Blood and Blood Product Utilization

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DISCLOSURES
– Nothing to disclose
– Discussion of off label medication use

Objectives
• Identify the different types of blood products and how they are best used in the hospital setting
• Provide the indications, risks and alternatives to the various blood products
• Employ blood conservation and adjuncts to transfusions
When concentration of hemoglobin is less than 8 to 10 grams per 100 cubic centimeters of whole blood, it is wise to give a blood transfusion before operation. When indicated, the value

Basic Principles of Transfusion

- Transfuse only what is needed
- Transfuse only when a clinically significant problem exists
- Weigh risk, benefit, and alternatives to transfusion

Blood

- Total blood volume ~ 5L in the “70 kg” adult
- To replace total blood volume
  - 10 U PRBC
  - 10-12 U FFP
  - 2 U of platelets
Clinical Assessment

- No specific clinical signs or laboratory parameters that can consistently and reliably indicate the need of patients for transfusion

- Blood Pressure
- Pulse
- Mental Status
- Respiratory Rate

Laboratory Values

Basic Tests
- Hemoglobin / Hematocrit
- Platelet count
- Prothrombin time (PT-INR)
- Activated partial thromboplastin time
- Fibrinogen level

Hemodilution

- Hemoglobin: amount of hemoglobin in blood
  - Hemoglobin fills up the RBC
- Hematoctit: % of RBC in a volume of blood
- BOTH DEPENDENT ON PLASMA VOLUME!
Blood Volume

- Blood Volume Studies?
  - Could be overestimating or even underestimating anemia

- Is the patient euvolemic?

Example: Blood Volume

![Blood Volume Chart]

Example: Blood Volume

![Blood Volume Chart]
Example: Blood Volume

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BVA Result</th>
<th>Patient Ideal</th>
<th>Deviation from Ideal</th>
<th>Excess / Deficit %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Blood Volume</td>
<td>1551 mL</td>
<td>1364 mL</td>
<td>-187 mL</td>
<td>-14.6% Normal Deficit</td>
</tr>
<tr>
<td>Red Blood Cell Volume</td>
<td>2151 mL</td>
<td>1945 mL</td>
<td>-206 mL</td>
<td>-10.6% Normal Excess</td>
</tr>
<tr>
<td>Plasma Volume</td>
<td>4278 mL</td>
<td>4928 mL</td>
<td>-649 mL</td>
<td>-13.2% Normal Excess</td>
</tr>
</tbody>
</table>

Blood Volume Interpretation Guidelines:
- Normal: 0-10
- Mild: 11-20
- Moderate: 21-30
- Severe: 31-40
- Extreme: >40

<table>
<thead>
<tr>
<th>BVI PE Deviation ( × %)</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>0-10</td>
<td>10-20</td>
<td>20-30</td>
<td>&gt;30</td>
<td>&gt;40</td>
</tr>
</tbody>
</table>

Additional Analysis

<table>
<thead>
<tr>
<th>Hemostatic Analysis</th>
<th>mEq/kg Analysis</th>
<th>Allogeneic Transfusion Analysis/Volume (%/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Result</td>
<td>Normal (Male)</td>
<td>Reference Range</td>
</tr>
<tr>
<td>Platelet Function</td>
<td>20-30% (5%)</td>
<td>Normal: 0 to 0.5%</td>
</tr>
<tr>
<td>Normalized Hot (after)</td>
<td>25% (10%)</td>
<td>High: 0.5 to 0.9%</td>
</tr>
</tbody>
</table>

Figure 1

Analytical software graphical representation of a TEG tracing.

Thromboelastogram
Blood Component Therapy

- Whole Blood
- Packed Red Blood Cells
- Fresh Frozen Plasma
- Cryoprecipitate
- Platlets

Blood Component

- 1u PBRC + 1u Plt + 1u FFP + 10pk cryo = 650ml of cold products
- Hct 29%, Coag activity at 65%, Plts 87k, 750mg Fibrinogen
Blood Transfusions

- 15 million units RBC annually in US
- 85 million units RBC worldwide
- 2 million U FFP / year in US
- 1 million U Cryo / year in US

Whole Blood

- All the right stuff in it
- Optimal transfusion
- Limits
- Used extensively in Iraq and Afghanistan

Packed Red Blood Cells

- 340 ML Volume
- HCT = ~50% (50-70)
- Storage up to 42d
  - 2,3 DPG deficiency
  - Lysis of cells
- Frozen blood
Who needs a blood transfusion?

- Actively bleeding patients
  - Hemorrhage not controlled
  - Shock (hemorrhagic)
- Patients with clinical sequella to anemia
  - AMI
  - Hypotension, Altered Mental Status, Shock

“Transfusion Triggers”

- Do NOT use Hb/Hct level alone as “trigger”
- Decide based on
  - Intravascular status
  - Presence / absence of shock
  - Duration / extent of anemia
  - Physiologic parameters
- General consensus that consideration for transfusion is between 6-7 hgb
TRICC and Triggers

- Hgb <7 vs 10

“The mortality rates during hospitalization were lower in the restrictive-strategy group (22.2 percent vs. 28.1 percent, P=0.05)”

— Active ST Segment MI ~ 8g/dl Hgb

Six Key Clinical Trials of Blood Transfusion in Adults

<table>
<thead>
<tr>
<th>Clinical Setting (Ref)</th>
<th>Hemoglobin Threshold (g/dL)</th>
<th>Age (Years)</th>
<th>Patients Transfused</th>
<th>Hemoglobin at Transfusion (g/dL)</th>
<th>Part. of Eligible Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive Care 1</td>
<td>7 vs 10</td>
<td>57.1 ± 15.3</td>
<td>100%</td>
<td>8.7 ± 0.6*</td>
<td>64%</td>
</tr>
<tr>
<td>CT Surgery 2</td>
<td>8 vs 10</td>
<td>52.7 ± 11.5</td>
<td>80%</td>
<td>8.0 ± 1.3*</td>
<td>55%</td>
</tr>
<tr>
<td>High Risk 3</td>
<td>8 vs 10</td>
<td>56.2 ± 11.6</td>
<td>80%</td>
<td>9.1 (8.9-9.3)</td>
<td>54%</td>
</tr>
<tr>
<td>Acute Upper GI Bleeding 4</td>
<td>7 vs 9</td>
<td>NA</td>
<td>100%</td>
<td>8.0 ± 1.5</td>
<td>53%</td>
</tr>
<tr>
<td>Symptomatic Coronary Artery Disease 5</td>
<td>8 vs 10</td>
<td>74.3 ± 11.1</td>
<td>95%</td>
<td>9.1 ± 0.6*</td>
<td>43%</td>
</tr>
<tr>
<td>Sepsis Trial 6</td>
<td>7 vs 9</td>
<td>67 vs 67</td>
<td>100%</td>
<td>9.3 ± 1.5*</td>
<td>82%</td>
</tr>
</tbody>
</table>


Blood
• We overestimate need for transfusion
• Increased morbidity / mortality rare in Hgb >7g/dl
• Cardiovascular collapse threshold?
  – 3-5g/dl
IF you give blood...
• Give blood in single unit doses
• AND re-assess!

Fresh Frozen Plasma
• Needs thawing*
• Correction of coagulopathy
  – INR > 2.0
  – Each unit = 0.25 decr
• Replacement of factors: II, V, VII, X, XI, PC, PS
• Plasmapheresis

Cryoprecipitate
• One Unit = 15ml (pool)
• 150 mg Fibrinogen
• 80-100 IU F VIII, vWF and F XIII
• “5 unit pool” increases fibrinogen level by 25
• Fibrinogen < 100
• Hemophilic disease
Platlets

- Plt <10: Risk of spont bleed
- Plt < 50: Pre-op
- Plt 75-100: Bleeding
Don’t use in
  - Idiopathic Thrombocytopenic Purpura*
  - Heparin Induced Thrombocytopenia

1 Pltpheresis = “6 pack”
Increases plts 30-50

Massive Transfusion

- Generally defined as replacement of an entire blood volume in 24 hrs or 50% loss in 3 hrs.
- Once MTP in effect the blood transfusions should be “automatic”
  - Protocol
  - Transfusion Medicine
Transfusion of blood products in a 1:1:1 fashion may improve mortality.
Blood Conservation

- Selective labs
- Pediatric tubes for blood draws
- Use of adjuncts
  - Iron, Multivitamin
  - Vitamin C
- Darbepoetin alpha
Adjuncts

- Vitamin K: Coumadin / Liver Dysfunction
- Desmopressin (DDAVP): ASA, Fact deficiencies
- Antifibinolitics: Surgery, thrombocytopenia, and trauma
- Conjugated Estrogens: Uremia
- rVIIa: Hemophilia, massive bleeding?
- Dialysis: Uremia
- Darbe, Epo, Iron, Vit C: Anemia

Prothrombin Complex Concentrate Profilnine®

- "Antidote" to Coumadin
- Vit K dependent proteins
- rVIIa alone does not correct warfarin coag defect

- Profilnine 4000 units (50u/kg)
  - Replenishment of factors II, IX, and X
- 1 mg rVIIa
- 10 mg Vit K

Drug / Medication Associated Bleeding Problems

- ASA: DDAVP, Plts?
- GP2b/3a, clopidigrel: Plts
- Warfarin: PCC, VitK, rVIIa
- Heparin / Lovenox: protamine
- Direct Thrombin Inhibitors: rVIIa?
- Fibrinolitic Agents: cyro, FFP, Plts, TXA

- Newer agents: ???
Transfusion Reactions

• 1: 50 transfusions has a reaction
• 1:1000 can be severe
• Unknown how many patients get evaluated for reactions

Transfusion Reactions and Complications

• Acute Hemolytic Transfusion Reactions (1:12-35,000)
• Bacterial Sepsis (1:54,000)
• TRALI (1:5000)
• Delayed Hemolytic Reaction (1:1000)
• Febrile Non-Hemolytic Reaction
• TACO (1:100)
• Allergic (1:300)

Effects on Oxygen Delivery

• Stored blood has less 2,3 DPG so less able to donate oxygen
• Studies have demonstrated no change or decrease tissue oxygen delivery after transfusion
Viral Risks of Transfusions

- Hepatitis B: 1:150,000
- Hepatitis C: 1:2,000,000
- HIV: 1:2,000,000

On average one new blood borne disease every 10 years!!!
Bottom Line

The safest blood product is the one never transfused

Take Home Message

• Blood and Blood Products are medications
  — Use them as such
• Transfusions often make the medical staff feel better and sometimes help the patient
• Don’t withhold products in the massively bleeding patient
• Surgical intervention may be needed