasty surgeries involving the shoulder of which 15(26.3%) were cemented hemiarthroplasty,8(14%) total shoulder replacement and 23(40.3%) Copeland resurfacing. Shoulder revision surgery was done in 5(4%) patients, 5(4%) Delta shoulders for rotator cuff problems and one(0.7) excision arthroplasty. There were 15(12%) primary elbow replacements in this study and 11(8.7%) revision elbows with 4 patients undergoing a 2 stage procedure and 2 one stage procedure. One patient underwent revision following failure of fixation following trauma.

Pre-operative Haemoglobin ranged from 9.4G/dl to 17.9G/dl (average 12.7) and post-operative Haemoglobin 6.8G/dl to 14.3G/dl (average 10.6).Six(4.7%) patients had post-operative Haemoglobin of less than 8.0G/dl. A total of 103(82%) were cross matched 2 units each (206 units) while the resurfacing were not cross matched as the authors experience was they did not require transfusion but to make sure there was no antibodies, a group and save was done. Blood transfusion (100 units) was done in 53(42%) patients. Average number of transfusion per patient was 1.88 (Range 1 – 4 units) with 28(65.1%) transfusions in arthroplasties for trauma,12(75%) transfusions in revision arthroplasties and 13(10%) patients with other procedures also needed transfusion.

DISCUSSION

Given the high cost of autologous blood donation for elective surgery and the risk of various transmissible diseases with allogeneic transfusion, it would be desirable to predict which patients are most likely to benefit from predicting the likelihood of blood transfusion in upper limb arthroplasty. Preoperative anaemia, revision surgery and increasing age were one of the most important predictor of blood transfusion after arthroplasty.[6,7] Transfusion threshold vary from centre to centre and increased hospital stay has direct relation with transfusion after arthroplasty.[8]

Table I: Beta Coefficients of our study.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	-.426	.488		-.873	.384
	Revision	.900	.225	.298	3.996	.000
	Co-morb	.257	.164	.110	1.566	.120
	Trauma	1.227	.149	.589	8.214	.000
	Shoulder	.241	.167	.107	1.449	.150
	Age	.000	.007	.003	.046	.963
	Sex	.215	.164	.097	1.315	.191

To understand this better we have shown three possible scenarios:

Scenario I: Requirement for blood transfusion Primary shoulder replacement

Variables	Beta Coefficients	Significance
Male/Female	.215	.191
Co-morbidities	.257	.120
Shoulder / Elbow	.241	.150
Revision	.900	.000
Trauma	1.227	.000
Constant	- .426	.384

Female + Shoulder replacement + comorbidity – Constant =?
0.215 + 0.241 + 0.257 -0.426 = 0.287 units

Scenario II: Requirement for blood transfusion Revision elbow replacement

Variables	Beta Coefficients	Significance
Male/Female	.215	.191
Co-morbidities	.257	.120
Shoulder / Elbow	.241	.150
Revision	.900	.000
Trauma	1.227	.000
Constant	- .426	.384

Male + Elbow replacement + Revision – Constant =?
0.215 + 0.241 + 0.900 – 0.426 = 0.930 units

Scenario III: Requirement for blood transfusion Trauma& Revision

Variables	Beta Coefficients	Significance
Male/Female	.215	.191
Co-morbidities	.257	.120
Shoulder / Elbow	.241	.150
Revision	.900	.000
Trauma	1.227	.000
Constant	- .426	.384

Male + Shoulder Replacement + trauma + revision – Constant =?
0.215 + 0.241 + 1.227 +0.900 – 0.426 = 2.157 units

Our analysis sought to build an ordinary linear regression model of the blood needs of patient undergoing shoulder or elbow arthroplasty. The dependent variable being units of allogeneic blood transfusion, the independent variables being age, sex, revision status, significant recorded co-morbidity, trauma diagnosis, and elbow or shoulder site. All were dichotomous variables except for age. The beta coefficients from an ordinary linear regression model are shown in table I.

But the overall fit of the model was not perfect (R square of 40.2) as shown in Table II. And this may simply be a function of the small sample size. However the two most important variables which were highly significant were revision and trauma ($p < 0.001$), which fitted nicely with what is peer experience. Age, surprisingly, was not very significant at all.

Table II: Our Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.657(a)	.431	.402	.763

It may be possible to devise a crude predictive model based upon adding each of the beta-coefficients for the presence or absence of the dichotomous variables and subtracting the constant. This can ignore age, as the co-efficient that one would multiply by age, was very small.

So female with shoulder trauma would be predicted to need 0.215 + 0.241 + 0.9 -0.426 units of blood i.e. .966 or one unit of blood. If she needed revision then would be predicted to need 0.215 + 0.241 + 1.227 + 0.9 -0.426 units of blood i.e. 2.157 or 2 units. One would have to put limits around these using 1.96 x the standard errors of the beta Co-efficient. This would give us a large range and as the data stand would not lead to a useful scoring system being developed. Hence, the predictive power of this model is quite weak at the moment; more

observations are clearly required, however the methodology has potential.

However, even this small sample clearly shows that certain variables have a significant impact upon blood needs and that a model with a useful degree of predictive power could be constructed from routinely collected hospital data.

The role of other variables such as more precise diagnostic coding and surgical technique has yet to be explored. Also the statistical methods used may not be the most appropriate for this purpose. Examining simply whether or not the patient needed blood using a binary logistic regression model may result in beta co-efficient that would more easily lend them to risk prediction. Also some more sophisticated analysis of the effects of co-linearity between variables may be needed, again being something which is only worth exploring with a bigger sample.

Different scoring system are present which showed increases morbidity with blood loss and transfusion.[9] Limited resources of allogeneic blood for transfusion and risk of infection people have also used auto transfusion of pre donation blood after surgery.[10,11]Cell saver Systems (CSS) were developed as an alternative to allogeneic transfusion but CSS transfusion may cause coagulation, infection and haemodynamic instability.[12,13]To decrease blood transfusion and reduction of blood loss Tranxemic acid was also tried with promising results but after all that the need of autologous blood transfusion after arthroplasty surgeries remain high.[14]

Various recommendations have been made for improving the cost- effectiveness of blood transfusion for elective surgery including avoidance of over transfusion. Different scoring has been postulated for transfusion after arthroplasty in hip and knee. The need for blood transfusion in patients undergoing upper limb arthroplasty and the importance predicting the lack of need for transfusion is as important as the actual amount transfused. Risk factors associated with autologous blood transfusion in shoulder arthroplasty were included age, gender, race, insurance status, hospital region, and hospital annual caseload and revision surgery.[15]

As the frequency of blood transfusion has decreased generally in recent years, our model may yet represent the true picture, as we found that most occasions there was no need for transfusion, however as earlier mentioned it may also be cost effective in instances to not cross match but just group and save as if and when blood not used is discarded.[6]

Before the institution of any specific recommendations it will be necessary to validate these results. The authors also conclude that a larger number of patients are needed to make the results more significant, i.e, the power of the study should be improved.

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CONCLUSION

It is possible to predict patients undergoing upper limb arthroplasty that will need postoperative blood transfusion. Shoulder and elbow arthroplasty in trauma and revision cases are strong predictor of blood transfusion.

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