Emergency Blood and Massive Transfusion:

The Surgeon’s Perspective

Transfusion Medicine Update
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Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- **Agenda**
  - History
  - Hemorrhagic shock
  - Transfusion is “Bad”
  - Transfusion Prevention
  - Transfusion “The Red Chest” Concept
    - Why your hospital should have “The Red Chest” and a Massive Transfusion Protocol
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Agenda
Emergency Blood and Massive Transfusion: The Surgeon’s Perspective

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*The Surgeon’s Perspective*

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Emergency Blood and Massive Transfusion: The Surgeon’s Perspective

- History
  - 1628 William Harvey M.D. published “An Anatomical Study of the Motion of the Heart and of the Blood in Animals”, described the circulation of blood
  - 1655 Richard Lower M.D. transfuses blood between dogs in England, keeps dogs alive
  - 1818 James Blundell M.D. transfused blood to treat postpartum hemorrhage (donor was husband)
  - 1937 Bernard Fantus M.D., Cook County, established first blood bank
  - 1994 Bickell M.D. *Immediate versus delayed fluid resuscitation for Hypotensive patients with penetrating torso injuries*
  - 2003 Kenneth Mattox M.D. “Permissive Hypotension”
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Hemorrhagic shock
Emergency Blood and Massive Transfusion: 
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Emergency Blood and Massive Transfusion: The Surgeon’s Perspective

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Emergency Blood and Massive Transfusion:  
*The Surgeon’s Perspective*

- Hemorrhagic shock
  - “Hemorrhage is the most common cause of shock in the trauma patient”
  - “Hemorrhage is defined as an acute loss of circulating blood volume”

ATLS. American College of Surgeons. Chicago, 1997. p 93
Emergency Blood and Massive Transfusion: The Surgeon’s Perspective

- Hemorrhagic shock
  - Massive transfusion may be defined as the replacement of 50% or more of a patient's blood volume in 12 to 24 hours

Collins, JA. Problems associated with the massive transfusion of stored blood. Surgery 1974; 75:274.
Emergency Blood and Massive Transfusion: The Surgeon’s Perspective

- Hemorrhagic shock
Emergency Blood and Massive Transfusion: 
The Surgeon’s Perspective

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Emergency Blood and Massive Transfusion:  
*The Surgeon’s Perspective*

- Hemorrhagic shock
  - Based on Ideal body weight a 70kg male has a circulating blood of 5 liters, about 7% of body weight
  - Blood volume for a child is calculated as 8% to 9% of the body weight (80 to 90cc/kg)
  - How much volume loss causes shock?
    - Class I (donate a pint of blood)
    - Class II (uncomplicated but you need crystalloids)
    - Class III (Blood will be required)
    - Class IV (Death is pending)

ATLS. American College of Surgeons. Chicago, 1997. p 93
Emergency Blood and Massive Transfusion:
*The Surgeon’s Perspective*

- **Hemorrhagic shock**

<table>
<thead>
<tr>
<th></th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood loss</td>
<td>750 or less</td>
<td>750 – 1500</td>
<td>1500 – 2000</td>
<td>➤2000</td>
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<tr>
<td>% Blood Vol</td>
<td>&lt; 15</td>
<td>15 – 30</td>
<td>30 - 40</td>
<td>➤40</td>
</tr>
<tr>
<td>% Blood Vol</td>
<td>&lt; 100</td>
<td>&gt; 100</td>
<td>➤120</td>
<td>&gt; 140</td>
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<tr>
<td>Blood Pressure</td>
<td>Normal</td>
<td>Normal</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Pulse Pressure</td>
<td>Normal or Inc</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
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<tr>
<td>Respiratory Rate</td>
<td>14 – 20</td>
<td>20 -30</td>
<td>30 -40</td>
<td>&gt; 35</td>
</tr>
<tr>
<td>Urine output cc/hr</td>
<td>➤30</td>
<td>20 -30</td>
<td>5 – 15</td>
<td>Negligible</td>
</tr>
<tr>
<td>CNS/Mental</td>
<td>Slightly Anxious</td>
<td>Mildly Anxious</td>
<td>Anxious Confused</td>
<td>Confused lethargic</td>
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<tr>
<td>Fluid replacement</td>
<td>Crystalloid</td>
<td>Crystalloid</td>
<td>Crystalloid/blood</td>
<td>Crystalloid/blood</td>
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<tr>
<td>3:1 rule</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Hemorrhagic shock

- R. Adams Cowely M.D. “*There is a golden hour between life and death. If you are critically injured you have less than 60 minutes to survive. You might die right then; it may be three days or two weeks later – but something has happened in your body that is irreparable*”

- French World War I data, mortality from wound and treatment
  - 1 hr 10%
  - 2 hr 20%
  - 3 hr 12%
  - 4 hr 33%
  - 5 hr 36%
  - 6 hr 41%
  - 8 hr 75%
  - 10 hr 75%

Emergency Blood and Massive Transfusion:
The Surgeon’s Perspective

- Hemorrhagic shock
  - Experience has taught me often the Golden hour is Golden minutes and may be Golden seconds in our city of Detroit
    - Need blood now
    - Need to control blood loss now
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Hemorrhagic shock
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Emergency Blood and Massive Transfusion:  
*The Surgeon’s Perspective*

- Transfusion is bad
  - What we know and is fact
    - Increased Acute lung Injury
    - Increased Renal Failure
    - Increased Coagulopathy
    - Increased Infections
    - Increased Volume overload
    - Decreased Oxygen affinity
Emergency Blood and Massive Transfusion:  
*The Surgeon’s Perspective*

- Transfusion is bad
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- Transfusion is bad
Emergency Blood and Massive Transfusion: The Surgeon’s Perspective

- Transfusion Prevention
  - Factor VIIa
    - Initial FDA approval was for Hemophilia.
    - Hemophilia is a failure of platelet surface thrombin generation
    - Recombinant factor 7a, Man made protein, replicated human activated factor VII.
    - The Golden Bullet?
Human FVII gene

Amplification

Multiple copies of hFVII gene

Incorporate into BHK cells

Fermentation of BHK cells

BHK cells

hFVII = human factor VII

BHK = baby hamster kidney

hFVII Gene

Single copy of gene isolated
Emergency Blood and Massive Transfusion:  
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Factor VIIa, how does it work?
    - Tissue factor (TF) is a membrane bound glycoprotein expressed on cells in the sub endothelium.
    - Any tissue injury that disrupts the endothelium allows TF to enter circulation.
Transfusion Prevention

- Factor VIIa, how does it work?
  - TF is a high affinity receptor for rfVIIa
  - The TF/rfVIIa compound directly catalyzes the conversion of factor X to Xa.
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Factor VIIa, how does it work?
    - Xa facilitates conversion of prothrombin (II) to thrombin (IIa)
    - Thrombin aids in the conversion of fibrinogen (I) to fibrin (Ia).
    - Accumulation of fibrin into the aggregating platelets results in the formation of the primary platelet plug.
Emergency Blood and Massive Transfusion:  
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Factor VIIa, does it work?
    - Multiple citations in the literature demonstrating efficacy in hemophilia as approved by the FDA.
    - Multiple citations in the literature citing increased survival and decreased use of blood transfusions.
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Factor VIIa, Limitations
    - 1.2 mg vial $1200
    - 4.8 mg vial $4000
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Lessons from Gulf War one and two
Emergency Blood and Massive Transfusion: 
_The Surgeon’s Perspective_

- **Transfusion Prevention**
  - Lessons from Gulf War one and two
  - **FFP**
    - High ratio of FFP to PRBC increases survival
    - 246 patients at Army Combat hospital in Iraq
    - FFP: PRBC (1:1.4) 81% survival rate
    - FFP: PRBC (1:2.5) 66% survival rate
    - FFP: PRBC (1:8) 35 % survival rate
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Lessons from Gulf War one and two
  - Hypotension
Emergency Blood and Massive Transfusion:  
_The Surgeon’s Perspective_

- **Transfusion Prevention**
  - Lessons from Gulf War one and two
  - Hypotension
  - We all recall the adrenalin rush in the field or emergency center resuscitation of the post traumatic hypotensive patient. We raise the blood pressure with the "treatment de jour" and get the patient to the operating room or ICU, only to face a complication or death later. We swell with pride as we brag that the patient was normotensive when he/she left our care. For decades, we have refused to even question whether or not our aggressive hyper resuscitation contributed to that death or complication.

*Ken L. Mattox, trauma.org 8:1, January 2003 Permissive Hypotension*
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Lessons from Gulf War one and two
  - Hypotension
  - Ken Mattox M.D.
    - Permissive hypotension
    - “Pop the clot”
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Lessons from Gulf War one and two
  - Hypotension
  - Ken Mattox M.D.
    - “Pop the clot” occurs at systolic of 80
Emergency Blood and Massive Transfusion: 
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- Transfusion Prevention
  - Lessons from Gulf War one and two
  - Topical dressings
Emergency Blood and Massive Transfusion: 
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- Transfusion Prevention
  - Lessons from Gulf War one and two
  - Topical dressings
  - Quick Clot
    - Absorbs water from blood, leaving concentrate of clotting factors over site if injury
  - HemCon
    - Made from chitosan (+charge) and bonds with RBC (-charge) and a seal results over the injury
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Emergency Blood and Massive Transfusion: 
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- Transfusion Prevention
  - Lessons from Gulf War one and two
  - Tourniquets
    - Control bleeding
    - Reducing transfusion requirements
    - Saving life
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion Prevention
  - Lessons from Gulf War one and two
  - Tourniquets
Emergency Blood and Massive Transfusion: 
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- Transfusion Prevention
  - Lessons from Gulf War one and two
  - Tourniquets
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion “The Red Chest” Concept
  - Systemic hypotension
  - Systemic hypotension is a late marker of shock after trauma
    - Need Blood and need it quick

Emergency Blood and Massive Transfusion:  
*The Surgeon’s Perspective*

- Transfusion “The Red Chest” Concept
  - Systemic hypotension
  - Shock is a common and frequent treatable cause of death in injured patients and is second leading cause if death in trauma patients (TBI is number one)
Emergency Blood and Massive Transfusion: *The Surgeon’s Perspective*

- Transfusion “The Red Chest” Concept
  - Massive transfusion protocol
Emergency Blood and Massive Transfusion: 
The Surgeon’s Perspective

- Transfusion “The Red Chest” Concept
  - Massive transfusion protocol
  - Red Chest 1
    - 4 units PRBC O neg, 2 Units Thawed Plasma
  - Red Chest 2
    - Repeat Red Chest I or 4u type specific and 2 units Thawed Plasma
  - Red Chest 3
    - 4u type specific, 2 units Thawed, 10U platelets and 5 Cryo
Emergency Blood and Massive Transfusion: 
*The Surgeon’s Perspective*

- Transfusion “The Red Chest” Concept
  - Massive transfusion protocol
  - Red Chest 4
    - 4u type specific and 2 Units Thawed Plasma
  - Red Chest 5
    - 4u type specific and 2 units Thawed Plasma
  - Red Chest 6
    - 4u type specific, 2 units Thawed, 10U platelets and 5 Cryo
Emergency Blood and Massive Transfusion: The Surgeon’s Perspective

- Transfusion “The Red Chest” Concept
  - Massive transfusion protocol
  - Red Chest 7
    - Revert to red chest 4 and repeat red chest 4, 5, 6
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END, QUESTIONS?