Patient Blood Management (PBM)
A New Perioperative Transfusion Concept

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Austria
Disclosure - Conflicts of Interest

In the past years I received honoraria and travel support for consulting and lecturing from

- Australian Red Cross Blood Service
- Austrian Federal Ministry of Health
- Abbott
- CSL Behring
- Fresenius Kabi
- Haemonetics
- Janssen-Cilag
- Novo Nordisk
- Ortho Biotech
- Pentapharm/TEM
- Vifor Pharma
- Western Australian Department of Health

...
What is patient blood management?

• PBM views a patient’s own blood as a valuable and unique natural resource that should be conserved and managed appropriately.

• PBM employs a patient-specific perioperative multidisciplinary, multimodal team approach to optimising, conserving and managing patients own blood.

• PBM aims to identify patients at risk of transfusion and provide a managed plan aimed at reducing or eliminating the need for allogeneic transfusion with an acceptable risk of anemia.
Patient Blood Management: The Pragmatic Solution for the Problems with Blood Transfusions


EDITORIALS

New Blood, Old Blood, or No Blood?
John W. Adamson, M.D.

Patient blood management

WHA63.12 adopted by resolution May 21, 2010:

„Bearing in mind that patient blood management means that before surgery every reasonable measure should be taken to optimize the patient’s own blood volume, to minimize the patient’s blood loss and to harness and optimize the patient-specific physiological tolerance of anaemia following WHO’s guide for optimal clinical use (three pillars of patient blood management)“
Meeting of the Advisory Committee on Blood Safety and Availability

A Notice by the Health and Human Services Department on 05/06/2011

On June 8, 2011, the Committee will be asked to review and comment on WHA 63.12 regarding the availability, safety and quality of blood products. [http://apps.who.int/iblibwha/pdf_files/WHA63/A63_Rt2-en.pdf](http://apps.who.int/iblibwha/pdf_files/WHA63/A63_Rt2-en.pdf) Specifically the Committee will be asked to review the current status of safe and rational use of blood products in patient blood management and assess the current status in the U.S.
The review of the 2001 NHMRC/ASBT Clinical Practice Guidelines for the Use of Blood Components is being undertaken with funding and project management provided by the National Blood Authority (NBA) on behalf of all governments. The NBA has facilitated the formulation of a Steering Committee, Expert Working Group, and Clinical/Consumer Reference Groups.

NHMRC Guidelines Development:

Module 1 - Critical Bleeding/Massive Transfusion
Module 2 - Peri operative
Module 3 - Medical
Module 4 - Intensive Care
Module 5 - Obstetric
Module 6 - Paediatric/Neonates

The Real World
Rationale for PBM

• Blood supply issues
• Cost of blood
• Transfusion practice variability
• Transfusion safety and effectiveness
Source of swine flu discovered!!
Pathogens – Costly Fear

The AUSTRALIAN RED CROSS discarded 33,600 liters of donated blood as the result of fears that it was contaminated with dengue fever following an outbreak of the disease in northern Queensland in late 2009 and 2010, according to a report in the Sunday Herald Sun.

That loss ... accounted for about 7% of its overall blood supply.
A Multicenter, Randomized, Controlled Clinical Trial of Transfusion Requirements in Critical Care (Complications during ICU-stay)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Restrictive (n=418)</th>
<th>Liberal (n=420)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>55 (13.2%)</td>
<td>88 (21.0%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>106 (25.4%)</td>
<td>122 (29.0%)</td>
<td>0.22</td>
</tr>
<tr>
<td>Infectious</td>
<td>42 (10.0%)</td>
<td>50 (11.9%)</td>
<td>0.38</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>13 (3.1%)</td>
<td>19 (4.5%)</td>
<td>0.28</td>
</tr>
<tr>
<td>Neurologic</td>
<td>25 (6.0%)</td>
<td>33 (7.9%)</td>
<td>0.28</td>
</tr>
<tr>
<td>Shock</td>
<td>67 (16%)</td>
<td>55 (13.1%)</td>
<td>0.23</td>
</tr>
<tr>
<td>Any</td>
<td>205 (49.0%)</td>
<td>228 (54.3%)</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Hebert P.C. et al: NEJM 340, 409-17, 1999
### Table 2. Frequencies of Composite Infection and Ischemic Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Not Transfused</th>
<th>Transfused</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>n</td>
</tr>
<tr>
<td>Infection*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nadir hematocrit &lt;21</td>
<td>52</td>
<td>1</td>
</tr>
<tr>
<td>Nadir hematocrit ≥21 and &lt;24</td>
<td>390</td>
<td>16</td>
</tr>
<tr>
<td>Nadir hematocrit ≥24 and &lt;27</td>
<td>1176</td>
<td>42</td>
</tr>
<tr>
<td>Nadir hematocrit ≥27</td>
<td>2056</td>
<td>82</td>
</tr>
<tr>
<td>Ischemia†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nadir hematocrit &lt;21</td>
<td>52</td>
<td>1</td>
</tr>
<tr>
<td>Nadir hematocrit ≥21 and &lt;24</td>
<td>390</td>
<td>13</td>
</tr>
<tr>
<td>Nadir hematocrit ≥24 and &lt;27</td>
<td>1175</td>
<td>40</td>
</tr>
<tr>
<td>Nadir hematocrit ≥27</td>
<td>2053</td>
<td>72</td>
</tr>
</tbody>
</table>

Intraoperative Transfusion of 1 U to 2 U Packed Red Blood Cells Is Associated with Increased 30-Day Mortality, Surgical-Site Infection, Pneumonia, and Sepsis in General Surgery Patients

Propensity and risk adjusted odds ratios (95% CI) for 30-day mortality and morbidity by level of intraoperative transfusion. Both morbidity and mortality risks were substantially increased after only 1 U RBC transfusion intraoperatively and continued to increase with increasing units. Circles, mortality; squares, morbidity.

Influence of Erythrocyte Transfusion on the Risk of Acute Kidney Injury after Cardiac Surgery Differs in Anemic and Nonanemic Patients

Rationale for PBM

• Blood supply issues
• Cost of blood
• Transfusion practice variability
• Transfusion safety and effectiveness
Centers – Both Evaluations

Centers 2004/5

Additional centers 2009/10
Pre-operative blood request

- Ordered and not transfused: 60.3%
- Not ordered and transfused: 11.0%
- Ordered and transfused: 28.7%
Prevalence of Preoperative Anemia

Female

Male

Patients

ACBG 32.1% 24.9%

HTEP 17.6% 16.3%

KTEP 0% 5%

10% 20% 30% 40%
RBC Transfusion in Patients with Preoperative Anemia

No preop. Anemia
Preop. Anemia

ACBG
HTEP
KTEP

1.6
0.5
1.4
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
N-RBC’s
Treatment of Preoperative Anemia

Epo and Iron
Iron
No Treatment
Percentage of Patients Transfused in Different Centers (HTEP)
Percentage of Patients Transfused in Different Centers (KTEP)
Rationale for PBM

• Blood supply issues
• Cost of blood
• Transfusion practice variability
• Transfusion safety and effectiveness
Impact of the Ageing Population on Blood Demand

- The 70- to 80-year-olds have an eightfold higher RBC consumption than 20- to 40-year-olds.

Fig. 2. RBC usage per capita by age in Finland 2002 to 2006. Current annual RBC usage in Finland is 50 units per 1000 inhabitants.
Implications of demographics on future blood supply: a population-based cross-sectional study

Absolute numbers in 2005 and projection for 2020

Greinacher et al: TRANSFUSION **,**,**,**,**.
Rationale for PBM

• Blood supply issues
• **Cost of blood**
• Transfusion practice variability
• Transfusion safety and effectiveness
Blood Safety Measures
– Another Cost Driver

America's Blood Centers
Safety Measures and Median Red Cell Service Fees in Current Dollars
1985 - 2009

- Source: America's Blood Centers, 2004
Activity Based Cost of Transfusion from a Provider’s Perspective

Cost of transfusion outcome
Frequency and outcomes of blood products transfusion across procedures and clinical conditions warranting inpatient care: an analysis of the 2004 healthcare cost and utilization project nationwide inpatient sample database.

- Retrospective cohort study of all hospitalisations in the US in 2004 (n=38.66 million) to assess in-hospital outcomes associated with blood transfusion.
- 5.8% (2.33 million) transfused
- After adjustment for age, gender, comorbidities, admission type or DRG transfusion associated with:
  - 1.7 increased odds of death (P<0.0001)
  - 1.9 increased odds of infection (P<0.0001)
  - 2.5 days longer LOS
  - $17,194 higher charges (P<0.0001)

→ $40.1 billion more charges for txed pts!

Implementing Patient Blood Management
Scenario 1 – Patient treated w/o PBM

- Blood loss 1,800ml
- Expected Nadir Hb Patient 1
- Pre-op Hb Patient 1

Clinician’s Transfusion-Trigger Hb

© Axel Hofmann Vienna Vifor 09-2010
Expected Nadir Hb
Patient 1

Blood loss 1,800ml

Hb g/dL

Scenario 2 – Patient treated w/ PBM

Clinician’s Transfusion-Trigger Hb

Pre-op Hb
Patient 1

1st Pillar
Optimise haemopoiesis

• Fe
• B₁₂
• Folic Acid
• ESAs

© Axel Hofmann Vienna Vifor 09-2010
Scenario 2 – Patient treated w/ PBM

- Meticulous surgical hemostasis,
- Topical hemostatic agents
- Systemic hemostatic agents
- Anesthesiological techniques
- Normothermia
- Induced hypotension
- etc.

Primed blood loss

Blood loss 1,000 ml

Expected Nadir Hb Patient 1

Clinician’s Transfusion-Trigger Hb

Pre-op Hb Patient 1

© Axel Hofmann Vienna Vifor 09-2010
**3rd Pillar**

Harness & optimise physiological tolerance of anaemia

- Keep pt. normovolemic
- FiO₂ 100%
- Minimising metabolic demand

**Clinician’s Transfusion-Trigger Hb**

**Expected Nadir Hb Patient 1**

**Blood loss 1,000ml**

**Scenario 2 – Patient treated w/ PBM**

© Axel Hofmann Vienna Vifor 09-2010
Components of PBM

- Evaluation of the actual blood usage (data management)
- Optimising blood ordering schedules
- Increasing tolerance of anemia
- 3 pillar strategy
  - Optimising preoperative red cell mass
  - Minimising perioperative blood loss
  - Reducing transfusion trigger
Data Management

Single RBC unit txns vs total units txd

Example from EMMC USA
# MSBOS
## Maximum Blood Ordering Schedule

<table>
<thead>
<tr>
<th>Authors</th>
<th>Type of surgery</th>
<th>CTR before</th>
<th>CTR after</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rogers et al. 2006</td>
<td>Orthopedics</td>
<td>3.21 : 1</td>
<td>1.62 : 1</td>
</tr>
<tr>
<td>Mehra et al. 2004</td>
<td>Knee replacement</td>
<td>4.90 : 1</td>
<td>1.70 : 1</td>
</tr>
<tr>
<td>Foley et al. 2003</td>
<td>Gynecology</td>
<td>2.25 : 1</td>
<td>1.71 : 1</td>
</tr>
<tr>
<td>Richardson et al. 1998</td>
<td>Various</td>
<td>1.80 : 1</td>
<td>1.80 : 1</td>
</tr>
</tbody>
</table>

1.7: 1 = reduction of ....€
Components of PBM

- Evaluation of the actual blood usage (data management)
- Optimising blood ordering schedules
- Increasing tolerance of anemia

- 3 pillar strategy
  - Optimising preoperative red cell mass
  - Minimising perioperative blood loss
  - Reducing transfusion trigger
1st Pillar
Optimise patient’s own red cell mass
- Detect anaemia
- Identify underlying disorder(s) causing anaemia
- Manage disorder(s)
- Refer for further evaluation if necessary
- Treat iron deficiency/anaemia of chronic disease/iron-restricted erythropoiesis
- Note: Anaemia is a contraindication for elective surgery

Intraoperative
- Timing surgery with haematological optimisation

Preoperative
- Stimulate erythropoiesis
- Be aware of drug interactions that can increase anaemia

2nd Pillar
Minimise blood loss
- Identify and manage bleeding risk
- Minimising iatrogenic blood loss
- Procedure planning and rehearsal
- Preoperative autologous blood donation (in selected cases or when patient choice)
- Other

Postoperative
- Meticulous haemostasis and surgical techniques
- Blood-sparing surgical techniques
- Anaesthetic blood conserving strategies
- Autologous blood options
- Pharmacological/haemostatic agents

3rd Pillar
Harness & optimise physiological tolerance of anaemia
- Assess/optimise patient’s physiological reserve and risk factors
- Compare estimated blood loss with patient-specific tolerable blood loss
- Formulate patient-specific management plan using appropriate blood conservation modalities to minimise blood loss, optimise red cell mass and manage anaemia
- Restrictive transfusion strategies

Intraoperative
- Optimise cardiac output
- Optimise ventilation and oxygenation
- Restrictive transfusion strategies

Postoperative
- Optimise tolerance of anaemia
- Maximise oxygen delivery
- Minimise oxygen consumption
- Avoid/treat infections promptly
- Restrictive transfusion strategies
1st Pillar
Optimise patient’s own red cell mass

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Preoperative

Intraoperative

Postoperative

2nd Pillar
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- Other

- Meticulous haemostasis and surgical techniques
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- Vigilant monitoring and management of post-operative bleeding
- Avoid secondary haemorrhage
- Rapid warming / maintain normothermia (unless hypothermia specifically indicated)
- Autologous blood salvage
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- Haemostasis/anticoagulation management
- Prophylaxis of upper GI haemorrhage
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- Optimise cardiac output
- Optimise ventilation and oxygenation
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- Optimise tolerance of anaemia
- Maximise oxygen delivery
- Minimise oxygen consumption
- Avoid/treat infections promptly
- Restrictive transfusion strategies
Patients for elective surgery should present at the preoperative ambulance as soon as possible (4 weeks before their surgery).
<table>
<thead>
<tr>
<th>Nach Grunderkrankung</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>14 - 15 %</td>
</tr>
<tr>
<td>Herzinsuffizienz</td>
<td>10 - 80 %</td>
</tr>
<tr>
<td>Akuter Myokardinfarkt</td>
<td>6 - 18 %</td>
</tr>
<tr>
<td>Infektionen</td>
<td>bis zu 95%</td>
</tr>
<tr>
<td>Tumorerkrankungen</td>
<td>bis zu 77%</td>
</tr>
<tr>
<td>Autoimmunenerkrankung</td>
<td>bis zu 71%</td>
</tr>
<tr>
<td>Nierenerkrankungen</td>
<td>bis zu 50%</td>
</tr>
<tr>
<td>COPD</td>
<td>23%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Präoperativ</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA I und ASA II</td>
<td>1 %</td>
</tr>
<tr>
<td>Knie- und Hüftoperation</td>
<td>20 - 35 %</td>
</tr>
<tr>
<td>Allgemeinchirurgische Eingriffe</td>
<td>bis zu 40 %</td>
</tr>
<tr>
<td>Colonchirurgie</td>
<td>25 - 70 %</td>
</tr>
<tr>
<td>Herz- und Gefäßoperationen</td>
<td>16 - 40 %</td>
</tr>
</tbody>
</table>

Gombotz et al: AINS 2011 Jul;46(7-8):466-74
30-day mortality, by anaemia and risk factor status

Mussallam et al: www.thelancet.com Published online October 6, 2011 DOI:10.1016/S0140-6736(11)61381-0
30-day composite morbidity, by anaemia and risk factor status

![Composite morbidity chart](chart.png)

Mussallam et al: www.thelancet.com Published online October 6, 2011 DOI:10.1016/S0140-6736(11)61381-0
Patient blood management is key before elective surgery

Writing in The Lancet, Khaled Musallam and colleagues address an important topic through their analysis of the American College of Surgeons' National Surgical Quality Improvement Program database, namely, what is the prevalence of preoperative anaemia in patients undergoing major non-cardiac surgery and what are the implications? Moreover, by removal of data for allogeneic red-blood-cell transfusions in their analysis (and thus in the absence of treatment for anaemia) the independent and natural course of preoperative anaemia is shown. The main finding of their study was that preoperative anaemia—even to a mild degree—was significantly and independently associated with increased postoperative morbidity and mortality. This association might be aggravated by concomitant perioperative blood loss and (frequently unnecessary) allogeneic transfusions. I believe that Musallam and colleagues' findings could have an enormous effect on health-care systems worldwide because preoperative diagnosis and treatment of anaemia (apart from transfusions of red blood cells) has almost never been undertaken routinely before surgery.

Anaemia is a serious but easily treatable condition. Treatment is less costly than is transfusion and would possibly improve outcomes, not only by increased tolerance of perioperative blood loss and avoidance of allogeneic transfusions but also through elimination of the risk of anaemia by maintaining increased physiological haemoglobin values throughout the perioperative period.

Because of the nature of Musallam and colleagues' retrospective observational study, the cause of anaemia was not assessed. However, about a third of patients with anaemia probably would have had nutritional deficiencies, a third probably would have had chronic disease, and a third would have had anaemia from an unknown cause. Moreover, diagnostic and interventional blood loss might have had an additional role in the rates of anaemia reported.

Because of the prevalence, treatability, and negative outcomes of preoperative anaemia, preservation and improvement of preoperative red-blood-cell mass is essential as one of the three pillars of the new patient blood management strategy, which lasts for the entire perioperative period and has a patient-specific perioperative multidisciplinary and multifaceted team approach.

Gombotz H: www.thelancet.com
Published online October 6, 2011 DOI:10.1016/xxxx

Invited comment
Detection, evaluation, and management of preoperative anaemia in the elective orthopaedic surgical patient: NATA guidelines.

**1st Pillar**
Optimise patient’s own red cell mass
- Detect anaemia
- Identify underlying disorder(s) causing anaemia
- Manage disorder(s)
- Refer for further evaluation if necessary
- Treat iron deficiency/anaemia of chronic disease/iron-restricted erythropoiesis
- Note: Anaemia is a contraindication for elective surgery

**2nd Pillar**
Minimise blood loss
- Identify and manage bleeding risk
- Minimising iatrogenic blood loss
- Procedure planning and rehearsal
- Preoperative autologous blood donation (in selected cases or when patient choice)
- Other
- Meticulous haemostasis and surgical techniques
- Blood-sparing surgical techniques
- Anaesthetic blood conserving strategies
- Autologous blood options
- Pharmacological/haemostatic agents
- Vigilant monitoring and management of post-operative bleeding
- Avoid secondary haemorrhage
- Rapid warming / maintain normothermia (unless hypothermia specifically indicated)
- Autologous blood salvage
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- Haemostasis/anticoagulation management
- Prophylaxis of upper GI haemorrhage
- Avoid/treat infections promptly
- Be aware of adverse effects of medication

**3rd Pillar**
Harness & optimise physiological tolerance of anaemia
- Assess/optimise patient’s physiological reserve and risk factors
- Compare estimated blood loss with patient-specific tolerable blood loss
- Formulate patient-specific management plan using appropriate blood conservation modalities to minimise blood loss, optimise red cell mass and manage anaemia
- Restrictive transfusion strategies
- Optimise cardiac output
- Optimise ventilation and oxygenation
- Restrictive transfusion strategies
- Optimise tolerance of anaemia
- Maximise oxygen delivery
- Minimise oxygen consumption
- Avoid/treat infections promptly
- Restrictive transfusion strategies
General standards and advanced measures

Modify Surgery??

General standards to minimize *intra- und postoperative* blood loss:
1. Maintaining normovolemia
2. Maintaining normothermia
3. Minimizing diagnostic blood losses/microsampling
4. Exact intra- and postoperative management of hemostasis
5. Accepting low transfusion trigger

Advanced anesthesiological measures to minimize *intraoperative* blood loss:
1. Controlled hypotension (contraindication!)
2. Regional anesthesia

Surgical standards to minimize blood loss:
1. Using surgical standards
2. Using anatomically sound and atraumatic surgical techniques
3. Applying meticulous surgical hemostasis

Advanced surgical measures to minimize blood loss:
1. Using optimal surgical instruments depending on indication (laser, ultrasonic scalpel, Dissectors, etc.)
2. Using local ischemia during certain sequences of operation (clamping vessels of high blood volume)
Approximate contributions of selected PBM modalities in the surgical patient

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
<th>Number of RBC units saved</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perioperative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harnessing patient’s tolerance of anaemia (restrictive transfusion trigger)</td>
<td>1-2&lt;sup&gt;146&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Restricted phlebotomy</td>
<td>1&lt;sup&gt;128&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Pre-operative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimisation of RBC mass (perioperative anaemia management)</td>
<td>2&lt;sup&gt;184, 185&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Intra-operative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meticulous haemostasis &amp; surgical technique</td>
<td>1 or more&lt;sup&gt;186&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Acute normovolaemic haemodilution (ANH)</td>
<td>1 or more&lt;sup&gt;89, 187&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Autologous cell salvage</td>
<td>1 or more&lt;sup&gt;188&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Post-operative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Autologous blood salvage</td>
<td>1&lt;sup&gt;189&lt;/sup&gt;</td>
</tr>
</tbody>
</table>


Up to 50% reduction of blood loss!!!
The influence of baseline hb concentration on tolerance of anemia in cardiac surgery

The relationship between maximum decrease in Hb concentration and adverse outcomes was independently associated with increased risk!!

### 1st Pillar
**Optimise patient’s own red cell mass**
- Detect anaemia
- Identify underlying disorder(s) causing anaemia
- Manage disorder(s)
- Refer for further evaluation if necessary
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- Note: Anaemia is a contraindication for elective surgery

### 2nd Pillar
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- Identify and manage bleeding risk
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### 3rd Pillar
**Harness & optimise physiological tolerance of anaemia**
- Assess/optimise patient’s physiological reserve and risk factors
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### Preoperative
- Timing surgery with haematological optimisation

### Intraoperative
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### Postoperative
- Vigilant monitoring and management of post-operative bleeding
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- Avoid/treat infections promptly
- Be aware of adverse effects of medication

### Other
- Assess optimise patient’s physiological reserve and risk factors
- Compare estimated blood loss with patient-specific tolerable blood loss
- Formulate patient-specific management plan using appropriate blood conservation modalities to minimise blood loss, optimise red cell mass and manage anaemia
- Restrictive transfusion strategies

### Note:
- Anaemia is a contraindication for elective surgery
- Identify and manage bleeding risk
- Minimising iatrogenic blood loss
- Procedure planning and rehearsal
- Preoperative autologous blood donation (in selected cases or when patient choice)
- Other

### Intraoperative
- Optimise cardiac output
- Optimise ventilation and oxygenation
- Restrictive transfusion strategies

### Postoperative
- Optimise tolerance of anaemia
- Maximise oxygen delivery
- Minimise oxygen consumption
- Avoid/treat infections promptly
- Restrictive transfusion strategies
Start postoperative phase

Potential weak point through lack of communication

Team receives patient and gets informed about individual trigger determination

Secondary hemorrhage?

Collection and retransfusion of drainage blood

Bleeding persistent?

Hemostasis, blood pressure, etc. optimized?

Reoperation (liberal indication)?

Reoperation (cycle process)

Optimizing hemostasis, blood pressure etc.

Bleeding persistent?

Administration of recombinant factor VIIa?

Administration of factor VIIa

Bleeding persistent?

Ende of algorithm (1)
Transfusion thresholds and other strategies for guiding allogeneic red blood cell transfusion

- Restrictive transfusion strategies reduced the risk of receiving a red blood cell (RBC) transfusion by a relative 42%. This equates to an average absolute risk reduction (ARR) of 40%.
- The volume of RBCs transfused was reduced on average by 0.93 units.
- However, heterogeneity between these trials was statistically significant (p<0.00001) for these outcomes.
- Mortality, rates of cardiac events, morbidity, and length of hospital stay were unaffected. Trials were of poor methodological quality.

Principal Investigators

Jeffrey L Carson, MD
Principal Investigator and Study Chairman
Clinical Coordinating Center

Focus trial
Gombotz H. et al. Unpublished data.
Retrospektiver Vergleich bei anämischen PatientInnen mit einseitigem Hüftgelenksersatz

Unpublished data.

Hb-Anstieg vs. Behandlungszeit

Behandlungszeit (Wochen)
Retrospektiver Vergleich bei anämischen PatientInnen mit einseitigem Hüftgelenksersatz

Unpublished data.

n = 2x50 Patientinnen
Study evaluating PBM Outcomes

The Impact of Blood Conservation on Outcomes in Cardiac Surgery: Is It Safe and Effective?

David M. Moskowitz, MD, Jock N. McCullough, MD, Aryeh Shander, MD, James J. Klein, MD, Carol A. Bodian, DrPH, Richard S. Goldweit, MD, and M. Arisan Ergin, MD

Department of Anesthesiology, Critical Care Medicine, Hyperbaric Medicine and Pain Management, Department of Cardiothoracic Surgery, and Division of Cardiology, Department of Internal Medicine, Englewood Hospital and Medical Center, Englewood, New Jersey; and Department of Anesthesiology, Division of Biostatistics, The Mount Sinai Hospital and Medical Center, New York, New York


propensity-score matched cohort of 586 pts from institutions without a PBMP

Isolated CABG includes elective & urgent and primary & redo procedures
The Impact of Blood Conservation on Outcomes in Cardiac Surgery: Is It Safe and Effective?

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PBM strategies used:
1. Preop haemoglobin optimisation
2. Intraop ANH and Intra & Postop cell salvage
3. Meticulous surgical technique
4. Endovascular vein harvesting
5. Point-of-care coagulation testing
6. Targeted haemostatic therapy
7. Tolerance of perioperative anaemia (60 - 70 g/L depending on patient-specific physiology)
CABG Outcomes PBMP vs Non-PBMP

<table>
<thead>
<tr>
<th>Outcome</th>
<th>PBMP cohort (n=586)</th>
<th>Non-PBMP cohort (n=586)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Transfused</td>
<td>10.6%</td>
<td>42.5%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mortality</td>
<td>0.8%</td>
<td>2.5%</td>
<td>0.02</td>
</tr>
<tr>
<td>Serious complication</td>
<td>11.1%</td>
<td>18.7%</td>
<td>0.0002</td>
</tr>
</tbody>
</table>