Summary

Introduction
In the autumn of 2003, the West Midlands Regional Transfusion Committee set up an audit group to co-ordinate audit in blood transfusion in our region. Patients undergoing primary arthroplasties continue to use around 6% of all allogeneic blood, and this group was therefore selected as the subject of our first regional audit.

Audit Aims
The aims of the audit were to provide comparative data across the region of transfusion practice in elective primary joint replacement surgery, and to determine the number of inappropriate transfusions. We also sought to determine the feasibility of such audit without reference to patient notes.

Audit Plan
All hospitals performing hip and knee replacement surgery within the West Midlands were invited to take part. Data was gathered retrospectively for the period 01/10/03 and 31/12/2003. We asked for at least 50 cases for each of the hip and knee patients. Data was gathered from the Blood Bank and Haematology Computers, and the Patient Administration System with no access to the patient notes.

Results
13 sites took part provided data on 1751 cases in total (867 hip replacements and 884 knee replacements). We found that 41% of hips and 19% of knees received allogeneic blood and there was wide variation across sites (27 to 67% for hips and 0 to 39% for knees). Although it was not possible to identify patients who had received inappropriate blood, it was possible to identify patients who had been over transfused (defined in this audit as a post transfusion haemoglobin of >12g/dl). Again we found wide variation. Overall, of patients who received a transfusion, at least 11% of hips and 15% of knees were over transfused, with a wide range between sites (0 to 31% for hips and 0 to 55% for knees). A clear relationship between preoperative haemoglobin level and transfusion rate was demonstrated.

We have successfully demonstrated that audit of this nature can be carried out without reference to patient notes, though with current IT systems there are some limitations related to the timing of transfusions.

Commentary
This audit has identified wide-ranging rates of transfusion across the region, suggesting that there is considerable room for improvement at some sites. The reasons for this variation are not clear from this audit though are likely to include surgical technique, the use of cell salvage and clear transfusion policies. The relationship between pretransfusion haemoglobin and need for transfusion serves to emphasise the potentially important role of preoperative assessment clinics in reducing the use of allogeneic blood in this patient group.
**Introduction**

The SHOT report and ‘Better Blood Transfusion 2’ have repeatedly endorsed the value of clinical audit locally, regionally and nationally. With this in mind, in the autumn of 2003, the West Midlands Regional Transfusion Committee set up an audit group to co-ordinate audit in blood transfusion in our region. The aim of the group is to organize two regional audits a year, to allow all trusts the opportunity to take part in at least one. This audit represents the first coordinated by that group.

Patients undergoing primary arthroplasties continue to be major users of blood and the Northern Regional audit of 'Where blood goes', showed that around 6% of all allogeneic blood goes to this group of patients. Although a great deal of progress has been made in recent years towards reducing the use of red cells, it is clear that practice still varies, and there is considerable scope for further improvement.

**Audit Aims**

The aims of the audit were:

- To provide comparative data across the region of transfusion practice in elective primary joint replacement surgery.
- To determine the number of apparently inappropriate transfusions taking place on the basis of haemoglobin levels.
- To determine the feasibility of such audit without reference to patient notes.

**Audit Plan**

All hospitals performing hip and knee replacement surgery within the West Midlands were invited to take part. They were asked to retrospectively gather data on all primary hip and knee replacement surgery over a period of 3 months between 01/10/03 and 31/12/2003. We asked for at least 50 cases for each of the hip and knee patients. Patients were identified through records in the orthopaedic departments and theatres, and data was gathered from the Blood Bank and Haematology Computers, and the Patient Administration System. No access was made to the patient notes.

There was some delay in gathering data, and the final data was submitted in August 2004.

**Results**

The comparative data in this report has been anonymised, and in all of the following graphs your site is represented by the number .... The overall mean result for all the cases is represented by ‘ALL’. An individual site report will be issued shortly.
Participation

13 sites took part in the audit and provided data on 1751 cases in total (867 Hip replacements and 884 knee replacements) the contribution from each site is shown below.

![Graph showing participation](image)

Patient Characteristics

There was little variation in patient characteristics across the sites. The mean age of all patients was 69 years (Median 71, range 16 to 94 years), and the mean length of hospital stay was 8 days (Median 7 days, range 2 to 75 days). Two sites (2 and 12) did not supply length of stay data for all cases.

![Graph showing mean age](image)
There were 11 in hospital deaths,
• 8 in hip surgery (0.9%).
• 3 in knee surgery (0.3%).

**Haemoglobin Monitoring**

BCSH guidelines suggest that the need for transfusion should be judged on both blood loss and the haemoglobin level. There are no guidelines for the postoperative checking of the haemoglobin level, though it could be considered reasonable practice to check the haemoglobin before and after surgery, before and after any transfusions given, and before discharge. We therefore asked for the following:
• A preoperative haemoglobin result nearest to the time of surgery.
• A postoperative result from within 2 days of surgery
• A postoperative result taken between 3 and 11 days postoperatively.

The results are shown in the table below and indicate that the vast majority of patients have a preoperative haemoglobin and at least one postoperative haemoglobin checked.

<table>
<thead>
<tr>
<th></th>
<th>Preoperative Sample</th>
<th>Postoperative Sample</th>
<th>Day 3-11 Sample</th>
<th>Day 1-11 Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Surgery</td>
<td>98%</td>
<td>90%</td>
<td>50%</td>
<td>97%</td>
</tr>
<tr>
<td>Knee Surgery</td>
<td>99%</td>
<td>90%</td>
<td>42%</td>
<td>98%</td>
</tr>
<tr>
<td>Overall</td>
<td>99%</td>
<td>90%</td>
<td>46%</td>
<td>97%</td>
</tr>
</tbody>
</table>

The preoperative sample was on average taken 18 days prior to surgery for hips, and 17 days for knees.

Mean Haemoglobin levels pre and postoperatively varied very little between sites. The overall figures are given in the table below.
<table>
<thead>
<tr>
<th></th>
<th>Mean Hb in Hip Surgery (g/dl)</th>
<th></th>
<th>Mean Hb in Knee Surgery (g/dl)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Hips</td>
<td>Untransfused</td>
<td>Transfused</td>
<td>All Knees</td>
</tr>
<tr>
<td>Pre op</td>
<td>13.6</td>
<td>14.0</td>
<td>13.1</td>
<td>13.7</td>
</tr>
<tr>
<td>Post op</td>
<td>10.4</td>
<td>10.8</td>
<td>10.0</td>
<td>10.9</td>
</tr>
<tr>
<td>Day 3-11</td>
<td>10.4</td>
<td>10.4</td>
<td>10.4</td>
<td>10.4</td>
</tr>
</tbody>
</table>

**Transfusions**

Details of transfusions are given in the table.

<table>
<thead>
<tr>
<th></th>
<th>Number of Patients audited</th>
<th>Number of patients transfused</th>
<th>% of patients transfused</th>
<th>Number of units transfused</th>
<th>Transfusion rate units/operation</th>
<th>Number of units received per transfused patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>1751</td>
<td>525</td>
<td>30%</td>
<td>1170</td>
<td>0.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Hip surgery</td>
<td>867</td>
<td>358</td>
<td>41%</td>
<td>818</td>
<td>0.9</td>
<td>2.3</td>
</tr>
<tr>
<td>Knee surgery</td>
<td>884</td>
<td>167</td>
<td>19%</td>
<td>352</td>
<td>0.4</td>
<td>2.1</td>
</tr>
</tbody>
</table>

At least 25 patients (17 Hip and 8 knee) received more than one transfusion.

Due to the nature of the data gathering without reference to the patients notes it has not always been possible to determine the exact timing of transfusions.

- Overall 41% of transfusions were given at an uncertain time during or after surgery.
- 34% were given perioperatively – defined as during or within 24 hours of surgery. This was the same for both hip and knee surgery.

The transfusion rates between sites varied widely. The following comparative charts show the transfusion rates for each operation and site. These are expressed both as the percentage of patients transfused and the mean amount of blood required for every patient going to theatre. The data in each case has been ordered according to ‘performance’.
Transfusion Rate in Hip Surgery
Mean Units of Blood per Patient

Transfusion Rate in Total Knee Surgery
Percentage of Patients Transfused

Transfusion Rate in Knee Surgery
Mean Units of Blood per Patient
Preoperative Haemoglobin Level and Transfusion Rate

Transfusion rate according to preoperative haemoglobin levels are shown in the following charts.

It is clear that patients who are anaemic preoperatively require more blood. However, there was no threshold over which patients were never transfused. The incidence of transfusion with a preoperative haemoglobin of less than 12g/dl is 77% for hip surgery and 50% for knee surgery, compared with 37% and 15% respectively if the preoperative haemoglobin is above 12g/dl.
Transfusion Rate According to Preoperative Haemoglobin

<table>
<thead>
<tr>
<th>Preoperative Hb - g/dl</th>
<th>Transfusion rate (units/patient)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 to 10</td>
<td>0</td>
</tr>
<tr>
<td>10 to 12</td>
<td>0.5</td>
</tr>
<tr>
<td>12 to 14</td>
<td>1</td>
</tr>
<tr>
<td>14 to 16</td>
<td>1.5</td>
</tr>
<tr>
<td>&gt;16</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Hips

Knees

Over Transfusion

It has not been possible to assess the appropriateness of transfusion based on the pretransfusion haemoglobin as was hoped. This has been due to the way that the data has been collected without reference to the patients notes, in that it has not been possible to determine the timing of every transfusion and therefore which haemoglobin was the pretransfusion result.

It has however been possible to identify the post transfusion results and an assessment of appropriateness has been based on this information together with the following:

- BCSH Guidelines state that:
  - Transfusion is not indicated when the Hb is greater than 10g/dl
  - Transfusion back to a normal Hb is not necessary
- The mean increment from one unit of blood is approximately 1.0g/dl

We have therefore defined ‘over transfusion’ as a ‘post transfusion haemoglobin of greater than 12g/dl’. This is not to say that patients with a post transfusion Hb>12g/dl did not require transfusion at all, but that they received too much.

A post transfusion Hb was available for 392 (75%) transfused patients (77% of patients transfused in hip surgery and 73% of those transfused in knee surgery). The post transfusion haemoglobin range is shown in the graph below.
The mean post transfusion haemoglobin was 10.6g/dl for both hip and knee surgery.

Figures for over transfusion are given in the table. Percentages have been given based on both the total transfused population and on only those for whom a post transfusion haemoglobin was available.

<table>
<thead>
<tr>
<th>Percentage of patients being over transfused</th>
</tr>
</thead>
<tbody>
<tr>
<td>All transfused patients</td>
</tr>
<tr>
<td>All Patients</td>
</tr>
<tr>
<td>Hip surgery</td>
</tr>
<tr>
<td>Knee surgery</td>
</tr>
</tbody>
</table>

Comparative data on over transfusion is given in the charts below. The charts only use figures derived using the total transfused population and therefore may represent an under-estimate.
Over Transfusion in Knee Surgery

Examples of over transfusion

A 63 year old lady had a unilateral total knee replacement. Her preoperative Hb was 13.9g/dl. She did not have a haemoglobin taken within 2 days of surgery and she received 2 units of red cells at an uncertain time. Hb 5 days postoperatively was 16.1.

A 73 year old lady had a unilateral total hip replacement. Her preoperative Hb was 15.6g/dl. She received 1 unit of blood perioperatively. Hb 3 days post operatively was 13.8.

Under Transfusion

Untransfused patients

2 patients had a post op Hb below the BCSH threshold for transfusion and were reportedly not transfused. However, in both cases the second post op Hb had risen to an acceptable level which suggests that the patients were either transfused, or were haemodilute at the time of the first sample. In both cases the post op sample was taken 2 days post op.

8 patients had a day 3-11 haemoglobin below the BCSH threshold and were apparently not transfused. The most striking of these was a 93 year old patient who was apparently discharged with an Hb of 6.8g/dl.

Transfused patients

9 patients undergoing hip and 4 undergoing knee surgery had a post transfusion Hb below the BCSH threshold for transfusion.

As the audit was not designed to look for under transfusion the validity of these findings has to be questioned.
Coding

We asked for coding information to assess its usefulness as a means of gathering patient details for audit.

98% of operations were coded correctly.
32% of transfusions were coded.

The majority of transfusions were not coded, and it would therefore seem that this is not a reliable way of identifying transfused patients for audit purposes.

Use of cell salvage and Near patient testing (an additional survey)

Following the analysis of the data we undertook an additional survey of participating hospitals and asked whether cell salvage and near patient haemoglobin testing were used on their site. No attempt was made to correlate their use with individual patients however.

We found that 12 of 13 sites used some form of cell salvage for at least some of the knee replacements. 3 used it occasionally for hip replacement surgery, though 0 of 13 used it regularly. 7 of the 13 sites had facilities for near patient testing, and 1 had recently purchased equipment.

An analysis of transfusion rates and over transfusion was carried out according to whether cell salvage and near patient testing were available. The results are summarised in the tables below.

<table>
<thead>
<tr>
<th>Cell Salvage (CS)</th>
<th>Number of sites</th>
<th>Transfusion Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>3</td>
<td>49%</td>
</tr>
<tr>
<td>No CS</td>
<td>10</td>
<td>41%</td>
</tr>
<tr>
<td>Knee Surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>12</td>
<td>18%</td>
</tr>
<tr>
<td>No CS</td>
<td>1*</td>
<td>55%</td>
</tr>
</tbody>
</table>

*Site 11

<table>
<thead>
<tr>
<th>Near Patient Testing (NPT)</th>
<th>Number of sites</th>
<th>Transfusion Rate</th>
<th>Over transfusion (% of transfused patients with post Tx Hb&gt;12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Surgery</td>
<td>NPT</td>
<td>41%</td>
<td>10%</td>
</tr>
<tr>
<td>No NPT</td>
<td>6</td>
<td>41%</td>
<td>13% (9% **)</td>
</tr>
<tr>
<td>Knee Surgery</td>
<td>NPT</td>
<td>17%</td>
<td>9%</td>
</tr>
<tr>
<td>No NPT</td>
<td>6</td>
<td>24% (18% **)</td>
<td>29% (7% **)</td>
</tr>
</tbody>
</table>

**Excludes site 11 as an outlier

It should be noted that site 11 used neither cell salvage nor near patient testing and had particularly high transfusion, and over transfusions rates in knee surgery. When the results for this site are removed from the analysis, no differences are found between those sites with cell salvage or near patient testing, and those without.
Commentary

This audit has collected transfusion data on a large number of patients undergoing orthopaedic surgery from 13 centres across the West Midlands. It has included teaching, district general and specialist orthopaedic hospitals as well as hospitals from the private sector. It can therefore be considered representative of transfusion practice in the region.

This audit was carried out without the benefit of reviewing the patient notes. This has had benefits in terms of ease of data collection, however it has also resulted in a number of limitations:

- Inability to determine the exact time that a transfusion has been given, and therefore which Hb samples were pretransfusion.
- Lack of haemoglobin data from near patient testing results.
- Lack of clinical patient information that may have influenced the decision to transfuse.

Judging the appropriateness of a transfusion requires two separate questions:

- Was a transfusion indicated?
- Was an appropriate amount of blood given?

and the limitations in this audit have meant that the first of these questions cannot be addressed. We have however been able to address the second question, and have identified that 12% of all transfused patients were over transfused. This figure is probably an underestimate as post transfusion data was only available from 75% of transfused patients.

Great variation in transfusion practice has been demonstrated. The transfusion rate varied between 27 and 67% in hip replacement surgery, and between 0 and 39% in knee replacements. The reasons for this variation have not been addressed by this audit, though are likely to include a combination of variations in surgical practice, inappropriate transfusion and uptake of cell salvage technologies. It is interesting to note that high transfusion rate does not always correlate with a high over transfusion rate, which suggests that surgical practice (including the use of cell salvage) remains an important factor in determining blood loss.

The additional survey of the use of cell salvage and near patient testing sought only to determine whether the facilities were available, and not whether any individual patient benefited from them. This survey lacks the sensitivity to detect any benefit and this area should clearly be a topic for future audit.

A clear relationship was observed between preoperative haemoglobin and transfusion rate. This emphasizes the important role that preoperative assessment clinics can play in reducing the need for blood transfusion. Anaemia is known to be common in the community and the proper investigation and management of anaemia preoperatively is crucial.

There are currently no guidelines for how to deal with anaemia preoperatively, or how this should be defined. From this audit however, it would be reasonable to suggest that efforts should be made to ensure that all patients have an Hb of at least 12g/dl preoperatively, as those below this level have a markedly increased need for transfusion. The need for transfusion remains at all Hb levels however, and a case could be put for optimizing all patients...
haemoglobin levels preoperatively to ensure that any individual has the best possible chance of avoiding transfusion.

The timing of the postoperative haemoglobin sample is important, and may be responsible for some over transfusion. A sample taken too early may give an unexpectedly low result due to haemodilution, leading to inappropriate transfusion. It has not been possible in this audit to consider this issue, but is one worth considering when writing local protocols.

It is beyond the scope of this audit to make any specific recommendations, though we hope that the data presented will be useful to clinicians and will stimulate local initiatives to improve practice.

References

http://bmj.bmjournals.com/cgi/reprint/325/7368/803.pdf

The clinical use of red cell transfusion. British Journal of Haematology 2001; 113, 24-31
http://www.bcshguidelines.co.uk/pdf/bjh2701.pdf

http://www.dh.gov.uk/assetRoot/04/01/22/93/04012293.pdf

Acknowledgements

Many thanks go to all those who have collected the data for this audit from across the West Midlands. The data collectors have included transfusion practitioners, blood bank managers and consultant anaesthetists. We also thank John Grant-Casey and David Dalton from the National Blood Service for their assistance in collating the data.

Finally we would like to thank the West Midlands Regional Transfusion Committee for their support for the work of the audit group.

Contact Details

Dr Craig Taylor
Consultant Haematologist
National Blood Service
Vincent drive
Edgbaston
Birmingham
B15 2SG

Tel: 0121 253 4015
craig.taylor@nbs.nhs.uk

Dr Matthew Lumley
Consultant Haematologist
Good Hope Hospital
Rectory Road
Sutton Coldfield
Birmingham
B75 7RR

Tel: 0121 378 2211
matthew.lumley@goodhope.nhs.uk
Appendix A  

**Form A:** During the study period please complete a form for every patient who has undergone primary total hip replacement or primary knee replacement whether or not they are transfused.

**Patient/Operation Details**

<table>
<thead>
<tr>
<th>Audit ID</th>
<th>Male</th>
<th>Female</th>
<th>dd</th>
<th>mm</th>
<th>yyyy</th>
</tr>
</thead>
</table>

Date of Birth

Diagnosis (if known)  
- Osteoarthritis  
- Rheumatoid

Other (Specify)

Date of Surgery

Surgeon (unique number)

Total Hip Replacement  
Total Knee Replacement  
Unilateral  
Bilateral

**Haemoglobin Results** *(Please tick or insert figures in relevant box)*

<table>
<thead>
<tr>
<th>Date of Test</th>
<th>Result g/dl</th>
<th>Not available</th>
</tr>
</thead>
<tbody>
<tr>
<td>dd</td>
<td>mm</td>
<td>yyyy</td>
</tr>
</tbody>
</table>

Pre op Hb

Post Op Hb within 48 hours of surgery

Post op days 3-11

**Red Cell Transfusions**

Number of units transfused intra-operatively *(or within 24 hours of surgery)*

Number of units transfused post operatively *(> 24 hours post op)*

Total number of units transfused  
*(Please fill this in if it is not possible to distinguish intra/post operative transfusion)*

**Coding Information**

Operation Confirmed?  
- Yes  
- No

Length of post-op Stay  
Days

Blood transfusion code?  
- Yes  
- No