Reinfusing Shed Blood: Valuable

Surgery Grand Rounds
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OVERVIEW

• Concepts
• Advantages
• Major concerns?
• Conclusions
CONCEPTS

- **Intraoperative blood salvage** It is one of 4 categories of autologous blood transfusion.
- Collection and reinfusion of autologous red cells lost by a patient during surgery.
- 2 broad classes of devices:
  1. **RBC washing type** collect, washes and centrifugally separates out the RBC and then reinfuses them.
  2. **Hemofiltration only device** just collects the blood, filters it and reinfuses it.
ADVANTAGES

• Rapidity\textsuperscript{5}
• Can provide 225ml of washed, saline-suspended red cells with hct of $\geq 50\%$ in 3 min\textsuperscript{5}.
• Can provide the equivalent of 10-12 units of banked blood per hour\textsuperscript{4,5}
• Immediately available in the event of rapid blood loss\textsuperscript{4}
• Continue for the duration of surgery\textsuperscript{5}
• Replace blood in proportion to the vol of blood lost\textsuperscript{5}
ADVANTAGES

• Hb’s ability to bind and release $O_2 \rightarrow$ levels of 2,3 di phosphoglycerate

• Washed autologous RBC have higher levels of 2-3, DPG than stored homologous RBC (Thurer, Hauer)

• Reduces the risk of blood transfusion reactions

• Limit potential infectious risk
### Table 3. Risks of Blood Transfusion.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Estimated Frequency</th>
<th>No. of Deaths per Million Units</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per Million Units</td>
<td>Per Actual Unit</td>
<td></td>
</tr>
<tr>
<td><strong>Infection</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Viral</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Hepatitis A</td>
<td>1</td>
<td>1/1,000,000</td>
<td>0</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>7–32</td>
<td>1/30,000–1/250,000</td>
<td>0–0.14</td>
</tr>
<tr>
<td>Hepatitis C</td>
<td>4–36</td>
<td>1/30,000–1/150,000</td>
<td>0.5–17</td>
</tr>
<tr>
<td>HIV</td>
<td>0.4–5</td>
<td>1/200,000–1/2,000,000</td>
<td>0.5–5</td>
</tr>
<tr>
<td>HTLV types I and II</td>
<td>0.5–4</td>
<td>1/250,000–1/2,000,000</td>
<td>0</td>
</tr>
<tr>
<td>Parvovirus B19</td>
<td>100</td>
<td>1/10,000</td>
<td>0</td>
</tr>
<tr>
<td><strong>Bacterial contamination</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red cells</td>
<td>2</td>
<td>1/500,000</td>
<td>0.1–0.25</td>
</tr>
<tr>
<td>Platelets</td>
<td>83</td>
<td>1/12,000</td>
<td>21</td>
</tr>
<tr>
<td>Acute hemolytic reactions</td>
<td>1–4</td>
<td>1/250,000–1/1,000,000</td>
<td>0.67</td>
</tr>
<tr>
<td>Delayed hemolytic reactions</td>
<td>1000</td>
<td>1/1,000</td>
<td>0.4</td>
</tr>
<tr>
<td>Transfusion-related acute lung</td>
<td>200</td>
<td>1/5,000</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

*HIV denotes human immunodeficiency virus, and HTLV human T-cell lymphotropic virus.

ADVANTAGES: Reduce the rate of exposure to allogeneic RBC

- Allergic reactions 1%-4%\(^{10}\)
- Febrile reaction 0.1%-1%\(^{10}\)
- Graft vs host disease 1/400-1/10,000\(^{10}\)
- Volume overload 10%-40%\(^{10}\)
- Depressed erythropoiesis Universal\(^{10}\)
- **TT virus 52%\(^{10}\)**
- West Nile virus 1/1.4 million\(^{10}\)
- CMV conversion 7%\(^{10}\)
- EBV 5%\(^{10}\)
- Outbreaks of other infections in allogeneic blood\(^{2}\)
  - *Yersinia enterocolitica*\(^{2}\)
  - contamination rate < than 1 per million red cell units
ADVANTAGES: Reduce the rate of exposure to allogeneic RBC

- In 1999 Huët et al.\textsuperscript{13}
- Meta-analysis: Effectiveness of Cell Salvage to Minimize Perioperative Allogeneic Blood Transfusion in Cardiac and Orthopedic Surgery
  - 1966-1997
  - Twenty-seven studies
  - 12 in cardiac surgery, and 16 in orthopedic surgery
- Decrease the proportion of patients who receive a perioperative allogeneic transfusion
ADVANTAGES: Reduce the rate of exposure to allogeneic RBC

• In 2006 Henry C et al.
• Meta-analysis: Evidence for the efficacy of CS in reducing allogeneic BT and the evidence for any effect on clinical outcome\(^\text{12}\)

• 51 randomised studies (1978-2003):
  - 47 studies: # of subject exposed to allogeneic BT.
  - Total of 3857 patients → 1952 randomised to CS
  - Reduce the rate of exposure by a relative 39%
  - Absolute reduction in risk of exposure was 23%
  - Number needed to treat = 4.3
  - Orthopaedic surgery (Relative risk of reduction = 58%)
  - Cardiac trials (RRR = 23%)

• Sufficient evidence to support the use of CS
MAJOR CONCERNS: Significant derangement of postoperative clotting profiles and increased risk of postop bleeding?

- 1999 Murphy G et al., studied the safety, efficacy, and cost of intraoperative CS and autotransfusion after off-pump coronary artery bypass surgery.

- **Randomized Trial**
  - 61 patients
  - Study was powered to detect a significant effect of autotransfusion on postop clotting profiles.

- **No statistical difference was noted** with respect of thromboelastograph values or laboratory measures of clotting pathway function.
**MAJOR CONCERNS:** Significant derangement of postoperative clotting profiles and increase risk of postop bleeding?

- 2004 Murphy G et al., studied the safety and efficacy of perioperative CS and autotransfusion after CABG

- **Randomized trial**
  - 98 randomized to autotransfusion: washed blood from intraop CS and postop mediastinal fluid CS
  - 102 control: homologous blood
  - Autotransfusion: more significant derangement of APTT ratio

- Autotransfusion of washed cells is not associated with a derangement of clotting profiles
MAJOR CONCERNS: Significant derangement of postoperative clotting profiles and increase risk of postop bleeding?

• 2006 Niranjan et al, studied the effects of cell saver autologous blood transfusion on blood loss and homologous blood transfusion requirements in patients undergoing cardiac surgery on – versus off- CPB.

• Randomised trial
  - 80 patients: 4 groups
    1. CPB with CS BT (cell saver blood transfusion)
    2. CPB without CS BT
    3. Off CPB with CS BT
    4. Off CPD with CS BT
  - Coagulation markers increased significantly on POD#1 but no difference between group

• Autologous CS BT is safe and do not cause a clinically significant coagulopathy
MAJOR CONCERNS: Significant derangement of postoperative clotting profiles and increase risk of postop bleeding?

- 2006 Henry C et al
- Meta-analysis: Evidence for the efficacy of CS in reducing allogeneic BT and the evidence for any effect on clinical outcome\(^\text{12}\)
- 14 trials: re-operation due to bleeding
  - 1119 patients
  - 563 were randomised to CS
- Use of CS did not statistically impact on the rates of re-operation for bleeding

- Homologous blood itself has anticoagulant properties and can induce a coagulopathy\(^\text{6}\)
MAJOR CONCERNS: Infection?

- In 2006 Henry C et al meta-analysis\textsuperscript{12}:
  - 13 trials: infection of any type
    - Total of 1390 patients.
    - 721 were randomised to CS.
  - Use of CS did not impact adversely on the rates of infection.
  - 9 trials: wound complications.
    - Total of 730 patients
    - 392 were randomised to CS.
  - Use of CS did not statistically significant impact on the rates of wound complications.
MAJOR CONCERNS: Infection?

- Prospective randomized studies out of the orthopaedic literature
- Patients randomized to receive either autologous blood or allogeneic transfusion
- Allogeneic transfusion increases the risk of serious bacterial infection, including wound dehiscence and artificial joint infection \(^{10, 16}\)
- The increased risk has been estimated to be 1.3-fold to 3.5-fold \(^{10}\)
MAJOR CONCERNS: Infection?

- Risk of pneumonia is increased by 5% with each unit of PRBC$^{15}$
- The number of units transfused had a direct relationship to increases risk of infection$^{10}$
- Depression of the recipient’s ability to respond to bacterial insult$^{10}$
**MAJOR CONCERNS: Infection?**

- Known risk exists with allogeneic blood
- Theoretical risk of bacterial contamination is associated with CS blood\(^\text{11}\).
- Until data are generated supporting the theoretical risk of CS in these circumstances, it seems reasonable to avoid the known risk of allogeneic blood through the use of CS\(^\text{11}\).
MAJOR CONCERNS: Cost?

• In 2005 Murphy et al studied the safety, efficacy and cost of intraoperative cell salvage and autotransfusion after off-pump coronary artery bypass surgery.\(^8\)
  - Randomized trial
  - They found a significant difference in the median operative cost per patient between 2 groups. 2/2 increase cost of the CS.
  - Increase in operative cost as result of using CS device did not result in a statistically significant increase in overall costs.
MAJOR CONCERNS: Cost?

- In 1996 Goodnough et al conducted a retrospective review of patients undergoing elective AAA repair to evaluate cost-effectiveness of intraoperative blood salvage.
  - 184 patients
  - Cost of CS = $326+73
  - Cost savings in 22% of the patients
  - Intraoperative cell salvage was beneficial for those who have intraop blood losses of >1000ml
MAJOR CONCERNS: Cost?

• In 1993 Ouriel et al studied intraoperative autotransfusion and homologous BT in patients undergoing aortic reconstructive procedures\textsuperscript{17}.
  - 100 autotransfusion
  - 100 homologous blood
  - Hospital cost were compared and no overall differences were seen.
  - The cost of BP and infusion equipment was lower in the AT group.
  - Cost savings of $288 per patient (p<0.001)

• Cost savings $\rightarrow$ high blood loss and high RBC salvage rate\textsuperscript{17}
MAJOR CONCERNS: Cost?

- A “stand-by” setup costs comparably to the reagent costs for typing and crossing 2 units\textsuperscript{11}
CONCLUSIONS

• Significant reduction in homologous blood use
• Immediately available
• Not associated with a derangement of clotting profiles
• Not associated with increase rates of infection
• Overall there is not a statistically significant increase in costs
Ask yourself:
If given a choice, would you want your own blood or the blood of a stranger?
REFERENCES


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THANK YOU