Blood, Sweat, and Tears: ECHO Massive Transfusion Protocol!

TeleCritical Care Medicine Project ECHO
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Disclosure

The content of this presentation does not relate to any product of a commercial entity; therefore, I don’t have any relationships to report.
Learning Objectives

• Describe the principles of hemorrhagic shock and massive transfusion protocols
• Understand the lethal triad pathophysiology and association with calcium
• Formulate patient-specific treatment regimens for patients during massive transfusion protocol activation
Massive Transfusion Protocol
Patient Case

• Overhead: “Trauma one activation, here now!”
• Flip phone: “MTP activation. L&D RM x////. FIN: //////////”
• Pale patient, clenching abdomen: “I fell onto a bench doing the Milk Crate Challenge”
Background

• Hemorrhagic shock accounts for more than 60,000 deaths in the United States and 1.9 million worldwide each year
• Fluid and/or blood replacement AND treat lethal triad
• Massive Transfusion Protocols (MTP) improve survival rates
• Standardization of best practices begins with education and open discussion

# Common Causes of Hemorrhagic Shock

<table>
<thead>
<tr>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antithrombotic therapy</td>
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<tr>
<td>Coagulopathies</td>
</tr>
<tr>
<td>Gastrointestinal bleeding</td>
</tr>
<tr>
<td>Obstetric/gynecologic</td>
</tr>
<tr>
<td>Pulmonary</td>
</tr>
<tr>
<td>Ruptured aneurysm</td>
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<tr>
<td>Retroperitoneal bleeding</td>
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<tr>
<td>Trauma</td>
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</tbody>
</table>

Pathophysiology

- Hypovolemia
- Reduced cardiac output
- Hypoperfusion
- Multiorgan failure

Lethal Triad

- Coagulopathy
  - Exacerbated with hemodilution
- Acidosis
  - Reduction of coagulation factor activity
- Hypothermia
  - Inhibits thromboxane A2
  - Impaired oxygen delivery

Significance of Massive Transfusion Protocol

• Common MTP definitions
  o Transfusion of > 10 packed red blood cells (PRBC) units
  o Transfusion of > 20 units of PRBC units in 24 hours
  o Transfusion > 4 PRBC in 1 hour with anticipation of continued blood product support need
  o Replacement of > 50% total body volume by blood products within three hours

Better Outcomes with Massive Transfusion Protocol

• MTP activation impact
  o Reduced mortality and morbidity
  o Reduction in blood product requirements
  o Reduction in health-care costs

• Use your resources!
  o Save institutional-specific MTP documents onto an approved e-device
  o Quick electronic references
  o Phone/text/direct message help

O’Keeffe et al. Archives of Surgery. 2008;143:686-690
Massive Transfusion Protocol Activation

• Pre-arrival and assemble team with identification of roles
• Procurement and delivery of blood products
  o Dedicated runner
  o Access to transfusion service / blood bank
  o Prioritization of access for blood products
  o Reserve cooler
• Pertinent laboratory measures
  o CBC, type/screen, TEG, etc.
• Endpoints of transfusion

Massive Transfusion Protocol Administration

**MTP**

**Pack 1 – Whole blood (4 units)**

<table>
<thead>
<tr>
<th>Pack A</th>
<th>Pack B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 unit PLT</td>
<td>3 units PRBC</td>
</tr>
<tr>
<td>3 units PRBC</td>
<td>2 units FFP</td>
</tr>
<tr>
<td>2 units FFP</td>
<td>3 units PRBC</td>
</tr>
<tr>
<td>2 5-packs cryoprecipitate (obstetrics)</td>
<td>2 units FFP</td>
</tr>
</tbody>
</table>

PLT = platelets  
PRBC = packed red blood cells  
FFP = fresh frozen plasma

Massive Transfusion Protocol
Pharmacologic Interventions
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- Supportive care
- Calcium supplementation
- Vasopressors
- Hemostatic agents

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Supportive Care

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Supportive Care

- Permissive hypotension (SBP > 65 mmHg)
- Hemodilution with over fluid resuscitation
- Minimize crystalloid fluids (< 2L)
- Blood is the primary replacement “fluid”

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Blood Products

- Give blood as soon as possible
- Type and cross-matched PRBC are best
- Use emergency-release blood, if indicated
- Resuscitation with FFP, PLT, and PRBC
- 1:1:1 unit ratio

Lethal Triad Diamond?

- Calcium replacement is essential in maximizing other treatment modalities within the lethal triad

Sims et al. JAMA Surg. 2019 Nov 1;154(11)994-1003
Hypocalcemia and Calcium Supplementation

• More than half of trauma patients present with hypocalcemia (iCal < 1.12 mmol/L) before any blood products
• 97% of MTP patients experience hypocalcemia with 71% having severe hypocalcemia (iCal < 0.90 mmol/L)
• Higher mortality and increased blood requirements
• Overcorrection (iCal > 1.25 mmol/L) associated with increase mortality

Sims et al. JAMA Surg. 2019 Nov 1;154(11)994-1003
Vasopressors

- Advanced Trauma Life Support (ATLS) does not recommend use of vasopressors
- Priority management include hemorrhage control WITH volume resuscitation
- Increased mortality with early use of vasopressors
- May be needed to prevent circulatory arrest
- Norepinephrine and vasopressin preferred

Sims et al. JAMA Surg. 2019 Nov 1;154(11)994-1003
**Effect of Low-Dose Supplementation of Arginine Vasopressin on Need for Blood Product Transfusions in Patients With Trauma and Hemorrhagic Shock: A Randomized Clinical Trial**

<table>
<thead>
<tr>
<th>Population</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Outcome</th>
</tr>
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</table>
| Single center trial  
May 2013 – 2017  
Trauma patients (18-65 years old) who received at least 6 units of any blood product within < 12 hours (n=49) vs standard of care (n=51)  
Primary: total volume of blood product transfused at 48 hours | Arginine vasopressin (AVP)  
4 units IV bolus, then titrate drip (≤ 1.8 units/hr) for 48 hours to maintain MAP > 65 mmHg | Placebo | Primary: significantly less blood products requirements in AVP group (*median reduction of 1L*)  
Secondary: no difference in crystalloid/vasopressor requirements, mortality, and total complications |

Sims et al. JAMA Surg. 2019 Nov 1;154(11)994-1003
## Hemostatic Agents

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<tr>
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<th>Mechanism</th>
<th>Indication</th>
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<tbody>
<tr>
<td>Tranexamic acid</td>
<td>Displaces plasminogen from fibrin → inhibition of fibrinolysis</td>
<td>TBI, postpartum hemorrhage</td>
</tr>
<tr>
<td>KCentra (4F-PCC)</td>
<td>Factor II, VII, IX, X, and Protein C/S</td>
<td>Warfarin/DOAC reversal</td>
</tr>
<tr>
<td>Vitamin K (phytonadione)</td>
<td>Promotes synthesis of Factor II, VII, IX, X</td>
<td>Warfarin reversal, coagulopathy from liver disease</td>
</tr>
<tr>
<td>Andexxa (andexanet alfa)</td>
<td>Binds and sequesters factor Xa inhibitors</td>
<td>Life-threatening bleeding from factor Xa inhibitors</td>
</tr>
<tr>
<td>Protamine</td>
<td>Binds to heparin and forms a salt</td>
<td>Reversal of unfractionated heparin and low molecular weight heparin</td>
</tr>
<tr>
<td>Desmopressin</td>
<td>Increases plasma levels of von Willebrand factor, factor VIII</td>
<td>Hemophilia A, von Willebrand disease, uremic bleeding, antiplatelet reversal</td>
</tr>
</tbody>
</table>

Conclusion

• Early identification and activation of MTP improves patient-centered outcomes
• Prevention of “Lethal Triad” progression during MTP
• Avoid excessive crystalloids, prioritize blood
• Consider alternative treatments in setting of national blood shortage
• Primary goal is hemorrhage control
Patient Case

- 45M, 75kg
- Multiple gunshot wounds
- Received 2L Lactated Ringers enroute
- IV access established
- SBP 80s, alert, oriented
- “Hang fluids!”
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What fluid should be prioritized in hemorrhagic shock?

A. Sodium chloride 0.9%
B. Lactated Ringers
C. Blood products
D. Albumin
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• 19W, 68kg
• Autoped traumatic arrest with ROSC
• Initial iCal 1.02 mmol/L (10 minutes prior to MTP)
• MTP activated, Pack 1 initiated
• Refractory shock with maximal fluid resuscitation

What pharmacologic options may be considered? *(Select all that apply)*

A. Tranexamic acid
B. Calcium salts
C. Vasopressors
D. Corticosteroids
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Contact Information

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