Initial Assessment and Management of the Multiply Injured Patient

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Disclosures

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The issues...
Outline

• Evaluation of the polytrauma patient
• Scoring Systems important to polytrauma
• Urgencies and Emergencies
• MOF, ARDS
• Physiologic responses to trauma
• Definition of *Damage Control Orthopaedics*, (DCO)
• History of DCO and *Early Total Care*, (ETC)
• Evidence for DCO
• Occult Hypoperfusion and Resuscitation
• Modes of DCO
• Timing of definitive fixation in DCO
Evaluation of the polytrauma patient

• ATLS
• Primary Survey
  – Airway
  – Breathing
  – Circulation
  – Disability
  – Exposure/Environmental Control
• Secondary Survey
• Tertiary Survey
Evaluation of the polytrauma patient

- Primary Survey
  - Airway
    - Establishment of an airway with regard for associated cervical spine injury
    - Clinical evaluation for obstruction
      - Facial fractures, mandible fractures, laryngeal or tracheal injury, aspiration, foreign body
Evaluation of the polytrauma patient

• Primary Survey
  – Breathing
    • Clinical and radiographic (CXR) evaluation
    • ABG
    • Common causes of hypoxemia:
      – Flail chest with contusion, tension pneumothorax, open pneumothorax
Evaluation of the polytrauma patient

• Primary Survey
  – Circulation
    • Clinical and radiographic (CXR, pelvic XRay evaluation)
    • Application of circumferential sheet or binder where indicated
    • Application of direct pressure to areas of obvious hemorrhage
    • Initiation of resuscitation
Evaluation of the polytrauma patient

• Primary Survey
  – Disability
    • Neuro evaluation
Evaluation of the polytrauma patient

• Primary Survey
  – Exposure/Environmental Control
    • Clinical evaluation to identify occult injuries
    • Rewarming of patients
Evaluation of the polytrauma patient

• Must differentiate hemorrhagic shock from shock secondary to other etiologies:
  – Neurogenic
  – Cardiogenic
Evaluation of the polytrauma patient

• Initiation of Resuscitation

• Anticipated needs based on degree ("Class") of hemorrhage at presentation
  – Crystalloid
    • 1-2 L crystalloid
  – Assess response
    • Rapid, transient, or minimal/none
Class of Hemorrhage

- Class I: up to 15% (750cc) blood volume loss
- Class II: 15-30% (750-1500cc) blood volume loss
- Class III: 30-40% (1500-2000cc) blood volume loss
- Class IV: >40% (>2000cc) blood volume loss
# Class of Hemorrhage

<table>
<thead>
<tr>
<th></th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blood loss (mL)</strong></td>
<td>Up to 750</td>
<td>750-1500</td>
<td>1500-2000</td>
<td>&gt;2000</td>
</tr>
<tr>
<td><strong>Blood loss (%) of volume</strong></td>
<td>Up to 15%</td>
<td>15-30%</td>
<td>30-40%</td>
<td>&gt;40%</td>
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<tr>
<td><strong>Heart rate</strong></td>
<td>&lt;100</td>
<td>100-120</td>
<td>120-140</td>
<td>&gt;140</td>
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<tr>
<td><strong>Blood pressure</strong></td>
<td>Normal</td>
<td>Normal</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td><strong>Pulse pressure (mmHg)</strong></td>
<td>Normal</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td><strong>Respiratory rate</strong></td>
<td>14-20</td>
<td>20-30</td>
<td>30-40</td>
<td>&gt;35</td>
</tr>
<tr>
<td><strong>Urine output (mL/hr)</strong></td>
<td>&gt;30</td>
<td>20-30</td>
<td>5-15</td>
<td>Negligible</td>
</tr>
<tr>
<td><strong>Mental status</strong></td>
<td>Slightly anxious</td>
<td>Mildly anxious</td>
<td>Confused</td>
<td>Lethargic</td>
</tr>
</tbody>
</table>
Blood Transfusion

• Transient or nonresponders to crystalloid (Class III/IV hemorrhage) will require transfusion
• Cross-matched, Type-specific, or Type O blood given based upon timing of need
Massive Transfusion

• Greater emphasis on more balanced product administration
  • *Damage control resuscitation*
    • 1:1:1 ratio of pRBC:plasma:platelets
Evaluation of the polytrauma patient

• Further Imaging
  – FAST
  – CT
Evaluation of the polytrauma patient

- FAST (focused assessment with sonography for trauma)
  - Intraabdominal free fluid
  - Pericardial effusion
  - Solid organ injury (limited sensitivity)

Evaluation of the polytrauma patient

• Secondary Survey
  – Complete physical exam with updating of patient’s history
  – Incorporates information from ongoing studies (FAST, CT, extremity XRays, etc.)
  – Usually within first 12-24 hours after injury
Evaluation of the polytrauma patient

• Tertiary Survey
  – Repeat physical exam with review of any additional labs and radiographs
  – 12% of injuries in polytrauma patients are missed in first 24 hours
  – Standardized tertiary survey has shown to decrease missed injuries by 36%

Scoring Systems

• Glasgow Coma Scale
• Abbreviated Injury Scale
• Injury Severity Score
• New Injury Severity Score
Glasgow Coma Scale

- Summation of **best** motor, verbal, eye response
- Observer dependant
- Predictive of mortality (admission > field)
- Affected by pharmacological agents, level of resuscitation

- **Eye Opening**
  - Spontaneous: 4
  - To voice: 3
  - To pain: 2
  - None: 1

- **Verbal Response**
  - Oriented: 5
  - Confused: 4
  - Inappropriate words: 3
  - Incomprehensible sounds: 2
  - None: 1

- **Motor Response**
  - Obeys commands: 6
  - Localized pain: 5
  - Withdraw to pain: 4
  - Flexion to pain: 3
  - Extension to pain: 2
  - None: 1
Abbreviated Injury Scale (AIS)

- 9 anatomic areas:
  - Head
  - Face
  - Neck
  - Thorax
  - Abdomen
  - Spine
  - Upper Extremity
  - Lower Extremity
  - External
Abbreviated Injury Scale (AIS)

- Each area scored from 0 to 6
- Values are consensus driven
- Values found in “dictionary”

0 None
1 Minor
2 Moderate
3 Serious
4 Severe
5 Critical
6 Not survivable
Abbreviated Injury Scale

• Examples:
  – Femur fracture → serious, AIS=3
  – Pulmonary contusion → serious, AIS=3
  – Flail chest → severe, AIS=4
Injury Severity Score (ISS)

- Calculated from AIS
- Highest AIS value from each individual anatomic area (6)
  - Head/ neck
  - Face
  - Chest
  - Abdomen
  - Extremities including pelvis
  - External
- Three highest AIS values (from different anatomic areas)
  - squared
  - summed

\[ \text{AIS}^2 + \text{AIS}^2 + \text{AIS}^2 \]
Injury Severity Score (ISS)

• Highest Score: 75 (not survivable)
  – AIS of 5 in three anatomic areas
  – AIS of 6 in any anatomic area
Injury Severity Score (ISS)

- Defines polytrauma
  - ISS ≥ 18
- Correlates with:
  - Morbidity
  - Mortality
  - Length of hospital stay
Injury Severity Score (ISS)

• A problem with ISS...
Injury Severity Score (ISS)

• A problem with ISS... injuries within the same anatomic system are only counted once
ISS and Bilateral Femur Fractures

Unilateral Femur fracture ≠ Bilateral Femur fractures
Bilateral Femur Fractures

• Historical mortality rates ~40%
Bilateral Femur Fractures

• Independent risk factor for ARDS

Bilateral Femur Fractures
Contemporary Results

- 5.6% mortality
- Treated with retrograde IMN at same setting

Bilateral Femur Fractures
Contemporary Results

• 6.9% overall mortality
• 60/72 patients treated definitively <24hours (2 patients died before fixation)
• 2 patients treated with external fixation
• Results:
  – 0% ARDS; 2.9% MOF
  – 3 deaths after fixation
    • 2/3 → MOF (s/p IMN <24hr)
  – “not possible to determine which patients may be safely treated with early definitive fixation”

New Injury Severity Score (NISS)

• Three highest AIS values regardless of anatomic region are utilized
• May be a better predictor of morbidity and mortality
Life > Limb
in the initial treatment of polytrauma patient

• However, care of the orthopaedic injuries does impact mortality
• Orthopaedic urgencies and emergencies must be treated within overall context of polytraumatized patient’s condition
Orthopaedic Urgencies and Emergencies

- Unstable pelvic fractures
- Fractures or dislocations with associated vascular injuries
- Acute compartment syndrome (ACS)
- Spine injury with deficit
- Joint dislocations or fracture/dislocations with neurologic or potential neurologic sequelae
- Joint dislocations associated with avascular necrosis
- Fractures or dislocations with associated soft tissue compromise
- Open fractures
Urgencies and Emergencies

- Unstable pelvic fractures
Urgencies and Emergencies

- **Unstable pelvic fractures**
  - Associated with significant transfusion requirements
  - Initial Treatment:
    - Mechanical stabilization
    - Assessment of response to resuscitation
      - Angiography
      - Pelvic Packing

Urgencies and Emergencies

- Fractures or dislocations with associated vascular injuries
Urgencies and Emergencies

- Fractures or dislocations with associated vascular injuries
  - Initial Treatment:
    - Control hemorrhage (direct pressure)
    - Realign limb
    - Splint
    - Further evaluation (intraop arteriogram, etc.)
    - Vascular repair +/- skeletal stabilization
Urgencies and Emergencies

- Acute compartment syndrome (ACS)
Urgencies and Emergencies

• Acute compartment syndrome (ACS)
  – Initial treatment:
    • Remove splint or dressing
    • Place extremity at level of heart
    • Emergent fasciotomy
Urgencies and Emergencies

• Spine injury with deficit
Urgencies and Emergencies

- Spine injury with deficit
  - Initial treatment:
    - Immobilization to prevent further neurologic insult
    - Further treatment depends upon injury (consider reduction when appropriate)
Urgencies and Emergencies

- Traumatic amputations
Urgencies and Emergencies

• Traumatic amputations
  – Control of bleeding (tourniquets or direct pressure)
  – Obtain definitive proximal control of bleeding
  – Situation will dictate whether *urgency* or *emergency*
Urgencies and Emergencies

• Joint dislocations or fracture/dislocations with neurologic or potential neurologic sequelae
Urgencies and Emergencies

- Joint dislocations or fracture/dislocations with neurologic or potential neurologic sequelae

- Initial treatment:
  - Emergent Reduction
  - Assessment of vascularity
    - Physical Exam
    - Ankle Brachial Index (ABI)
    - Arteriogram
Urgencies and Emergencies

- Joint dislocations associated with avascular necrosis
Urgencies and Emergencies

- Joint dislocations associated with avascular necrosis
  - Initial treatment:
    - Emergent Reduction
Urgencies and Emergencies

• Fractures or dislocations with associated soft tissue compromise
Urgencies and Emergencies

- Fractures or dislocations with associated soft tissue compromise
  - Initial treatment:
    - Emergent Reduction
Urgencies and Emergencies

- Open fractures
Urgencies and Emergencies

• **Open fractures**
  – **Initial treatment:**
    • Sterile dressing, restore alignment/stabilize limb
    • **Antibiotics**
    • Tetanus
  – **Timing of debridement generally has NOT been associated with infection**
  – **Patients should be taken OR as soon as possible** after life threatening conditions have been treated and stabilized
  – **Early administration of antibiotics → decreased rates of infection**


What are we trying to avoid in care of polytrauma patient?
What are we trying to avoid in care of polytrauma patient?

- MOF
- ARDS
Multiorgan Failure (MOF)

- Multiorgan Dysfunction Syndrome
- Affects multiple organ systems
- Many theories re: etiology
- High incidence of mortality
Multiorgan Failure (MOF)

- Multiorgan Dysfunction Syndrome
- Affects multiple organ systems
- Many theories re: etiology
- High incidence of mortality
- May be related to imbalance between proinflammatory and antiinflammatory mediators
Acute Respiratory Distress Syndrome

- ARDS
- Acute onset
- Bilateral infiltrates on CXR
- PaO2/FiO2 < 200
- High incidence of mortality
Acute Respiratory Distress Syndrome

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Physiologic Response to Trauma

- Systemic Inflammatory Response (SIRS)
- Compensatory Anti-inflammatory Response (CARS)
Systemic Inflammatory Response

- “First hit” phenomena
- Proinflammatory cytokine response (IL-6, IL-8, etc.)
Clinical Manifestations of the Systemic Inflammatory Response

- Fever
- Tachycardia
- Hyperventilation
- Leukocytosis
Quantifying the Systemic Inflammatory Response

- SIRS Score
- Four variables, each scored 0 or 1
  - HR > 90
  - WBC < 4,000 or > 12,000
  - RR > 20 (or PaCO2 < 33 mmHg)
  - Temperature < 34 or > 38 (100.4 degrees Fahrenheit)
- Total Score = sum of four variables (0 to 4)
- Score > 1 indicative of Systemic Inflammatory Response Syndrome
Systemic Inflammatory Response Syndrome (SIRS)

• Predictive of:
  – ARDS
  – DIC
  – ARF
  – Shock
Inflammatory Mediators

- CRP
- Lipopolysaccharide-binding protein
- Procalcitonin
- Tumor necrosis factor
- IL-1, IL-6, IL-8, IL-10, IL-18
- Cytokine receptors
- Adhesion molecules
- Elastase
- Human leukocyte antigens
- DNA
IL-6

- Produced by T- and B-cells, and endothelial cells
- Correlates with:
  - soft tissue trauma, chest trauma, ISS, MODS, ARDS, sepsis, and overall outcome
Definition of Damage Control Orthopaedics

- Approach to treating polytrauma patients with the goal of minimizing the impact of the “second hit”
Definition of Damage Control Orthopaedics

- Initial priorities →
  - Hemorrhage control
  - Soft tissue management
  - Provisional fracture stabilization
Definition of Damage Control Orthopaedics

- Definitive treatment delayed until physiology improved
History of DCO

- Before 1950’s, “too sick to operate on”
History of DCO

- Late 1980’s, “too sick not to operate on”
History of DCO

• Late 1980’s, “too sick not to operate on”

→ Early Total Care (ETC)
History of DCO

• Bone et al JBJS 1989 → Early Total Care
• Prospective randomized study:
  – Femur fractures treated < 24 hours vs
  – Femur fractures treated > 48 hours

• Early fixation in patients with an ISS ≥ 18 → decreased:
  • Pulmonary complications
  • ICU LOS
  • Hospital LOS

History of DCO

• Early 1990’s, complications associated with ETC begin to be described
  – ARDS
  – MOF
History of DCO

- Pape and others have done extensive work in identifying patients in whom ETC may not be appropriate leading to an alternative treatment strategy →

“Damage Control Orthopaedics”
Certain patients who do not tolerate ETC?

- Retrospective
- Polytrauma patients with femur fracture treated with IMN
- Analyzed patients based upon
  - chest injury (AIS thorax <2 versus AIS thorax ≥2)
  - timing of fixation (<24hrs vs >24hrs)
- Trend towards higher ARDS (33% vs 7.7%) in patients with severe chest injury managed acutely with IMN

Certain patients who do not tolerate ETC?

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- Polytrauma patients with femur fracture treated with IMN
- Analyzed patients based upon
  - chest injury (AIS thorax <2 versus AIS thorax ≥2)
  - timing of fixation (<24hrs vs >24hrs)
- **Trend** towards higher ARDS (33% vs 7.7%) in patients with severe chest injury managed acutely with IMN (did not reach statistical significance)

DCO

• Hannover Data, Pape et al J Trauma 2002
  – Reduction in rates of ARDS and MOF over time with increased usage of DCO

DCO

• Hannover Data, Pape et al J Trauma 2002
  – Reduction in rates of ARDS and MOF over time with increased usage of DCO

• “a long bone fracture is classified as an emergency that has to be stabilized acutely (at least < 8hrs)”

“First Hit”
“First Hit” → Systemic Inflammatory Response
Systemic Inflammatory Response

10 ↑ proinflammatory cytokines → “primed” PMNs

- “primed” PMNs likely involved in secondary tissue injury (secondary lung injury)
“Second Hit”

- Surgery may represent “second hit”
- May exacerbate systemic inflammatory response
- May lead to secondary lung injury
Intramedullary Nailing, not without physiologic effects…

- Blood loss
- Fluid loss
- Fat embolization
- Production cytokines
- Activation coagulation system
“First Hit”

We as surgeons have no control...
“Second Hit”

We as surgeons have control...
When do we fix the fracture in the polytrauma patient?
Impact of timing of the “second hit”

• An inappropriately timed secondary intervention may result in crossing threshold resulting in ARDS or MOF
The “Second Hit”

• Which patient’s are affected?
Patient risk stratification

- Stable
- Borderline
- Unstable
- In extremis
# Patient risk stratification

<table>
<thead>
<tr>
<th>TABLE 9-5 Classification Systems for Clinical Patient Assessment</th>
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</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
</tr>
<tr>
<td><strong>Shock</strong></td>
</tr>
<tr>
<td>Blood pressure (mm Hg)</td>
</tr>
<tr>
<td>Blood units (2 h)</td>
</tr>
<tr>
<td>Lactate levels</td>
</tr>
<tr>
<td>Base deficit (mmol/L)</td>
</tr>
<tr>
<td>ATLS classification</td>
</tr>
<tr>
<td><strong>Coagulation</strong></td>
</tr>
<tr>
<td>Platelet count (µg/mL)</td>
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<tr>
<td>Factor II and V (%)</td>
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<tr>
<td>Fibrinogen (g/dL)</td>
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<td>D-dimer</td>
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<tr>
<td><strong>Temperature</strong></td>
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<td><strong>Soft Tissue Injuries</strong></td>
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<tr>
<td>Lung function; PaO₂/FiO₂</td>
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<tr>
<td>Chest trauma scores; AIS</td>
</tr>
<tr>
<td>Chest trauma score; TTS</td>
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<tr>
<td>Abdominal trauma (Moore)</td>
</tr>
<tr>
<td>Pelvic trauma (AO class.)</td>
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</tbody>
</table>
Patient risk stratification

- Some controversy exists re: acute treatment of “borderline” patients
Potential issues with overutilization of DCO

- Unnecessary delay in definitive treatment
- Longer ICU stays
- Longer time on ventilator
- Longer hospital stays
- Increased cost
Borderline Patients

- ISS > 20 + thoracic injury
- Shock (SBP < 90)
- ISS > 40
- Bilateral pulmonary contusion
- Elevated pulmonary arterial pressure > 24 mmHg
- Pulmonary arterial pressure increase of 6 mmHg during procedure
- Hypothermia
- ?Severe abdominal injury (AIS abdomen ≥ 3)
- ?Bilateral femur fractures
- ?Head injured patient
Borderline Patients

- ISS > 20 + thoracic injury
- Shock (SBP < 90)
- ISS > 40
- Bilateral pulmonary contusion
- Elevated pulmonary arterial pressure > 24 mmHg
- Pulmonary arterial pressure increase of 6 mmHg during procedure
- Hypothermia
- ?Severe abdominal injury (AIS abdomen ≥ 3)
- ?Bilateral femur fractures
- ?Head injured patient
Borderline Patients

- Severe abdominal injury (AIS abdomen ≥ 3)

  Retrospective review of 3069 polytrauma patients treated for femur fracture with internal fixation

  ~50% relative risk reduction in mortality in patients treated after 12 hours

Borderline Patients

• **Severe abdominal injury** (AIS abdomen $\geq 3$)

Retrospective review of 3069 polytrauma patients treated for femur fracture with internal fixation

Patients with significant abdominal injury benefitted most from delay

Level I Data?

- RCT comparing IMN vs DCO in stable and borderline patients

Level I Data?

- RCT comparing IMN vs DCO in stable and borderline patients

Exclusion criteria included: AIS thorax >2; Body weight > 250 lbs.
Level I Data?

• Stable Patients
• \( \rightarrow \) acute IMN associated with decreased ventilator time
Level I Data?

• Borderline Patients

• → acute IMN associated with increased acute lung injury (ALI)
  – 6.69x greater chance of developing ALI, s/p acute IMN
Level I Data?

- Borderline Patients
- acute IMN associated with increased acute lung injury (ALI)
  - 6.69x greater chance of developing ALI, s/p acute IMN (CI = 1.01-44.08)
Level I Data?

• Definition of ALI?
  – Bilateral pulmonary infiltrates
  – Pulmonary capillary wedge pressure <18
  – PaO2/FiO2 < 300
Level I Data?

- Definition of ALI?
  - Bilateral pulmonary infiltrates
  - Pulmonary capillary wedge pressure < 18
  - PaO2/FiO2 < 300
  - Clinical Significance?
Morbid Obesity: ↑ Systemic Complications with IMN

- Morbidly obese polytrauma patients with femur fracture found to have higher rates of ARDS and death

ETC/DCO data may not be applicable to obese or morbidly obese
Unreamed IMN less of a “second hit?”
Reamed vs Unreamed IMN

- RCT
- 322 femur fractures
- IMN within 24 hours
Reamed vs Unreamed IMN

- Reamed IMN $\rightarrow$ 3/63 ARDS
- Unreamed IMN $\rightarrow$ 2/46 ARDS
- 2 deaths in each group
- No statistically significant difference
- 39,817 patients would be needed to appropriately power study

Evaluating Response to Resuscitation

- Patients with Class 1 or 2 hemorrhage may present occultly secondary to compensatory mechanisms
- Vitals signs not sensitive indicators of shock or resuscitation
- pH, base deficit, lactate, serum bicarbonate helpful in monitoring resuscitation
Evaluating Response to Resuscitation

• *Compensated Shock* →
  – Brain and heart perfused at expense of other organs
  – Occult hypoperfusion exists
Occult Hypoperfusion

• Patients with an ISS ≥ 18 and a femur fracture stabilized (reamed IMN) within 24 hours of admission

• No patients had any clinical signs of shock:
  • Normotensive
  • Not Tachycardic
  • Adequate urine output

Occult Hypoperfusion

- Retrospectively divided into 2 groups based on lactate levels (normal and abnormal)
- The group with a lactate of \( > 2.5 \) had higher pulmonary and infectious complication rates

Occult Hypoperfusion

- Retrospective study
- N=72
- Femur fracture with ISS ≥ 15
- Serum bicarbonate (SB) values analyzed based on quoted thresholds of metabolic acidosis:
  - BD of 6mmol/L $\Rightarrow$ 24.7 mequiv/L
  - BD of 5mmol/L $\Rightarrow$ 26.4 mequiv/L

Occult Hypoperfusion

• SB<24.7 within 6 hours of surgery → 12.2X odds of developing POD (pulmonary organ dysfunction)

• SB<26.4 within 6 hours of surgery → 10.9X odds of developing POD

Occult Hypoperfusion

- “appropriate damage-control measures and aggressive resuscitation prior to definitive fracture care are advised…”

Resuscitation and *Early Appropriate Care*

- pH, base excess, lactate utilized to determine when patient’s physiology appropriate for definitive care
  - pH ≥7.25
  - Base excess ≥-5.5
  - Lactate <4.0
- Definitive care would proceed when any one of three criteria has been achieved


Resuscitation and Early Appropriate Care

- Includes femur fractures and also other axially unstable injuries (fractures of pelvis, acetabulum, spine)
- Patients treated with EAC within 36 hours:
  - 1.5% ARDS
  - 0.37% MOF
  - 1.5% Mortality
  - Shorter ICU and total LOS, ventilation time

Resuscitation and “normalizing lactate”

- Retrospective review of protocol for treatment of femur fractures in polytrauma patients
- N=229; ISS≥17
- 88% patients treated with reamed IM nailing and 12% treated with DCO (External fixation)
- “Normalizing lactate” → parameter used to demonstrate adequate resuscitation
- Mean time between admission and IM nailing: ~14 hours

Resuscitation and “normalizing lactate”

- Results:
  - ARDS (overall): 1.5%
  - ARDS (pulmonary injured patients): 2.0%
  - ARDS (pulm. injured patients with ISS>28): 3.3%

Resuscitation and “normalizing lactate”

- Simple measures of resuscitation reasonable indicators as to when a patient can physiologically tolerate intramedullary nailing

“Resuscitated”

- Stable hemodynamics
- No hypoxemia
- Lactate
  - $< 2.5$ mmol/L (Crowl et al)
  - $< 4.0$ mmol/L (Vallier et al)
  - “normalizing,” or trending toward 2.5 mmol/L (O’Toole)
- Base Deficit
  - $<5.5$ (Vallier et al), $<5$, $<6$
- Serum Bicarbonate
  - $SB > 24.7$; $SB > 26.4$ (Morshed et al)
- pH $> 7.25$ (Vallier et al)
- Normal coags
- Normothermia
- Normal U/O ($>1$ cc/kg/hr)
Algorithm for ETC vs DCO

- **Stable**
- **Borderline**
- **Unstable**
- **Extremis**

**Patient at risk**
- **Endpoints of resuscitation?**
  - **Yes**
    - You may proceed with ETC
      - **Ongoing evaluation of physiology**
        - **ETC**
  - **No**
    - **If deterioration**
      - **DCO**
    - **Patient remains unstable**
      - **Consider DCO**

*Lactate, blood pressure, urine output, oxygenation, temperature, coagulation profile.*
Modes of DCO

• Retrospective review of protocol for treatment of polytrauma patients with sub analysis of patients undergoing DCO
• Overall rate of ARDS: 4.4%
• 39% of patients underwent DCO
• 60 patients ➔ skeletal traction
• 19 patients ➔ external fixation

Modes of DCO

• Results:
  – No significant differences between external fixation and skeletal traction in rates of:
    • ARDS
    • MOF
    • Pneumonia

Modes of DCO

Authors’ Conclusion:
Unless patient is already in operating room, no significant advantage to external fixation vs skeletal traction

Modes of DCO

Problems with study:

Small number of patients, particularly in external fixation group, raising possibility of Type II error

Modes of DCO

Theoretical concerns with traction:
Difficulty with pulmonary toilet?
Increased narcotic requirements secondary to increased pain with increased fracture instability?
Increased risk of FES?
Timing of definitive treatment in DCO

- Polytrauma patients managed with initial DCO followed by later definitive fixation
- Patients who underwent conversion between 2 and 4 days were compared to those who underwent conversion between 5 and 8 days
- MODS 46% in early group versus 16% in late group

Timing of definitive treatment in DCO

- Femoral shaft fractures and ISS >20
- Retrospective review
- Initial ex-fix vs early IMN
- 174 patients
- Ex fix group more severely injured
- SIRS score, modified Marshall multi-organ dysfunction score

Timing of definitive treatment in DCO

- DCO patients converted from external fixator while SIRS score still elevated → most pronounced post op inflammatory response and organ failure rate

Timing of definitive treatment in DCO

- An Interpretation of Pape’s Work ➔
  Majority of patients treated with DCO should probably wait until at least post injury day 5 before definitive treatment
Timing of definitive treatment in DCO

- An Interpretation of Pape’s Work →
  Majority of patients treated with DCO should probably wait until at least post injury day 5 before definitive treatment?
Timing of definitive treatment in DCO

• Utilization of the SIRS Score and possible serum measures of proinflammatory markers may allow more accurate assessment of patients (those that can be treated earlier with definitive surgery)
Summary

• Evaluation of polytrauma patient guided by algorithmic principles of ATLS.
• Identifying and treating orthopaedic urgencies and emergencies in the initial evaluation is critical in minimizing morbidity and mortality.
• Knowledge of certain scoring systems is necessary in managing polytrauma patients.
Summary

• Identifying patients with occult hypoperfusion is necessary to minimize morbidity and mortality.
• Knowledge of *Damage Control Orthopaedics* and when to implement methods of DCO is critical.
Summary

- Overwhelming majority of polytrauma patients with femur fractures **should** be treated and **benefit** from being treated within the first 24-36 hours.
- Further research will help clarify which patients can and can not tolerate acute intramedullary nailing and which patients should be treated with DCO.
References

- Advanced Trauma Life Support Student Course Manual. 9th Edition. American College of Surgeons
References (cont.)

Thank you