WHEN THE BLEEDING WON’T STOP

JACQUELINE PFLAUM-CARLSON, MD
EM/IM/CCM
HENRY FORD HOSPITAL DETROIT

DISCLOSURES
NONE
OBJECTIVES

- Understand basic management principles of hemorrhagic shock in ED trauma patients
- Review management strategies for controlling hemorrhage in non compressible torso hemorrhage
- Review available heroic measures for patients with severe bleeding and hemorrhagic shock

HEMORRHAGIC SHOCK

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CLASS I</th>
<th>CLASS II (MILD)</th>
<th>CLASS III (MODERATE)</th>
<th>CLASS IV (SEVERE)</th>
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</thead>
<tbody>
<tr>
<td>Approximate blood loss</td>
<td>&lt;3%</td>
<td>15-30%</td>
<td>31-40%</td>
<td>&gt;40%</td>
</tr>
<tr>
<td>Heart rate</td>
<td>++</td>
<td>++/↑</td>
<td>↑</td>
<td>↑/↑</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>++</td>
<td>++</td>
<td>++/↓</td>
<td>↓</td>
</tr>
<tr>
<td>Pulse pressure</td>
<td>++</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>++</td>
<td>++</td>
<td>++/↑</td>
<td>↑</td>
</tr>
<tr>
<td>Urine output</td>
<td>++</td>
<td>++</td>
<td>↓</td>
<td>↓/↓</td>
</tr>
<tr>
<td>Glasgow Coma Scale score</td>
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<td>++</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Base deficit</td>
<td>0 to -2 mEq/L</td>
<td>-1 to -6 mEq/L</td>
<td>-6 to -10 mEq/L</td>
<td>-10 mEq/L or Less</td>
</tr>
<tr>
<td>Need for blood products</td>
<td>Monitor</td>
<td>Possible</td>
<td>Yes</td>
<td>Massive Transfusion Protocol</td>
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BASIC MANAGEMENT PRINCIPLES

- Control of compressible bleeding sites
  - Sutures where visible lacerations exist
  - Fracture stabilization
  - Tourniquet
- Identify non-compressible bleeding sites via imaging
- Optimal resuscitation strategy: blood is stronger than water
- Prevention of the “trauma triad”

TRAUMA TRIAD

Trauma Triad of Death

- Blood clotting problem (coagulopathy)
- Increased lactic acid in blood
- Decreased coagulation
- Severe blood loss
- Low body temperature (hypothermia)
- Acidic blood (acidosis)
- Decreased heart performance
NON-COMPRESSIBLE TORSO HEMORRHAGE

• High grade traumatic injury to pulmonary, solid abdominal organ, major vascular or pelvic regions;
  • PLUS hemodynamic instability or the need for immediate hemorrhage control
• Distribution of injury:
  • Abdomen (~40%)
  • Chest (~30%)
  • Pelvis (~25%)

NON-COMPRESSIBLE TORSO HEMORRHAGE IDENTIFICATION

• Ultrasound
• Diagnostic peritoneal lavage
• CT scan
IDENTIFICATION OF NON-COMPRESSIBLE BLEEDING

• Bedside ultrasound:
  • Fast and portable, immediately interpretable
  • Accuracy is user dependent

IDENTIFICATION OF NON COMPRESSIBLE BLEEDING

• CT scan: for hemodynamically stable patients
  • More sensitive for slower/lower volume bleeds
  • Can be both diagnostic and therapeutic
  • FACT (focused assessment with CT for trauma): reading method that interprets pan-CT’s in three minutes.
    • Developing protocols (PRESTO) for rapid CT→ IR in subset of hemodynamically unstable patients
DAMAGE CONTROL RESUSCITATION

- Refers to the concept of simultaneous hemostatic resuscitation, permissive hypotension and damage control surgery
- Starts in the ED and continues through the OR and the ICU
VOLUME RESUSCITATION

- Favor blood over crystalloid
  - Data shows patients who receive >1.5L crystalloid resuscitation have worse outcomes.
  - Goal should be to reduce organ hypoperfusion while awaiting appropriate blood products.
    - Permissive hypotension, hypotensive resuscitation, etc.
  - Both saline and lactated ringers have drawbacks in high volumes and no study has demonstrated an overwhelming benefit of one versus the other.

BLOOD TRANSFUSION

- 1:1:1 (hemostatic) transfusion strategy with higher ratios of plasma and platelets than packed PRBC’s
- Activate your institution's massive transfusion protocol according to institutional guidelines.
- Warmed volume resuscitation is preferred when there is time and capability

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<td>Heart rate</td>
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</tr>
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ANTICOAGULATION REVERSAL

• Consider if there are any anticoagulants on board that require reversal- especially in the elderly.

• Institutional availability
  • Warfarin: 4PCCC (unactivated prothrombin complex concentrate) preferred over 3 PCC over FFP plus vitamin k
  • Direct thrombin inhibitors (dabigatran, rivaroxaban, apixaban, etc)
    • Dabigatran: idarucizumab (Praxbind) > FEIBA (factor 8 inhibitor bypassing activity) > TXA (tranexamic acid)
    • Rivarox, apixaban, etc: andexanet alfa (AndexXa) > 4PCC > TXA
TRANEXAMIC ACID

• Synthetic lysine analogue, antifibrinolytic drug that interferes with plasminogen binding to fibrin and prevents clot breakdown.

• CRASH-2 trial: adult trauma patients with significant bleeding, or risk of significant bleeding from traumatic injury randomized into TXA infusion v. Placebo
  • TXA dosing 1g loading dose over 10 minutes, then 1 gm over 8 hours
  • Showed that early administration of TXA (within 3 hours) reduced the risk of death
  • NO difference in number of patients requiring blood or in the number of RBC’s transfused.

• WOMAN trial: post partum hemorrhage
  • Maybe a benefit if given early

• CRASH-3: TXA in ICH
  • Fewer head injury related deaths if given within 3 hours.

THROMBOELASTOGRAPHY (TEG)

• TEG looks at the viscoelastic properties of clot formation in real time.

• Can be used in the resus room while evaluating patients response to resuscitation.
  • Observational studies have demonstrated effectiveness of protocols based on teg values
  • Denver health TEG based transfusion strategy
ROLE OF INTERVENTIONAL RADIOLOGY

- Transarterial embolization:
  - Most common solid organ injury is the spleen.
  - IR is now most preferred method of hemostasis for splenic bleed in hemodynamically stable patients.
  - Can also be utilized for renal and other retroperitoneal injuries
  - Pelvic trauma (after binding/fixation): bleeding usually from venous plexus bleeding or iliac vessel injury
  - IR capabilities include embolization with coils and temporary occluders (gelfoam or slurries), balloon occlusion devices, and stenting.
  - Temporary balloon catheter ablation

AORTIC OCCLUSION

- Traditionally obtained by cross clamping the aorta after thoracotomy in the ED or abdominal access in the OR.
  - High mortality with high morbidity
- Military anti shock trousers (mast) without proven benefit
- Intraperitoneal expanding foam
REBOA

RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA

- Indicated for use in abdominal or pelvic hemorrhage to preserve flow to brain and heart
- Less invasive than thoracotomy
- Can be inserted in the ED, IR suite, or OR.
REBOA ZONES

- Zone I may be used as a “physiologic bridge” to the OR in abdominal hemorrhage
  - <15 minutes
- Zone II = Rarely, if ever, used.
- Zone III for pelvic hemorrhage
  - Can be used while awaiting IR or OR

REBOA USES AND COMPLICATIONS

- Algorithms for placement and use are not well-defined
  - Small studies have demonstrated some survival benefit but patient identification indication is limited
    - Recent studies for zone 1 REBOA showed higher mortality in REBOA group, although case series seem to demonstrate lower mortality
    - Zone III has no definitive data and most case series do not show positive outcomes.
  - Would conventional therapies offer the same outcomes?

- Complications:
  - Limb ischemia leading to limb loss (~2%)
  - End organ failure
  - Arterial injury at site of insertion
  - Thromboembolic events related occlusion
  - Pseudoaneurysm (most common)
REBOA: COMING TO AN ER NEAR YOU?

• Ongoing preclinical trials
• 2018 ACEP and ACS COT joint statement:
  • “no current, high-grade evidence clearly demonstrates REBOA improves outcomes or survival compared to standard treatment of severe hemorrhage.”
  • Reboa is less invasive than traditional methods, but in skilled hands can be useful and acute care surgeons can learn and safely place reboa after a formal training course
  • EMCC with additional REBOA training OR EM with advanced military training can place only if vascular or ACS available
  • REBOA should be placed by acute care surgeon or interventional radiologist and ACS should be immediately available for long term management of hemorrhage
• Updated guidelines recommend that there is still no good data supporting its use but if you plan to do so, a multidisciplinary team needs to be in place.

TAKE HOME POINTS

• Avoid the trauma triad
• Give blood early and always with plasma and platelets
• Utilize appropriate imaging for suspected ongoing hemorrhage, with IR on call for assistance
• If you have TEG, use it
• Know your reversal and “rescue” agents
THANK YOU