The Concept of Patient Blood Management

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Conflicts of interest

Honoraria for lecturing and travel reimbursement from: Abbott, Bayer, B. Braun, Edwards, GlaxoSmithKline, Medtronic, Fresenius Kabi, MSD, Novo Nordisk, Pfizer, Sanofi-Aventis, Schering AG, Servier and Vifor Pharma.

Co-author of the trauma bleeding management guidelines which were supported by unrestricted grants from CSL Behring (Germany) and LFB Biomedicaments (France).
Patient Blood Management (PBM) is the timely application of evidence-based medical and surgical concepts designed to maintain hemoglobin concentration, optimize hemostasis and minimize blood loss in an effort to improve patient outcome.
Implementing patient blood management...
Blood product transfusions
Changing the paradigm

The Traditional Concept
• Blood products are an effective therapeutic intervention

The New Concept
• Transfusion of blood products is an undesirable outcome to be avoided

Blood still kills: six strategies to further reduce allogeneic blood transfusion-related mortality

Vamvakas EC, Blajchman MA. Transf Med Rev 2010
The culture of transfusion

Type of blood components transfused in different hospitals

If this blood was for myself or my child, would I accept the transfusion in these circumstances?
Key speaker: Bill Clinton

The 2013 Summit focused on three addressable challenges that are within our power to solve now:

• Challenge #1: Failure to Rescue
• Challenge #2: Medical Errors
• Challenge #3: Transfusion Overuse
Why the shift to PBM

- Infusion risks
- Supply issues
- Economics
- Ethics and legal considerations
- Patient outcomes
- Behaviour-based practice

Five Drivers Shifting the Paradigm from Product-Focused Transfusion Practice to Patient Blood Management

AXEL HOFMANN,\textsuperscript{a,b} SHANNON FARMER,\textsuperscript{b,c,d} ARYEH SHANDER\textsuperscript{e}

1) the \textcolor{red}{\textbf{aging}} population with a leveraged demand for blood products opposed to a shrinking donor base;

2) the growing awareness that transfusion is a complex service involving many different cost centers within a hospital and representing a multiple of the blood product \textcolor{red}{\textbf{cost}};

3) the continuous effort to protect blood pools from known, new, or re-emerging \textcolor{red}{\textbf{pathogens}} while facing uncertainty over their potentially long silent carrier states;

4) the emerging evidence that transfusion is an independent risk factor for \textcolor{red}{\textbf{adverse outcomes}};

5) a \textcolor{red}{\textbf{lack of evidence for benefit}} of transfusion for the vast majority of recipients
Blood is safer but... still unsafe!

Causes of allogeneic blood transfusion-related deaths as a percentage of all deaths reported

Risk for fatality from RBC transfusion contrasted with other life-events

Blood transfusion is not an effective means of managing perioperative anaemia

• Negative impact on patient outcomes
  – A large-scale review by an expert panel demonstrated that blood transfusion was independently associated in a dose-dependent manner with:
    • Higher mortality and morbidity rates, nosocomial infection, septicaemia, pneumonia, delayed wound healing, stroke, myocardial infarction, renal impairment, thromboembolism, ARDS, acute lung injury and multisystem organ failure

Association of Blood Transfusion With Increased Mortality in Myocardial Infarction

A Meta-analysis and Diversity-Adjusted Study Sequential Analysis

Saurav Chatterjee, MD; Jørn Wetterslev, MD, PhD; Abhishek Sharma, MD; Edgar Lichstein, MD; Debabrata Mukherjee, MD, MS

- N = 729 (10 for analysis)
- A systematic search of publications (Jan 1966 – March 2012) utilizing
  - MEDLINE, EMBASE, CINAHL, Scopus, Web of Science, and Cochrane Central Register of Controlled Trials databases
- All cause mortality in MI (Transfusion group 18.2% vs. non transfused group 10.2%)
- Multivariate analysis - blood transfusion associated with a higher risk for mortality
  - independent of baseline hgb, nadir hgb, and change in hgb during the hospital stay
- Blood transfusion or a liberal blood transfusion strategy is associated with higher all-cause mortality rates

Arch Intern Med. 2012 Dec 24:1-8
Blood transfusions and the subsequent risk of cancers in the United States elderly

Regina Riedl, Eric A. Engels, Joan L. Warren, Andrea Berghold, Winnie Ricker, and Ruth M. Pfeiffer

- N = 552,951 elderly cases with 100,000 frequency-matched controls
- Transfusions received 0 to 12, 13 to 30, and 31 to 48 months before cancer diagnosis or selection date
- Transfusions received 0 to 12 months before cancer diagnosis and/or selection were associated with significantly elevated risk of:
  - Overall cancer (OR, 2.05; 95% CI, 1.95-2.16), cancer of the stomach; cancer of the colon; cancer of the liver, kidney, renal pelvis, and/or ureter; lymphoma; myeloma; and leukemia
  - Overall cancer risk increased with the number of transfused periods (p-trend < 0.0001)
  - Risk of overall cancer and specific sites was elevated 0 to 12 months after blood transfusion

Transfusion. 2013 Jan 16
Risk vs. Benefit

“The issue (no longer) is whether or not blood transfusion is harmful, but the inflection point at which it is associated with more harm than benefit.”

Rao et al, JAMA 2005;292(13)
Benefit of transfusion?*

TRICC Trial

Lack of sustainable benefit of transfusion

Kaplan-Meier estimates of 30-day survival by transfusion strategy\(^1\)

<table>
<thead>
<tr>
<th>Time (day)</th>
<th>Restrictive</th>
<th>Liberal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>249</td>
<td>253</td>
</tr>
<tr>
<td>3</td>
<td>244</td>
<td>248</td>
</tr>
<tr>
<td>6</td>
<td>238</td>
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<td>9</td>
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<td>235</td>
<td>245</td>
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<tr>
<td>15</td>
<td>234</td>
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<tr>
<td>18</td>
<td></td>
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<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No. at risk
Restrictive: 249, 244, 238, 236, 235, 234
Liberal: 253, 248, 247, 245, 245, 242

Time zero was just after randomisation (12 hours before surgery). Hazard ratio, 1.28 (95% confidence interval, 0.60-2.73) (\(P=0.99\)) for restrictive strategy vs liberal strategy.

- Randomised controlled studies including TRACS (Transfusion Requirements After Cardiac Surgery) have shown no benefit from liberal transfusion\(^1,2\)

1. Adapted from: Hajjar LA et al. JAMA 2010; 304: 1559-1567
2. Hofmann A et al. The Oncologist 2011; 16 (suppl 3): 3-11
Liberal or restrictive transfusion in high-risk patients after hip surgery

- **Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair (FOCUS)**
  - Primary outcome: death or inability to walk 10 feet without assistance at 60 days
  - No difference between liberal and restrictive transfusion group
  - Low rate of cardiovascular adverse events in both groups
  - 65% fewer units transfused in restrictive group and half received no transfusion

*Carson, JL et al. NEJM. December, 2011*
Multicenter pilot study
51 pts. restrictive
49 pts. liberal
➢ 55 years
➢ > 4 days in ICU
Transfusion Strategies for Acute Upper Gastrointestinal Bleeding

Cándid Villanueva, M.D., Alan Colomo, M.D., Alba Bosch, M.D., Mar Concepción, M.D., Virginia Hernandez-Gea, M.D., Carles Aracil, M.D., Isabel Graupera, M.D., María Poca, M.D., Cristina Alvarez-Urturi, M.D., Jordi Gordillo, M.D., Carlos Guarner-Argenta, M.D., Miquel Santaló, M.D., Eduardo Muñiz, M.D., and Carlos Guarner, M.D.

- N = 921 patients – 2 groups [Restrictive strategy (n = 461) vs. Liberal strategy (n = 460)]
- 51% Restrictive strategy vs. 15% Liberal strategy, did not receive transfusions (P<0.001)
- The probability of survival at 6 weeks was higher in the restrictive-strategy vs. liberal-strategy group (95% vs. 91%)
- Further bleeding - 10% restrictive group vs. 16% liberal group (P=0.01)
- Adverse events - restrictive-strategy 40% vs. liberal-strategy 48% (P=0.02)
- Restrictive strategy significantly improved outcomes in patients with acute upper gastrointestinal bleeding

N Engl J Med. 2013 Jan 3;368(1):11-21
Patient Blood Management: The Three Pillars

1st Pillar
- Pre-op anemia screening
- Refer for further evaluation if necessary
- ESAs
- Intravenous Iron
- Note: anemia is a contraindication for elective surgery

2nd Pillar
- Identify and manage bleeding risk and anticoagulants
- ANH
- Cell Salvage
- DDAVP
- TXA, Amicar
- Topical hemostatics
- Meticulous surgical hemostasis
- Avoid secondary hemorrhage
- Minimize phlebotomy

3rd Pillar
- Optimize hemodynamics
- Optimize ventilation and oxygenation
- Low hemoglobin threshold for transfusion
- Minimize oxygen consumption
- Avoid/treat infections promptly

© Axel Hofmann/Shannon Farmer - SHEF Meeting Perth August 2010
### The pillars of patient blood management

<table>
<thead>
<tr>
<th>1st Pillar</th>
<th>2nd Pillar</th>
<th>3rd Pillar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optimize erythropoiesis</strong></td>
<td><strong>Minimize blood loss &amp; bleeding</strong></td>
<td><strong>Harness &amp; optimize physiological reserve of anemia</strong></td>
</tr>
<tr>
<td>- Detect anemia</td>
<td>- Identify and manage bleeding risk</td>
<td>- Assess/optimize patient’s physiological reserve and risk factors</td>
</tr>
<tr>
<td>- Identify underlying disorder(s) causing anemia</td>
<td>- Minimizing iatrogenic blood loss</td>
<td>- Compare estimated blood loss with patient-specific tolerable blood loss</td>
</tr>
<tr>
<td>- Manage disorder(s)</td>
<td>- Procedure planning and rehearsal</td>
<td>- Formulate patient-specific management plan using appropriate blood conservation modalities to minimize blood loss, optimize red cell mass, and manage anemia</td>
</tr>
<tr>
<td>- Refer for further evaluation if necessary</td>
<td>- Preoperative autologous blood donation (in selected cases or when patient choice)</td>
<td>- Restrictive transfusion thresholds</td>
</tr>
<tr>
<td>- Treat suboptimal iron stores/iron deficiency/anemia of chronic disease/iron-restricted erythropoiesis</td>
<td>- Identify and manage bleeding risk</td>
<td>- Optimize cardiac output</td>
</tr>
<tr>
<td>- Treat other hematocrit deficiencies</td>
<td>- Minimizing iatrogenic blood loss</td>
<td>- Optimize ventilation and oxygenation</td>
</tr>
<tr>
<td>- Note: Anemia is a contraindication for elective surgery</td>
<td>- Procedure planning and rehearsal</td>
<td>- Restrictive transfusion thresholds</td>
</tr>
</tbody>
</table>

**Preoperative**
- Timing surgery with hematological optimization

**Intraoperative**
- Meticulous hemostasis and surgical techniques
- Blood-sparing surgical techniques
- Anesthetic blood conserving strategies
- Autologous blood options
- Pharmacological/hemostatic agents

**Postoperative**
- Stimulate erythropoiesis
- Be aware of drug interactions that can increase anemia
- Vigilant monitoring and management of post-operative bleeding
- Avoid secondary hemorrhage
- Rapid warming/maintain normothermia (unless hypothermia specifically indicated)
- Autologous blood salvage
- Minimizing iatrogenic blood loss
- Hemostasis/anticoagulation management
- Prophylaxis of upper gastrointestinal hemorrhage
- Avoid/treat infections promptly
- Be aware of adverse effects of medication

**Hofmann A et al. The Oncologist 2011;16:3-11**
Can Patient Blood Management reduce the need for transfusions?
Reducing the amount of blood transfused by changing clinicians' transfusion practices

![Units Transfused](image)

Tinmouth A. Transfusion 2007:132S-136S
The benefits of patient blood management (PBM)

rHuEPO = recombinant human erythropoietin
PAD = preoperative autologous blood donation,
CS = intra- or postoperative cell salvage

Spahn DR. Anesthesiology 2010; 113: 482-495
Red cell units transfused
1994 – 2010

Eastern Maine Medical Center
Annual Red Cell Transfusions

Admissions
FY 05/06: 20,156
FY 09/10: 20,717
Patients transfused:
1994 - 2011
Number of allogeneic transfusions in the Netherlands from 2000 to 2010

The economic benefits of PBM

- Dutch hospitals began to implement PBM in 2002, especially for major orthopaedic surgery
  - There is a legal requirement for a complete preoperative assessment 3 – 4 weeks before all elective surgery
- Annual reports from the Dutch blood bank showed a 12% decline in the total number of allogeneic transfusions between 2000 – 2009
  - This decrease was concurrent with an increase in healthcare usage
- Hospital admissions increased from 1,600 to 2,300 per year per 10,000 inhabitants between 2000 – 2009
- PBM is estimated to have saved a net cost of €100 million nationwide in the Netherlands every year*

*Based on the current price of an allogeneic transfusion of RBCs at €204

The benefits of patient blood management (PBM)

PBM can reduce blood transfusion rate in surgical patients by 75%.

Transfusion rates all cases: CABG, Valve, CABG/Valve

Eastern Maine Medical Center
April 2008 – March 2011

Transfusion rate in 2006: 48%

- April 2008: 23%
- May 2008: 24%
- June 2008: 17%
- July 2008: 21%
- August 2008: 27%
- September 2008: 21%
- October 2008: 28%
- November 2008: 29%
- December 2008: 25%
- January 2009: 19%
- February 2009: 21%
- March 2009: 24%
- April 2009: 21%
- May 2009: 20%
- June 2009: 17%
- July 2009: 21%
- August 2009: 28%
- September 2009: 29%
- October 2009: 25%
- November 2009: 19%
- December 2009: 21%
- January 2010: 24%
- February 2010: 21%
- March 2010: 17%
- April 2010: 21%
- May 2010: 25%
- June 2010: 19%
- July 2010: 21%
- August 2010: 28%
- September 2010: 29%
- October 2010: 25%
- November 2010: 19%
- December 2010: 21%
- January 2011: 24%
- February 2011: 21%
- March 2011: 14%
Cardiac surgery and transfusions

• With reduction in transfusion rate from 48% to approximately 20%, there was a reduction in:
  – Perioperative AMI
  – New onset renal failure
  – Perioperative infection
  – Stroke
  – Length of stay
  – No change in mortality
Exposure to allogeneic transfusion
Institute of Cardiology 1999
Transfusion practice

- Mangano’s EPI II study
- 70 centers
- 16 countries
- 5065 patients
- Romania: 104 pts/year 2000

<table>
<thead>
<tr>
<th></th>
<th>inop (%)</th>
<th>postop (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC</td>
<td>9-100</td>
<td>25-87</td>
</tr>
<tr>
<td>FFP</td>
<td>0-98</td>
<td>3-95</td>
</tr>
<tr>
<td>Plts</td>
<td>0-51</td>
<td>0-39</td>
</tr>
</tbody>
</table>

Pts with NO transfusion: RBC 33% FFP 77% Plt 83%

Romania: RBC 32% FFP 52% Plt 46%

<table>
<thead>
<tr>
<th>Number of units per transfused patient</th>
<th>inop</th>
<th>postop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>total</td>
<td>RO</td>
</tr>
<tr>
<td>RBC</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>FFP</td>
<td>3.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Plts</td>
<td>6.3</td>
<td>4.5</td>
</tr>
</tbody>
</table>

*Snyder-Ramos S et al. Transfusion 2008:1284*
Exposure to allogeneic transfusion in our department

Filipescu D et al. NATA 2002, SRATI 2010
Reducing the amount of blood transfused by changing clinicians’ transfusion practices

Tinmouth A. Transfusion 2007 132S-136S
Elements for change

The elements required to create change in physician transfusion practice include:

1. A desire for change
2. Providing a new behavior/practice
3. The change must be viewed as safe and simple
4. It must be viewed as non-threatening to autonomy

Tinmouth A. Transfusion. 2007;47:132S-136S.
Promoting responsible blood product use: change of behavior

Francis JJ et al. Implementation Science 2009:70
Transfusion profile

4445 patients having cardiac procedures with CPB over 4 years.

- More than 50% do not get transfusion.
- Patients who receive > 10 units of blood are in 90th percentile.
- 10-20% of patients consume 80% of blood products.

The majority of RBCs and FFP (>70%) were given to a minority of patients (<12%).

Ferraris, Int. J. Angiology, 2006

Ravn HB et al. J Cardiothorac Vasc Anaesth 2011:36-41
3,865 pts. High risk of bleeding or clinically relevant diffuse bleeding after protamine

Gorlinger K et al. Anesthesiology 2011
Goal- directed therapy

- **Principles of the POC - supported coagulation management algorithm:**
  1. Optimization of haemostatic preconditions
  2. Reversal of residual heparin effects with protamine
  3. Fibrinogen substitution
  4. FFP transfusion or PCC for substitution of factors
  5. Platelet transfusion
  6. Factor XIII or rFVIIa as a rescue therapy

Gorlinger K et al. Anesthesiology 2011
Repeat ROTEM after each specific intervention

CT IN > 240 sec
CT HEP/CT IN < 0.8

- Yes
  - Repeat dose of Protamine 30Ui/kg

- No

A10 EX ≤ 40mm and A10 FIB ≤ 10mm

- Yes
  - Cryoprecipitate 10-15 UI or Fibrinogen 25-75 mg/kg

- No

CT EX > 90 sec or CT HEP > 280 sec

- Yes
  - PCC 20-40 UI/kg or FFP 15-25 ml/kg

- No

A10 EX ≤ 40mm or A10 FIB > 10mm

- Yes
  - Transfusion of PC

- No

MEA ????

- No

CT EX < 80 sec A10 EX > 15mm or A10 FIB > 50mm

- Yes
  - DDAVP, Factor XIII conc. or Factor rVIIa
Declamping of the Aorta

ROTEM

MCF FIB = 0 mm?

Yes

Cryoprecipitate
10-15 U
or
Fibrinogen
20-50mg/kg

Before Protamine

No

A10 Ex < 30mm and A10 FIB > 6mm

Yes

Order of PC

No

Optimize before weaning from CPB:
Temp > 36°, pH > 7.2
Ca i > 1mmol/l, Hb > 8g/dl

Yes

Protamine

Diffuse bleeding after protamine
Our goal-directed therapy in aortic dissection surgery

PRBC packed red blood cells
PC platelet concentrates
FFP fresh frozen plasma
CP cryoprecipitate

Filipescu D. et al.  NATA  2013
Our experience

No

Re-exploration | CRRT | Sepsis | Stroke | In-hospital mortality

Filipescu D. et al. NATA 2013
Perioperative Administration of Fibrinogen is Associated with Increased Risk of Postoperative Thromboembolic Complications after Cardiac Surgery

Carl-Johan Jakobsen¹*, Mariann Tang² and Lars Folkesen¹

<table>
<thead>
<tr>
<th>Factors</th>
<th>Neurological dysfunction</th>
<th>Myocardial infarction</th>
<th>Postoperative dialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (EuroSCORE)</td>
<td>1.16 (0.97 - 1.39)</td>
<td>0.97 (0.83 - 1.14)</td>
<td>1.16 (1.00 - 1.33)</td>
</tr>
<tr>
<td>Female</td>
<td>0.50 (0.23 - 1.11)</td>
<td>1.17 (0.63 - 2.16)</td>
<td>1.02 (0.60 - 1.75)</td>
</tr>
<tr>
<td>Patient factors comp a)</td>
<td>0.99 (0.83 - 1.19)</td>
<td>0.90 (0.73 - 1.10)</td>
<td>1.32 (1.17 - 1.48)</td>
</tr>
<tr>
<td>Neurological dysfunction</td>
<td>3.10 (1.46 - 6.57)</td>
<td>1.68 (0.73 - 3.86)</td>
<td>1.27 (0.61 - 2.62)</td>
</tr>
<tr>
<td>S-creatinine &gt;200 μmol/L</td>
<td>0.92 (0.19 - 4.38)</td>
<td>0.40 (0.05 - 3.10)</td>
<td>8.21 (4.12 - 16.5)</td>
</tr>
<tr>
<td>Preop. platelets inhibitors</td>
<td>0.57 (0.17 - 1.97)</td>
<td>0.73 (0.30 - 1.84)</td>
<td>0.55 (0.25 - 1.20)</td>
</tr>
<tr>
<td>Euroscore Cardiac state</td>
<td>1.13 (0.94 - 1.37)</td>
<td>1.29 (1.13 - 1.49)</td>
<td>1.27 (1.12 - 1.44)</td>
</tr>
<tr>
<td>Valve surgery</td>
<td>2.12 (1.09 - 4.12)</td>
<td>0.85 (0.47 - 1.52)</td>
<td>1.43 (0.84 - 2.45)</td>
</tr>
<tr>
<td>Aortic surgery</td>
<td>3.57 (1.35 - 9.46)</td>
<td>2.05 (0.72 - 5.84)</td>
<td>0.98 (0.36 - 2.69)</td>
</tr>
<tr>
<td>Other than aortic/valve/CABG</td>
<td>1.11 (0.41 - 3.01)</td>
<td>0.20 (0.05 - 0.88)</td>
<td>1.52 (0.80 - 2.89)</td>
</tr>
<tr>
<td>Perioperative Aprotinin</td>
<td>1.10 (0.34 - 3.50)</td>
<td>1.27 (0.39 - 4.12)</td>
<td>3.42 (1.74 - 6.77)</td>
</tr>
<tr>
<td>Perioperative NovoSeven</td>
<td>0.74 (0.09 - 6.30)</td>
<td>1.05 (0.12 - 8.89)</td>
<td>0.88 (0.20 - 3.99)</td>
</tr>
<tr>
<td><strong>Perioperative Fibrinogen</strong></td>
<td><strong>2.69 (1.24 - 5.87)</strong></td>
<td><strong>1.79 (0.79 - 4.05)</strong></td>
<td><strong>3.77 (2.02 - 7.03)</strong></td>
</tr>
</tbody>
</table>

Non Medline journal!
New goal: treat preoperative anemia and reduce the 1-3 U transfusion!

- Data from 188 consecutive patients who underwent CABG
- Mean perioperative transfusion rate of RBCs: 1.48 U
- In anaemic patients: 2.48 (±1.98)

## Anaemia is a predictor of red blood cell transfusions across surgery types

<table>
<thead>
<tr>
<th></th>
<th>Total patients (N)</th>
<th>Anaemic patients (%)</th>
<th>Patients transfused with allogeneic RBCs (%)</th>
<th>Non-anaemic</th>
<th>Anaemic</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABG</td>
<td>777</td>
<td>24</td>
<td>48</td>
<td></td>
<td>76</td>
<td>&lt;0.001</td>
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<tr>
<td>HECO</td>
<td>148</td>
<td>30</td>
<td>11</td>
<td></td>
<td>58</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>THR</td>
<td>1401</td>
<td>16</td>
<td>28</td>
<td></td>
<td>54</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TKR</td>
<td>1296</td>
<td>18</td>
<td>28</td>
<td></td>
<td>60</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3622</strong></td>
<td><strong>19</strong></td>
<td><strong>32</strong></td>
<td><strong>62</strong></td>
<td></td>
<td><strong>&lt;0.001</strong></td>
</tr>
</tbody>
</table>

CABG: Coronary artery bypass graft  
HECO: Hemicolecotomy  
THR: Total hip replacement  
TKR: Total knee replacement

Blood Transfusion: Who is at risk

The 1-3 units of RBC transfused

Goodnough LT, Shander A. A&A 2012
Proposed algorithm for the detection, evaluation, and management of preoperative anaemia

Hb < 120 g/l for females
Hb < 130 g/l for males

Evaluation necessary

Iron status?

Ferritin < 30 µg/l and/or TSAT < 15-20%
Ferritin 30-100 µg/l and/or TSAT > 20%
Ferritin >100 µg/l and/or TSAT > 20%

Serum creatinine
Glomerular filtration rate

Rule out iron deficiency
Inflammation/chronic disease

Low
Normal

Vitamin B₁₂ end/or folic acid

Chronic kidney disease (CKD)

Iron deficiency
Referred to gastroenterologist to rule out malignancy

Iron therapy
1) Oral iron in divided doses
2) IV iron if cannot tolerate oral iron, GI uptake problems (Hepcidin) or short timeline

Referral to nephrologist

No response

Anemia of chronic disease
Erythropoietin-stimulating agent therapy
Folic acid or vitamin B₁₂ therapy

No response

Normal
Low
The Future

• In the future we should aim to reduce the transfusion risk for all patients to the level of the ALARA (as-low-as-reasonably-achievable) risk

Spahn D & Vamvakas EC. Blood Transf 2013:172-174
So, why practice Patient Blood Management?

Blood transfusion is not an effective means of managing postoperative anaemia

The concept of PBM is aimed at optimising erythropoiesis, minimising blood loss and optimising the patient’s physiological tolerance of anaemia

Introduction of a PBM programme for surgical patients has been shown to:
- Significantly reduce the need for blood transfusion
- Significantly reduce serious complications, length of hospital stay and postoperative mortality
- Be cost-effective