Management of the Trauma Patient

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Trauma and Surgical Critical Care
Critical Care Symposium
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Saturday Night

- 25 yo M s/p high speed MVC
- Hypotensive in the ED, altered
- OR for laparotomy & thoracotomy
- Injuries:
  - Unknown head injury
  - Hemothorax with lung resection
  - Bowel injury with resection
  - Pelvic fracture
  - Near amputation lower leg
Arrival to the ICU

• *Per operating surgeon:*

“25 yoM, high speed MVC, nearly died in the ED. I took him to the operating, did an exlap, thoracotomy, controlled the bleeding. I gave a bunch of blood. He should do fine, not much else for you to do…just keep him alive.”
Arrival to the ICU

• Translation:
  – Multi-system trauma
  – Massive resuscitation
  – Possible ongoing bleeding
  – Unknown volume status
  – Incomplete injury workup
  – Long night ahead
What can I do in the ICU?
Trauma Care in the ICU

1. Hemorrhage Control
2. Coagulopathy of Trauma
3. Damage Control Resuscitation
4. Balanced Transfusion
#1 Cause of Death in Trauma

= Hemorrhage
Hemorrhagic Shock

- Physiologic Response
  - Tachycardia
  - Vasoconstriction
  - Narrowed pulse pressure
  - Hypotension
<table>
<thead>
<tr>
<th>Class</th>
<th>Blood Loss</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&lt;15%</td>
<td>HR&lt;100</td>
</tr>
<tr>
<td>II</td>
<td>15-30%</td>
<td>HR&gt;100, Orthostatic</td>
</tr>
<tr>
<td>III</td>
<td>30-40%</td>
<td>HR&gt;120, Hypotension, Confusion</td>
</tr>
<tr>
<td>IV</td>
<td>&gt;40%</td>
<td>HR&gt;140, Profound Hypotension, Lethargy</td>
</tr>
</tbody>
</table>
Uncontrolled Hemorrhage

↓

Coagulopathy
COAGULOPATHY OF TRAUMA

✓ 3-4x Mortality if Coagulopathic
Acidosis

Hemodilution

Hypothermia

COAGULOPATHY
Coagulopathy of Trauma

- Transfusion requirement
- ICU length of stay
- Hospital length of stay
- Mechanical ventilation days
- Incidence of MODS
Rule #1

Stop the Bleeding!
Arrival to the ICU

- Temporary abdominal closure
  - 200cc in the wound vac canister since transport
- Near amputation
  - dressings soaked with blood
- Pelvic fracture
  - no intervention
Compressible Hemorrhage

When the patient arrives:

✓ Check all pulses
✓ Check all dressings
✓ Direct pressure when needed
Hemorrhage Control

- External Compression
  1. Tourniquets
  2. Binders
Extremity Trauma

• Tourniquets/Direct Compression
Tourniquets
Tourniquets

Trauma care in the ICU
Pelvic Trauma

Potentially Compressible!
Who Bleeds?

• Pubic symphysis diastasis > 2.5 cm
• Sacroiliac joint disruption
• Persistent hemodynamic instability
• Active extravasation on CT scan
• Advanced age + major pelvic fracture
Pelvic Binder

No Binder

Binder
Pelvic Binder: How to?

Position over the greater trochanters
Pelvic Binder: Why?

Goals

1. Decrease pelvic volume
2. Hemorrhage control
3. Stabilize fracture
Iliac Wing Fractures
Rule #2

If you can’t stop it from the outside, try from the inside!
Hemorrhage Control

- Pharmacologic Agents
  1. Tranexamic Acid
  2. Prothrombin Complex Concentrate
Tranexamic Acid

• Anti-fibrinolytic
• Inhibits plasminogen to plasmin
• Who should get it?
• When should I give it?
20,211 patients, 40 countries

Broad inclusion criteria

~ 50% received blood transfusion

Does TXA influence outcome?
CRASH-2

✓ Decreased Mortality
- 14.5% vs 16.0%

✓ Less Mortality from Hemorrhage
- 4.9% vs 5.7%

✓ Mortality benefit at ≤ 3hrs
896 patients total, Military

293 patients received TXA

All patients received transfusion
Patients receiving TXA had:

- Improved coagulopathy
- Improved survival
- Most apparent in MTP
Bottom Line: TXA

• Anti-fibrinolytic
• May decrease transfusion requirement
• May decrease mortality
• Low side effect profile
• Remember to give early!
Surgeon’s Addendum

- One hour later...

“By the way, I think the ED nurse said he was taking warfarin at home for a DVT…”
Rule #3

Reverse Coagulopathy!
Special Considerations

The Anti-coagulated Trauma Patient
Anti-Coagulation in Trauma

- Mortality
- Morbidity
Everyone is doing it!

- Atrial Fibrillation
- Stroke
- Myocardial Infarction
- DVT/PE
- Heart Disease
- Valve Disease
- CAD
- PVD
- Arthritis
Aspirin

- 19.3% adults (43 mil)
- 48.5% adults ≥ 65
Warfarin

- 4.0% trauma patients
- 12.8% trauma patients > 65yrs

Warfarin + Trauma = Increased Mortality
Warfarin

- Vitamin K antagonist (VKA)
  - Factor II, VII, IX, X

- How can we reverse?
Warfarin Reversal

1. Vitamin K
2. Fresh Frozen Plasma (FFP)
3. Prothrombin Complex Concentrate
Vitamin K

• Dosing
  • IV: 5-10 mg
    • Anaphylaxis: 3 in 10,000*

• Onset of action
  • IV 6-8hrs
Fresh Frozen Plasma

- Contains coagulation factors
- Approximately 250cc/unit
- Initial dosing: 10-15 cc/kg
- Onset: immediate
- Duration: 6hrs
FFP: Concerns?

✓ ABO typing
✓ Thawing prior to administration
✓ Large volume load
✓ Time for infusion
✓ Repeat INR checks to titrate dose
✓ Potential viral transmission
Prothrombin Complex Concentrate
PCC
Clotting Factor Concentrate
What is it?

- 25x concentration
- Lyophylized powder
- Small volume
- Virus inactivated
- No ABO type required
- Immediate Onset
What is in it?

<table>
<thead>
<tr>
<th>4 Factor PCC</th>
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</thead>
<tbody>
<tr>
<td>II</td>
</tr>
<tr>
<td>VII</td>
</tr>
<tr>
<td>IX</td>
</tr>
<tr>
<td>X</td>
</tr>
<tr>
<td>Protein C &amp; S</td>
</tr>
<tr>
<td>Antithrombin III</td>
</tr>
<tr>
<td>Heparin</td>
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When to give it?

FDA Approval

“...indicated for the urgent reversal of ...VKA therapy in adult patients with acute major bleeding...”
“For patients with VKA-associated major bleeding, we suggest rapid reversal of anticoagulation with four-factor prothrombin complex concentrate rather than with plasma”
How much to give?

<table>
<thead>
<tr>
<th>Pre-treatment INR</th>
<th>2 - &lt;4</th>
<th>4-6</th>
<th>&gt;6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose 4F PCC Units/Kg</td>
<td>25</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>Max Dose</td>
<td>Not to exceed 2500</td>
<td>Not to exceed 3500</td>
<td>Not to exceed 5000</td>
</tr>
</tbody>
</table>

Dosing based on units Factor IX/kg body weight.
<table>
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<tr>
<th></th>
<th>4F-PCC (n=103)</th>
<th>FFP (n=109)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Infusion Volume</td>
<td>99.4 mL</td>
<td>813.5 mL</td>
</tr>
<tr>
<td>Duration Administration</td>
<td>17 min</td>
<td>148 min</td>
</tr>
</tbody>
</table>
Advantages: 4F PCC

☑ Easy Accessibility
☑ Low Volume Administration
☑ Rapid Infusion
☑ Rapid Onset of Action
☑ Effective Hemostasis
Saturday Night

- Ongoing hemorrhage controlled

- Now what?
What principles guide trauma patient resuscitation?

- Reversal of coagulopathy
- Balanced resuscitation
Trauma care in the ICU

Acidosis

Hemodilution  

Hypothermia

COAGULOPATHY
Damage Control Resuscitation

1. Limited crystalloid resuscitation

2. Early blood products plasma transfusion
Aggressive Fluid Resuscitation

- Decreased survival
- Increased coagulopathy
- Increased ARDS
- Abdominal compartment syndrome
- Increased trauma related SIRS
Crystalloidal = Morbidity

- SSI
- UTI
- Bacteremia

- Sepsis
- ARDS
- ARF
IVF Resuscitation

Limit crystalloid infusion
Rule #4

Don’t Miss Abdominal Compartment Syndrome!
Abdominal Compartment Syndrome

- High intra-abdominal pressure
- Strangulation of abdominal contents
Abdominal Compartment Syndrome Signs/Symptoms

- Increased abdominal distention
- Decreased urine output
- Increased peak airway pressures
- Hypotension
- Increased bladder pressures
Abdominal Compartment Syndrome Treatment

- Diuresis
- Sedation/Paralysis
- Decompression
Damage Control Resuscitation

1. Limited crystalloid resuscitation

2. Early blood products plasma transfusion
Balanced Resuscitation

• Early Product Administration
Blood Transfusion
PRBC:FFP ratios

• **Historical/Military:**
  – Whole blood

• **Current Trend:**
  – Component therapy
  – PRBC:FFP ratios
Does PRBC:FFP influence outcome?
Does FFP:PRBC influence outcome?

Increased FFP:PRBC

✓ Decreased Mortality
✓ Decreased Mortality due to Hemorrhage
✓ Independent predictor of survival
Does FFP:PRBC influence outcome?

- Increased FFP = Decreased Mortality
  - 41% vs 62% mortality
- Independent predictor of survival
Transfusion Goals

How much FFP is enough?
Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients With Severe Trauma
The PROPPPR Randomized Clinical Trial

PROPPPR
Pragmatic Randomized Optimal Platelets and Plasma Ratios

1:1:1 vs 1:1:2
PROPPR
Pragmatic Randomized Optimal Platelets and Plasma Ratios

✓ No difference in mortality
✓ No safety difference

1:1:1
✓ Earlier hemostasis
✓ Lower mortality due to exsanguination
Transfusion Goals

Why don’t we give FFP to everyone?
Patients with < 10u PRBC in 12hrs

- FFP transfusion increased:
  - ARDS
  - MSOF
  - PNA
  - Sepsis

- No survival benefit
Transfusion Goals

1. In Massive Transfusion, higher FFP ratios likely beneficial

2. FFP has a physiologic price

- Reserve use for massive transfusion
Rules #5 and 6

Give blood early

Balance resuscitation
Sunday Morning

- Dressings dry
- Hgb stable
- INR 1.2
- HR 95, BP 100/60
- UO 30cc/hr

...next patient rolling in...
Summary

• Identify ongoing hemorrhage
  – External compression
  – Pharmacologic agents

• Reversal of coagulopathy

• Minimize crystalloid infusion

• Balanced resuscitation
Trauma care in the ICU