Predicting Need for Allogeneic Transfusion Following Total Knee Arthroplasty

INTRODUCTION:
Given the substantial blood loss associated with TKA, transfusion of red blood cells is a common post-operative practice. In an effort to preemptively secure necessary blood resources to treat the possible onset of acute blood loss anemia, many centers encourage their patients to undergo autologous blood pre-donation (ABP) prior to surgery. Among the drawbacks of ABP programs are: pre-operative phlebotomy-induced anemia, more liberal transfusion practices by surgeons, and decreased cost-effectiveness when compared to heterologous blood transfusion. Transfusion with allogeneic blood as needed post-operatively is a cost-effective alternative to ABP. However, there is a need to pre-operatively identify patients at greatest risk for post-operative allogeneic transfusion (AllTx) in order to efficiently allocate limited blood resources. The objectives of this study were three-fold: 1) to determine the incidence of allogeneic blood transfusion following unilateral TKA at a large academic tertiary care medical center that discourages ABP, 2) to develop a model capable of predicting those patients that will require post-operative AllTx, and 3) to determine the accuracy of the model in an independent cohort of patients undergoing primary unilateral TKA.

METHODS:
We retrospectively evaluated 644 primary unilateral TKAs without ABP before September 2010 at our institution. Thirty-one independent variables were analyzed: age, gender, height, weight, body mass index, diagnosis; co-morbidities: hypertension, diabetes mellitus, coronary artery disease, bleeding dyscrasias, anemia, rheumatoid arthritis, chronic obstructive pulmonary disease; home medications: heparin, warfarin, aspirin, clopidogrel, non-steroidal anti-inflammatory drugs, corticosteroids, diuretics, iron, pre-operative laboratory values: prothrombin time, international normalized ratio, partial thromboplastin time, hemoglobin (Hgb), hematocrit (Hct), platelet count; intra-operative factors: anesthesia type, surgical time, tourniquet time, drain placement. The primary endpoint was AllTx.

Univariate analyses were used to identify statistically significant dependence between the primary outcome (the requirement of an allogeneic blood transfusion) and any one of the 31 independent parameters mentioned above. Two-tailed t-tests were performed to compare continuous variables satisfying criteria for normality, and chi-square tests were performed to compare categorical variables between the transfused group and the non-transfused group. A p-value equal to or less than 0.05 was considered to be significant. Variables found to display a statistically significant relationship in univariate analyses were included in a multivariate logistic regression analysis with step-wise elimination of insignificant variables. The final predictive equation was derived as an approximation of the multivariate logistic regression model.

RESULTS:
Of the 644 TKAs analyzed, 71 (11.0%) received an AllTx. Univariate analysis revealed a significant relationship between AllTx and age (p<0.0001), anemia (p=0.006), Hgb (p<0.0001), Hct (p<0.0001), surgical time (p=0.004), and tourniquet time (p<0.05) (Table 1). However, multivariate logistic regression analysis confirmed a significant relationship only between transfusion and age (p=0.0001), anemia (A, p<0.002, OR=5.5), Hgb (p<0.0001), and surgical time (ST, p<0.0001). We derived an equation for predicting the probability (ε) of needing an AllTx following primary TKA:

\[ E = \frac{.36e^{.06\text{Age} + 1.7\text{HCT} + 2.2\text{ST} - 5.7\text{Hgb}}}{1 + .36e^{.06\text{Age} + 1.7\text{HCT} + 2.2\text{ST} - 5.7\text{Hgb}}} \]

When applied to an independent cohort of 69 primary unilateral TKA procedures, this equation was 90% sensitive and 52.5% specific.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-Transfused Patients (n=573)</th>
<th>Transfused Patients (n=71)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>67.01 (18-92, 9.95)</td>
<td>72.46 (35-94, 10.13)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Anemia</td>
<td>8 (1.4)</td>
<td>5 (7.0)</td>
<td>0.006</td>
</tr>
<tr>
<td>Hgb (g/dL)</td>
<td>12.71 (8.7-18.7, 1.40)</td>
<td>11.5 (7.6-14.2, 1.52)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Hct (%)</td>
<td>38.87 (26.8-56.1, 3.89)</td>
<td>35.57 (24.5-43.7, 1.52)</td>
<td>&lt;0.0001</td>
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<tr>
<td>ST (min)</td>
<td>109.1 (65-315, 25.7)</td>
<td>123.6 (76-270, 40.51)</td>
<td>0.004</td>
</tr>
<tr>
<td>Tourniquet Time (min)</td>
<td>89.58 (0-225, 25.19)</td>
<td>95.89 (16-180, 28.13)</td>
<td>&lt;0.050</td>
</tr>
</tbody>
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DISCUSSION:
We conclude that advanced age, anemia, decreased pre-operative Hgb, and prolonged surgical times place patients at increased risk of needing an AllTx. Anemia and Hgb are two parameters which may be improved pre-operatively to decrease the risk for AllTx.

SIGNIFICANCE:
Based on the results of this study, we urge surgeons to recognize patients that are likely to require post-operative allogeneic blood transfusion based on patient age, co-morbidity of anemia, pre-operative hemoglobin level, and surgical time. For patients experiencing symptomatic post-TKA anemia, we recommend a conservative transfusion approach with allogeneic blood.

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REFERENCES: