Pre-operative predictors of the requirement for blood transfusion following total hip replacement

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We have reviewed prospective data on 1016 patients who underwent unilateral total hip replacement to establish the pre-operative risk factors associated with peri-operative blood transfusion. Most patients who required transfusion were older and were of lower weight, height, pre-operative haemoglobin level and body mass index than patients who were not transfused.

Multivariate analysis revealed that only the pre-operative haemoglobin level and the patients' weight were identified as significant independent factors increasing the need for transfusion (p < 0.001). A haemoglobin level below 12 g/dl was associated with a threefold increase in transfusion requirement.

Some loss of blood is inevitable during hip replacement surgery, and many patients require transfusion.1-3 Allogenic blood carries the risk of disease transmission and immunological reaction. In an attempt to reduce the risks, pre- and peri-operative interventions such as autologous blood donation,4 red cell salvage,5 medication with erthropoietin,6 haemostatic agents7 and normovolaemic haemodilution8 are practised in many centres.

Although pre-donation of autologous blood has been shown to reduce the requirement of allogenic blood transfusion, the risk of bacterial infection of stored blood9 remains and haemolytic transfusion reactions can still occur. Furthermore, there is evidence that patients who donate blood pre-operatively are more likely to require transfusion after surgery,3,10 and blood which is not used has to be discarded.

The identification of pre-operative variables associated with the need for transfusion will reveal the transfusion risk. In this study we examine the relationship between blood transfusion and body-weight, height, body mass index (BMI), gender and age in patients undergoing primary total hip replacement surgery at one centre. We also examine the relationship between these factors and the likelihood of transfusion in patients after primary total hip replacement.

Patients and Methods
Data were collected prospectively from 1058 patients who had primary total hip replacements at Victoria Hospital, Kirkcaldy between 1998 and 2002. Our transfusion protocol stipulated that patients with a post-operative haemoglobin level of less than 8.5 g/dl were transfused. Patients with a post-operative haemoglobin level of between 8.5 g/dl and 10 g/dl were only transfused if they had relevant symptoms, and those with a haemoglobin level above 10 g/dl were not transfused. Pre-operative cross matching of blood was performed only in patients with a pre-operative haemoglobin level below 11 g/dl. Patients’ age, weight, height and gender were recorded during a routine pre-operative assessment. Blood was taken one week before surgery to measure the pre-operative haemoglobin level; post-operative haemoglobin was measured on the day following operation, 17 to 24 hours after surgery. Of the 1058 patients who had hip replacement, 42 were excluded because the surgery was bilateral, leaving 1016 patients who had unilateral procedures. We also collected data related to transfusion requirements from 160 patients who underwent primary total hip replacement in the ten months before the transfusion protocol was instituted. We compared the rates of blood cross-matching before and after the implementation of the transfusion protocol.

Spinal anaesthesia was given to 851 patients; 61 received combined spinal and epi-
dural anaesthesia and 79 patients had a general anaesthetic; five patients were given an epidural combined with general anaesthetic and 20 a spinal combined with general anaesthetic. Hypotensive anaesthesia was not used. All patients received thromboprophylaxis consisting of dalteparin sodium, 5000 units subcutaneously once a day starting on the evening before the operation; this was discontinued on discharge from hospital.

Student’s t-test was used to compare differences in pre-operative haemoglobin, height, weight and BMI between patients who were or were not transfused. The relationship between transfusion requirements and categorical variables was examined using the chi-squared test. The relationship between transfusion requirements and all variables adjusted for one another was examined using forward stepwise multiple logistic regression.

Results
Blood transfusions (mean quantity 2.1 units) were given to 244 of 1016 patients (24%); 44 of 642 patients (6.8%) with a post-operative haemoglobin level of greater than 10 g/dl were transfused, indicating noncompliance with the transfusion protocol guidelines. In 26 patients the decision was made to transfuse blood during (13) or soon after surgery (13), all before the post-operative haemoglobin was measured. In general the patients who required transfusion were older, with a lower weight, height, pre-operative haemoglobin level and BMI than patients who were not transfused (Table I); 186 of 626 women (30%) required transfusion, compared with 58 of 390 men (15%) (p < 0.001).

Using multivariate analysis with forward stepwise multiple logistic regression, only pre-operative haemoglobin and patient’s weight correlated significantly with the need for transfusion (p < 0.001). The increased incidence of transfusion in women was explained by their lower pre-operative haemoglobin and weight. Regression analysis was repeated with exclusion of the 26 patients who were transfused during surgery or before the haemoglobin was measured; this did not alter the result.

The percentage risk of transfusions required in relation to pre-operative haemoglobin and weight is shown in Figures 1a and 1b. The number of patients in each pre-operative haemoglobin range is shown in Table II. Patients with a pre-operative haemoglobin below 12 g/dl had a 70%
operative haemoglobin level of >11 g/dl prior to the implementation of the protocol was 100% and 21.9%, respectively. Although cross-matching was performed in all patients with a haemoglobin level of >11 g/dl who had surgery prior to its introduction.

Cross-matching was performed in all patients with a haemoglobin level of >11 g/dl who had surgery prior to its introduction. The incidence of transfusion in patients with a haemoglobin level of 12 g/dl or less was 34% and 78% higher in patients with a weight <70 kg and a pre-operative haemoglobin level of <11 g/dl resulted in a 78% reduction in the number of units of blood cross matched. Furthermore, our protocol would have reduced the cross-match rate by 71% if instituted in the 160 patients with a haemoglobin level of >11 g/dl who had surgery prior to its introduction.

We would like to thank Lorraine McComiskie, Janette McDonald and Ann Simpson for data collection and Dr Robert A. Elton, PhD for assistance with statistical analysis. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

## Table II. Number of patients in relation to pre-operative haemoglobin range

<table>
<thead>
<tr>
<th>Pre-operative haemoglobin (g/dl)</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>10</td>
</tr>
<tr>
<td>10 to 10.9</td>
<td>28</td>
</tr>
<tr>
<td>11 to 11.9</td>
<td>75</td>
</tr>
<tr>
<td>12 to 12.9</td>
<td>182</td>
</tr>
<tr>
<td>13 to 13.9</td>
<td>300</td>
</tr>
<tr>
<td>14 to 14.9</td>
<td>232</td>
</tr>
<tr>
<td>15 to 15.9</td>
<td>135</td>
</tr>
<tr>
<td>&gt;15.9</td>
<td>54</td>
</tr>
</tbody>
</table>

## Table III. Cross-matching rates before and after the implementation of a transfusion protocol. Absolute figures relate to patients with a pre-operative haemoglobin level of >11 g/dl

<table>
<thead>
<tr>
<th></th>
<th>Before the protocol</th>
<th>After the protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross matched</td>
<td>160</td>
<td>215</td>
</tr>
<tr>
<td>No cross match</td>
<td>0</td>
<td>78</td>
</tr>
<tr>
<td>Total number of patients</td>
<td>160</td>
<td>978</td>
</tr>
<tr>
<td>Proportion cross-matched (%)</td>
<td>100</td>
<td>21.9 (p &lt; 0.05)</td>
</tr>
<tr>
<td>Proportion transfused (%)</td>
<td>29</td>
<td>21.9</td>
</tr>
</tbody>
</table>

## Discussion

Allogenic blood transfusion is associated with a spectrum of immune-related reactions, from pyrexia and self-limiting urticaria to haemolytic transfusion reactions with a risk of mortality. Blood transfusion also poses the risk of disease transmission with viral pathogens, hepatitis B and C, HIV, and human parvovirus. Although patient pre-donation of blood has been shown to reduce the need for autologous blood transfusion, re-transfusion of autologous blood is not a risk-free solution; there remains an incidence of sepsis as a result of bacterial contamination of stored blood. Recently there has been concern over the possible transmission of variant Creutzfeldt-Jacob disease through allogenic blood transfusion. Furthermore, non-transfused autologous blood is often wastefully discarded and pre-donation can result in pre-operative anaemia.

The identification of patients with increased need of transfusion is therefore desirable in order to reduce that incidence. Previous studies have shown that between 33% and 74% of patients require blood transfusion after unilateral total hip arthroplasty. The decision to transfuse may be based on a number of factors including post-operative haemoglobin levels and intra-operative blood loss but also pre-operative haemoglobin level. It may be further influenced by the application of local transfusion guidelines.

Compared with those who were not transfused, those who were on average older, with a lower pre-operative haemoglobin, height, weight and BMI of which the closest correlation was with pre-operative haemoglobin and weight. A pre-operative haemoglobin level of 12 g/dl or less and a weight of <70 kg increased the likelihood of allogenic transfusion more than threefold and twofold respectively. Our results largely support those of Feagan et al who investigated transfusion requirements in patients undergoing elective hip and knee arthroplasty. In both series pre-operative haemoglobin levels and weight were independent predictive factors for transfusion risk but Feagan et al also identified age as a significant predictive factor.

We found women twice as likely to require transfusion than men after total hip replacement. Gender differences have been described in previous studies and in this series appeared to be related to women having a lower weight and pre-operative haemoglobin level, both of which were identified as significant independent factors increasing the risk of requiring transfusion. Following the introduction of the transfusion protocol our policy of limiting pre-operative cross-matching to patients with a pre-operative haemoglobin level of >11 g/dl resulted in an 8% reduction in the number of units of blood cross matched. Furthermore, our protocol would have reduced the cross-match rate by 71% if instituted in the 160 patients with a haemoglobin level of >11 g/dl who had surgery prior to its introduction.

References