Predicting the Probability of Red Cell Transfusion in Surgical Patients

Romi Sinha
Kathryn Robinson
Susan Ireland

SA Health &
SA BloodSafe Program
Objectives

> To better predict the probability of red cell transfusion in ADULT patients undergoing:

  • **Cardiothoracic**
    Isolated CABG or on pump valve replacement
  • **Colorectal**
    Left or right sided procedures
  • **Joint replacement surgery**
    Primary hip or primary knee replacement

Based on pre-operative factors

*Help provide better local information for clinicians, patients & inform implementation of PBM strategies*
SA Public Hospital Red Cell Use by Specialty Related Group (SRG) from Data Linkage: Surgical users around 30%
Orthopaedics > Cardiothoracic > Vascular > Colorectal > General Surgery, highest surgical users (SRG) by total units transfused, with activity adjusted, surgical usage declining compared to increases in medical specialties.

Proportion of red cells transfused which are either above or below the expected result based on 06-07 experience.
Transfusion rate by FY for primary joint replacement (LMH, TQEH, RAH, RGH) from SA Data Linkage
National PBM Guidelines

- Optimise haemoglobin
- Minimise blood loss
- Tolerance of normovolaemic anaemia
Methods

> Linked electronic database for SA public sector containing clinical, epidemiological, transfusion & laboratory data was used
> Jan 2009 to June 2010
> 5 public metro hospitals
> 3 admission categories in dataset:
  - Elective: admission of patient which can be delayed for at least 24 hours
  - Elective booking list: admission of patient from designated booking list for surgery
  - Emergency: admission of patient for treatment which is necessary & should occur within 24 hours.

2/3 of cardiac & colorectal were elective and 95% of orthopaedic

SA Health
Methods & Statistical analysis

> Hb, MCV, MCH, ferritin (if available) & eGFR 8 weeks prior to surgery included
> Pre-op Hb defined as last Hb prior to surgery but within preceding 8 weeks
> Anaemia defined as Hb below lab reference range: < 135 g/L for men & < 115 g/L for women
> Logistic regression model that predicts probability of transfusion using pre-operative factors was performed: Sex, Age, Hb level
  • A linear predictor (xb) was generated (logit of predicted probability & its standard error)
  • 95% of confidence interval (CI) of linear predictor was calculated (xb +/- 1.96*SE)
  • Further logit scale was transformed to probability scale
## Results: Patient Demographics

<table>
<thead>
<tr>
<th>Surgery Type</th>
<th>Patients</th>
<th>Age (median, IQR)</th>
<th>Males: Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABG</td>
<td>621</td>
<td>65 (57-73)</td>
<td>76:24</td>
</tr>
<tr>
<td>Valve</td>
<td>390</td>
<td>70 (58-79)</td>
<td>63:37</td>
</tr>
<tr>
<td>Colorectal (Right)</td>
<td>305</td>
<td>72 (65-80)</td>
<td>54:46</td>
</tr>
<tr>
<td>Colorectal (Left)</td>
<td>332</td>
<td>68 (58-77)</td>
<td>54:46</td>
</tr>
<tr>
<td>THR</td>
<td>530</td>
<td>70 (61-77)</td>
<td>40:60</td>
</tr>
<tr>
<td>TKR</td>
<td>643</td>
<td>70 (63-76)</td>
<td>37:63</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2821</strong></td>
<td><strong>70 (58-79)</strong></td>
<td><strong>53:47</strong></td>
</tr>
</tbody>
</table>
Results: Pre-operative Anaemia

Overall rate of pre-op anaemia 28% (778/2821)
   36% of males, 18% of females (laboratory RR)
   27% of males, 27% of females (WHO definition)

Pre-op anaemia & age
   20% <65 years
   31% 65–85 years
   44% of >85 years

Red cell indices
   14% MCV <80 & 23% MCH <27 in anaemic patients
   2.4% MCV <80 & 5.3% MCH <27 in non-anaemic patients

Only 0.5% had ferritin/iron studies (by State Path) in 8 weeks prior to surgery

Anaemia and renal function:
   17.5% eGFR <45ml/min
   eGFR < 15ml/min in 2%, eGFR of 15–29 in 4.5%, eGFR of 30–44 in 11%,
   eGFR of 45–60 in 19% (not done in 3%)
## Transfusion rates in anaemic & non-anaemic patients

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Non-anaemic patients: transfusion rates</th>
<th>Anaemic patients: transfusion rates</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABG</td>
<td>(204/441) 46.3%</td>
<td>(127/180) 70.6%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Valve</td>
<td>(129/266) 48.5%</td>
<td>(104/124) 83.9%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Colorectal (Left)</td>
<td>(34/215) 15.8%</td>
<td>(54/117) 46.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Colorectal (Right)</td>
<td>(12/136) 8.8%</td>
<td>(80/169) 47.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>THR</td>
<td>(90/427) 21.1%</td>
<td>(36/103) 35.0%</td>
<td>0.003</td>
</tr>
<tr>
<td>TKR</td>
<td>(53/558) 9.5%</td>
<td>(25/85) 29.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>(522/2043) 25.6%</td>
<td>(426/778) 54.8%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Pre-op anaemia, red cell indices & transfusion rates by procedure
Transfusion rates by procedure, sex & pre-op Hb

- CABG
- Valve
- Colorectal (left)
- Colorectal (right)
- THA
- TKA

Legend:
- Males
- Females

Pre-op Hb (g/L):
- 150-190
- 140-149
- 130-139
- 120-129
- 110-119
- 100-109
- 80-99

Number of transfusions in each category.
<table>
<thead>
<tr>
<th>Independent Predictors Logistic Regression</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (Female)</td>
<td>1.42</td>
<td>1.151 - 1.772</td>
<td>0.001</td>
</tr>
<tr>
<td>Age &gt; 65 years</td>
<td>1.73</td>
<td>1.413 - 2.120</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CABG</td>
<td>14.75</td>
<td>10.561 - 20.626</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Valve</td>
<td>14.11</td>
<td>9.918 - 20.076</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Colorectal (Left)</td>
<td>1.96</td>
<td>1.345 - 2.882</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Colorectal (Right)</td>
<td>1.19</td>
<td>0.796 - 1.803</td>
<td>0.387</td>
</tr>
<tr>
<td>THR</td>
<td>2.31</td>
<td>1.658 - 3.211</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hb 80 - 99 g/L</td>
<td>31.3</td>
<td>17.871 - 54.724</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hb 100 - 109 g/L</td>
<td>11.9</td>
<td>7.644 - 18.620</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hb 110 - 119 g/L</td>
<td>6.6</td>
<td>4.610 - 9.451</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hb 120 - 129 g/L</td>
<td>4.3</td>
<td>3.151 - 5.975</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hb 130 - 139 g/L</td>
<td>2.2</td>
<td>1.617 - 2.944</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hb 140 - 149 g/L</td>
<td>1.0</td>
<td>0.728 - 1.407</td>
<td>0.944</td>
</tr>
</tbody>
</table>

Compared with TKR, Compared with Hb of 150 g/L or more
Predicted Probability of Transfusion: Cardiac

CABG, males

CABG, females

Valve Surgery, males

Valve Surgery, females

Haemoglobin (g/L)
Predicted Probability of Transfusion: Colorectal

Colorectal (Left), males

Colorectal (Left), females

Colorectal (Right), males

Colorectal (Right), females
Predicted Probability of Transfusion: Arthroplasty

THR, males

THR, females

TKR, males

TKR, females

Haemoglobin (g/L)
Limitations

>Predicted probability is based on data collected from different hospitals during a fixed period of time
>Variability in practices amongst centres, surgical teams, individual surgeons
>Model does not take into account:
  >Comorbidities, use of anti-haemostatic agents, weight, acuity, complexity of surgery…..
  >Intra-operative and post-operative variables such as variation in blood loss, use of blood conservation strategies, transfusion practices
>Needs validation
Conclusions

> Not new or unexpected findings
> Useful to help local clinicians better understand risk and inform patients
> Help guide local PBM strategies and priorities
> Reinforces the importance of pre-op Hb
> Mild anaemia should not be overlooked!
Overview

The diagnosis and management of iron deficiency anaemia (IDA) remains a challenge. It continues to be an important public health problem in Australia with the World Health Organization (WHO) estimating that 8% of preschool children, 12% of pregnant women and 15% of non-pregnant women of reproductive age in Australia are anaemic, with IDA a major cause.

Red cell transfusion remains an overused treatment for IDA. In physiologically compensated patients, transfusion carries unnecessary risks and fails to replenish deficient iron stores. This course examines the diagnosis, management and treatment of IDA, and this module will focus on IDA and its likely causes.

Press play to view the video.
Is anaemia present? 

Is haemoglobin below laboratory reference range for age, sex and gestation?

Yes  No

Full history and examination is essential in all cases.
“The red blobs are your red blood cells
The white blobs are your white cells
The brown blobs are coffee, we need to talk.”