Declarations of Conflict of Interest

• I have nothing to declare.
• I don’t own much stock, let alone anything medical (and I have a daughter in college . . .)
• I have given up on a company wanting to hire me
• I do play golf but not very well. . .
Objectives

- **Trauma Pitfalls--overview**
  - Human Factors
  - Team Dynamics
  - Medical Care

- **Lethal Trauma Triad—new concepts:**
  - Physiologic Reserve
  - Acute Traumatic Coagulopathy
  - Damage Control Resuscitation/DCSurgery
Coagulopathy and Trauma

• Trauma leading cause of death people < 40 years

• Uncontrolled hemorrhage responsible 50% of trauma deaths within 48 hr of admission

• About 25% of severely injured patients present with coagulopathy to the Emergency Department
  - Acute traumatic coagulopathy (ATC)

Maegele, Shock, 2014
TRAUMA PITFALLS
“Swiss Cheese” Model for errors

Reason J. Human error: models and management. BMJ 2000;320:768–70;
I. Human Factors

1. 23 y o male patient is hypotensive, tachycardic, GCS 7 after GSW to abdomen x 2
   • Tx: laparotomy

2. 25 y o male MVA snowmobile agitated, GCS 10, HR 97, BP 110 sys
   • Tx: transfer for head injury

3. 56 y o male has acute onset LLQ pain, chills for past 24 hours. HR 90, BP 124, Temp 37.4
   • Tx: acute diverticulitis
Human Factors:

3 most common and serious decision errors

1. **Diagnostic Labelling**
   - Premature or presumptive Diagnosis
   - Others assume is definitive, despite lack of evidence
   - Case One: Bullet tracked to L Chest, had tension hemopneumothorax, died.

2. **False-Negative Prediction**
   - Assuming lack of findings means no problem exists
   - Case Two: died on transfer to tertiary care from exsangination, ruptured spleen

3. **False Attribution**
   - Findings are incorrectly attributed to another cause
   - Died at home, ruptured AAA 2 days later
II. Trauma Team Dynamics

• **Errors in resuscitation room more often happen as a result of Team Dynamics failure than from medical errors.**

• Situational awareness and responsiveness is a critical determinant of successful management.

• Errors in:
  - Communication
  - Situational Awareness
  - Workload distribution or staffing
  - Conflict Resolution including leadership or management plans
Trauma Team Dynamics—5 hints

- Patients should generally be managed according to the worst “reasonable case” scenario.
- Constantly reassess, never assume “stability.”
- Trauma is a team sport.
- Maintain the “clock speed” for diagnosis and management.
- Never become married to the initial diagnosis.
III. Medical Care Issues—7 Hints

• Airway Issues
  • Esophageal intubation, difficult airway

• Failure to Recognize Hemorrhagic Shock
  • Ongoing strain on physiologic reserve

• Failure to properly assess Abdomen & Pelvis

• Cardiac Tamponade

• Physiologic traps in special populations

• Procedural pitfalls

• Missed Injuries:
  • Intestinal, pancreatic, Cervical spine, Cerebrovascular, Blunt Aortic Injury
Airway Issues

• Esophageal Intubation

• Difficult Airway
Most Common Error in Trauma Management?

- Because abdominal injuries may be severe without manifesting overt clinical signs or symptoms, the abdominal examination is notoriously unreliable in the trauma patient.

- the failure to appropriately evaluate the abdomen has been identified as the most common error in trauma management
Slow or Incomplete Response to “BAD” Pelvic Fracture: Top 5 Hints to improve outcomes

Patients do not tolerate delay

1. Pelvic Binders for external compression
2. Massive Transfusion Protocols (MTP)
   - 1:1:1 ratio of PRBCs, FFP, Platelets
3. CT with contrast: search for active bleeding amenable to embolization
4. Hypothermia precautions
5. Early ICU/anesthesia management/Monitoring
III. Medical Care Issues 2

- Cardiac Tamponade
- Physiologic traps in special populations
- Procedural pitfalls
- Missed Injuries:
  - Intestinal,
  - pancreatic,
  - Cervical spine,
  - Cerebrovascular,
  - Blunt Aortic Injury
- Failure to Recognize Hemorrhagic Shock—Lethal Triad
  - Ongoing strain on physiologic reserve
Tissue Injury & Shock . . .
Lethal Triad = Mortality:

- **Acidosis**
  - **Shock State**
    - Tissue hypoperfusion and hypoxia
    - Physiologic and proinflammatory disruption
    - Resulting coagulopathy

- **Hypothermia**
  - Mortality is increased in trauma patients with temperatures below 32°C (<89.6°F).
  - Effect may be due to low temperature effects on coagulation;
  - Impairs thrombin production and platelet function

- **Dilution**
  - Large volume resuscitation led to higher in hospital complications such as ARDS, multiorgan failure, etc.
  - Clotting factor depletion--coagulopathy
1. Acidosis, high lactate: Uncompensated or Partially Compensated Shock

Graph showing systolic blood pressure (BP) over time with symbols indicating fluid bolus given.
2. Acute Traumatic Coagulopathy

- **ATC**: direct tissue injury plus blood loss
- One quarter of all major trauma patients
- **Consequences**
  - Increased transfusion requirements
  - Increased multi organ failure
  - Longer length of ICU
  - Longer length mechanical ventilation
  - 3 – 4 times risk of hemorrhage
  - 8 x risk of death: first 24 hr.
Direct Tissue Injury Plus Shock State: Acute Traumatic Coagulopathy

Taken together:

- recognition of ATC and
- benefits of plasma-based resuscitation
- represent a paradigm shift in the resuscitative conduct after severe trauma.

- towards hemostatic resuscitation: the changing understanding of acute traumatic biology, massive bleeding, and damage-control resuscitation.

3. Hypothermia

- **Patients with severe trauma are prone to hypothermia and have increased mortality**
  - environmental heat loss.
  - Concurrent alcohol intoxication
  - exposure during resuscitation and rapid administration of cold fluids.

- **not clear if increased mortality is a result of hypothermia or that hypothermia is merely an indicator of severe injury and response to a massive transfusion of cold fluid**

- **Concept of Controlled Hypothermia in Trauma being explored**

Roberts: Roberts and Hedges’ Clinical Procedures in Emergency Medicine, 6th ed. © 2013 Saunders, Section XII – Special Procedures Chapter 65 – Procedures Pertaining to Hypothermia and Hyperthermia
Heather M. Prendergast, Timothy B. Erickson
Trauma Injury Pathways

Emerg Med J, 2010
## Risk of ATC

<table>
<thead>
<tr>
<th>Condition</th>
<th>% ATC</th>
</tr>
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<tbody>
<tr>
<td>Moderate Injury</td>
<td>1%</td>
</tr>
<tr>
<td>ISS &gt;25 + ↓BP</td>
<td>39%</td>
</tr>
<tr>
<td>+ pH &lt; 7.1</td>
<td>58%</td>
</tr>
<tr>
<td>+ Temp &lt;34</td>
<td>98%</td>
</tr>
</tbody>
</table>

Cosgriff, J. Trauma, 1997
Risk of ATC & Hemodilution

- Aggressive crystalloid, colloid resuscitation in absence of plasma increases likelihood of coagulopathy

<table>
<thead>
<tr>
<th>Volume Fluids</th>
<th>% Coagulopathy</th>
</tr>
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<tbody>
<tr>
<td>500 ml</td>
<td>10</td>
</tr>
<tr>
<td>2000 ml</td>
<td>40</td>
</tr>
<tr>
<td>3000 ml</td>
<td>50</td>
</tr>
<tr>
<td>4000 ml</td>
<td>80</td>
</tr>
</tbody>
</table>

Maegele, Injury, 2007
ATC with Isolated Brain Injury

- Meta-analysis of 22 studies
- ATC 35.2% (95% CI 29 – 41%)
- Mortality varied 17 – 86%

- ATC associated with
  - higher mortality
  - higher transfusion rates
  - longer length of stay
  - increased days on ventilator

Epstein, Injury, 2014
Fixing Shock & Coagulopathy: Thinking Outside the Box . . .
Damage Control Resuscitation DCR

- Data on two fronts led to the current concept of hemostatic damage control resuscitation (DCR).
  1. discovery and initial characterization of acute traumatic coagulopathy (ATC).
  2. discovery of the benefits of directly addressing hemostatic resuscitation
Damage Control Resuscitation DCR

- **Premise** that each patient has a limited amount of physiologic or biologic reserve before irreversible inflammatory perturbations, organ damage, and mortality occur.

- Without any resuscitation, the time before physiologic exhaustion and death is extremely short.

- Resuscitation is aimed at **improving physiologic reserve**.
Damage Control Resuscitation & Surgery: DCR & DCS

DCR:

- Proper resuscitative conduct seeks to extend reserve, thereby allowing intervention and repair of injuries without the patient exhausting this physiologic and inflammatory reserve.
- Results in mortality benefits by extending this period, which allows intervention and survival.

DCS:

- The next step is attenuating the surgical interventions through the concept of damage control to avoid accelerating physiologic collapse.
Goal: Improve mortality--DCR/DCS

To prevent exhaustion of physiologic reserve:

- **Fix hypovolemia early**, using products that
- **Reverse Coagulopathy**, and correct
- **Hypothermia**
  - Warm patient/fluids

- **Use Damage Control Surgical methods** with definitive repair later
What are you thinking about right now?