Blood Transfusion Project
Reducing Transfusion in the MARCQI Population
Anemia in Healthy Awake Volunteers

- Critical hemoglobin threshold unknown in humans
  - At 6 g/dL
    - Decline in cognitive function
  - At 5 g/dL
    - VO$_2$ maintained
    - ST changes in 5%
    - Memory formation impaired

Risks of Blood Transfusion

- Viral transmission
- Acute transfusion reactions
- Immunosuppression
- Acute inflammatory response

Noninfectious Hazards

Immunosuppression

Infection
Age of Stored Blood

Day 1  Day 21  Day 35

Serious Hazards of Transfusion

- Transfusion-transmitted infections: 3%
- Incorrect blood/component transfused: 15%
- Acute transfusion reaction: 14%
- Acute lung injury: 6%
- Graft vs host disease: 2%
- Delayed transfusion reaction: 15%
- Post-transfusion purpura: 8%

Based on 366 spontaneously-reported deaths/major complications between October 1996 and September 1998 in the UK and Ireland.

Immune Effects of Blood

- Decreased T-cell proliferation
- Decreased CD3, CD4, CD8 T-cells
- Increased Cell-mediated lympholysis
- Increased TNF-alpha
- Increased suppressor T-cell activity
- Reduced natural killer cell activity

TRIM – Transfusion-associated Immuno modulation

Innerhofer et al. Transfusion 1999 Oct;39(10):1089
Blood Transfusion Increases Risk of Postoperative Bacterial Infection

- 20 peer-reviewed studies, 1986-2000
- 13,152 patients
  - 5215 transfused
  - 7937 not transfused
- Association of Transfusion to Infection
  - OR 3.45 (range 1.43-15.15)
  - 17 of 20 studies with p < 0.05

Predictors and Complications of Blood Transfusion in Total Hip and Knee Arthroplasty

- Henry Ford Hospital
- Jan 2011 to Dec 2012
- 1573 patients
- 13.3% higher infection rate in transfused patients
- Factors associated with transfusion
  - Age
  - Female gender
  - BMI

Frisch, et al. AAHKS 11/2013
The TRICC Study

- 838 patients ICU patients
- Placed into one of two groups
  - **Restrictive group:**
    - Transfuse if Hb < 7
    - Maintain between 7 and 9
  - **Liberal group:**
    - Transfuse if Hb < 10
    - Maintain between 10 and 12
- The primary outcome measure was death from all causes in the 30 days after randomization

Herbert PC, et al. NEJM 1999
8.7% vs 16.1%

Herbert PC, et al. NEJM 1999

5.7% vs 13.0%
CRIT Study

- 4,892 ICU patients in the US
- Prospective, multiple center, observational cohort
- Examine the relationship of
  - Anemia
  - RBC transfusion
  - Clinical outcomes

35% of Blood transfused in patients with Hgb ≥ 9

RBC transfusion was independently associated with higher mortality
OR 1.65 (CI 1.35-2.03)
OR 2.62 if 3-4 units transfused

Transfusion in Coronary Artery Bypass Grafting is Associated with Reduced Long-Term Survival

Colleen Gorman Koch, MD, MS, Liang Li, PhD, Andra I. Duncan, MD, Tomislav Mihaljevic, MD, Floyd D. Loop, MD, Norman J. Starr, MD, and Eugene H. Blackstone, MD

Departments of Cardiothoracic Anesthesia, Quantitative Health Sciences, and Thoracic and Cardiovascular Surgery, The Cleveland Clinic Foundation, Cleveland, Ohio

FOCUS Trial

- Inclusion criteria:
  - Undergo surgery for hip fracture
  - Have a history of cardiovascular disease
  - Have a postoperative Hgb < 10 g/dL

- Randomized to keep Hgb > 10 g/dL or not

- Primary outcome
  - Ability to walk 10 feet without assistance at 60 days

- Negative outcomes
  - Postoperative unstable angina
  - Myocardial infarction
  - Death
Liberal or Restrictive Transfusion in High-Risk Patients after Hip Surgery


CONCLUSIONS

A liberal transfusion strategy, as compared with a restrictive strategy, did not reduce rates of death or inability to walk independently on 60-day follow-up or reduce in-hospital morbidity in elderly patients at high cardiovascular risk. (Funded by the National Heart, Lung, and Blood Institute; FOCUS ClinicalTrials.gov number, NCT00071032.)

Financial Burden

UMHHC direct cost of blood products

FY'04 FY'05 FY'06 FY'07 FY'08

$11.08 $10.76 $12.56 $12.56 $14.97

Millions
Exploring Surgery Level Risk Factors for Transfusion and Readmission
General versus regional anesthesia

Hip

Knee
Time in OR by hospital

Hip

Knee

Hospital

Hospital

MICHIGAN ARTHROPLASTY REGISTRY
COLLABORATIVE QUALITY INITIATIVE
Use of Tranexemic Acid

Hip

Knee
Associations of surgical variables with outcome for hip arthroplasty

<table>
<thead>
<tr>
<th>Variable</th>
<th>Blood Transfusion</th>
<th>Readmission</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
</tr>
<tr>
<td>Anesthesia General versus Regional</td>
<td>1.30 (0.92-1.86)</td>
<td>1.53 (1.18-1.97)</td>
</tr>
<tr>
<td>Operative Approach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterolateral versus Posterior</td>
<td>1.52 (1.21-1.90) *</td>
<td>0.88 (0.67-1.14)</td>
</tr>
<tr>
<td>Anterior versus Posterior</td>
<td>0.82 (0.30-2.23)</td>
<td>1.22 (0.76-1.96)</td>
</tr>
<tr>
<td>Tranexemic Acid</td>
<td>0.64 (0.44-0.93)</td>
<td>1.10 (0.93-1.29)</td>
</tr>
<tr>
<td>15 Minutes of OR time</td>
<td>1.04 (0.97-1.11)</td>
<td></td>
</tr>
<tr>
<td>Blood Transfusion</td>
<td></td>
<td>1.20 (1.09-1.33)</td>
</tr>
</tbody>
</table>

* Interpret with caution
## Associations of surgical variables with outcome for knee arthroplasty

<table>
<thead>
<tr>
<th>Variable</th>
<th>Blood Transfusion</th>
<th>Readmission</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
</tr>
<tr>
<td><strong>Anesthesia General versus Regional</strong></td>
<td><strong>1.38 (1.03-1.84)</strong></td>
<td>1.15 (0.83-1.61)</td>
</tr>
<tr>
<td><strong>Operative Approach</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPK vs SVK</td>
<td>1.12 (0.80-1.59)</td>
<td>1.02 (0.87-1.20)</td>
</tr>
<tr>
<td>MVK vs SVK</td>
<td>0.79 (0.61-1.02)</td>
<td>1.01 (0.87-1.17)</td>
</tr>
<tr>
<td>Tranexemic Acid</td>
<td>0.85 (0.58-1.25)</td>
<td>0.90 (0.72-1.11)</td>
</tr>
<tr>
<td>15 Minutes of OR time</td>
<td></td>
<td><strong>1.11 (1.07-1.16)</strong></td>
</tr>
<tr>
<td>Blood Transfusion</td>
<td></td>
<td><strong>1.27 (1.08-1.50)</strong></td>
</tr>
</tbody>
</table>
Crude and adjusted risk of blood transfusion for hip arthroplasty by MARCQI site
Crude and adjusted risk of blood transfusion for knee arthroplasty by MARCQI site
Allogenic Transfusion

- Risks
  - Disease transmission
  - Increased complication rates
  - Increased readmissions (MARCQI data)
  - Increased mortality
MARCQI Transfusion Data

- 9.8% of MARCQI patients are transfused
  - 14.2% of hips
  - 7% of knees
  - 23% of bilateral knees
- Only 1.5% of patients have nadir Hgb < 7 g/dL
- 4.6% receive TXA
MARCQI Sites:
Transfusion Guidelines

- Wide range of transfusion triggers
- Some have no protocol
- Asymptomatic patient
  - Hgb < 7 g/dL to Hgb < 9 g/dL
- Symptomatic patients
  - Hgb < 7 g/dL to Hgb < 11 g/dL
U of M Transfusion Guidelines

- Hgb < 6 g/dL in asymptomatic patient
- Hgb < 7 g/dL in post-op or ill patient
- Hgb < 10 g/dL acute coronary syndrome
Restrictive Transfusion Protocols

- Are safe
- Recommended by:
  - American Red Cross (ARC)
  - American Association of Blood Banks (AABB)
  - Cochrane Collaboration Review
Summary

- Transfusion may benefit patients during acute coronary syndromes if $\text{Hgb} < 8-10 \text{ g/dL}$
- There is very rarely an indication to transfuse ANY patient with a $\text{Hbg} \geq 10 \text{ g/dL}$
- Each unit incrementally increases risk
- Decreasing transfusion may
  - reduce risk of infection and readmission
  - reduce mortality
  - decrease cost
Guidelines for Blood Transfusion: PRBCs

- These guidelines are intended to ensure that the most appropriate, efficient and safe use of the blood supply is achieved.
- To establish evidence-based criteria for the transfusion of blood components.
- Every indication for the use of blood products cannot be anticipated.
- These guidelines are not intended to override physician judgement.
Guidelines for Blood Transfusion: PRBCs

- Administered as **single units** except for ongoing blood loss with hemodynamic instability.

- Transfusion decisions are clinical judgments that should **not** be based on laboratory parameters alone.
Transfusion Guidelines

- Red Cross Transfusion Guidelines
  - Post-operative patients
  - Indications for allogenic transfusion
    - Threshold of Hgb < 8 g/dL
    - Clinically significant symptoms of anemia
      - Unresponsive to fluid resuscitation
    - Clinical judgement in patients with Hgb < 10 g/dL and increased risk factors
MARCQI recommendation

- Encourage adoption of the Red Cross Guidelines or similar protocols at your institution and in your practice
- Transfuse one unit at a time
- Encourage these practices with your colleagues
Tranexamic Acid

- Low numbers in MARCQI
- Associated with reduced transfusion in hips
- Concerns over risks
- Increasing support in literature
- Will continue to monitor