Initial Assessment & Management of the Polytraumatized Patient

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Objectives

- Initial evaluation the traumatized patient
- Physiologic response to trauma and how it affects timing of care
- Orthopedics considerations in the traumatized patient

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The Trauma Patient

- Civilian trauma accounts for 35 million ED evaluations
- Leading cause of death in individuals 1-44 years old
- Blunt trauma accounts for 80% of mortality in the < 34 age group
- Third leading cause of death in all age groups
  - 45% Falls
  - 32% Motor vehicle collision
  - 9% Motorcycle collision
  - 8% Assault
  - 6% Gunshot wounds

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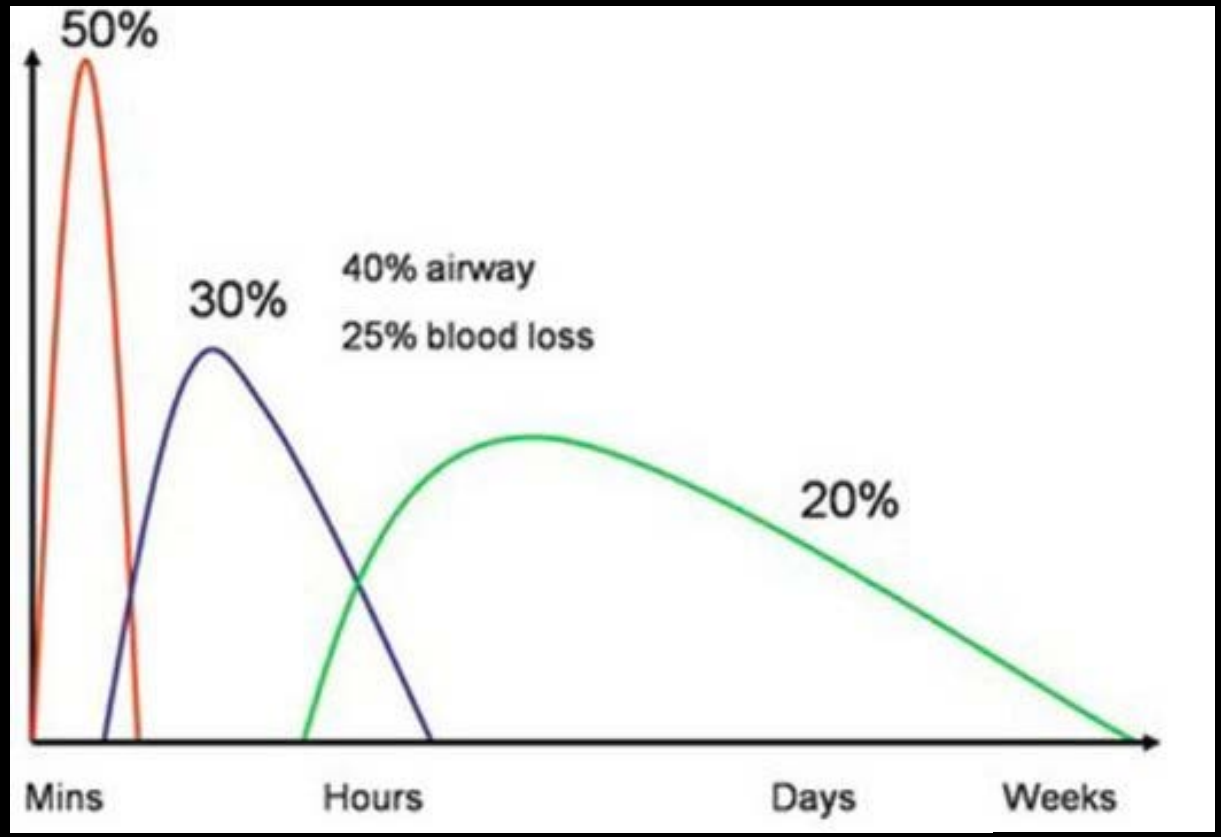
Trimodal Distribution of Mortality

- Three peak times of death after trauma
- 50% within the first minutes of injury
  - massive blood loss, great vessel transection, neurologic injury
- 30% within minutes to hours
  - most commonly from shock, hemo/pneumothorax, or neurologic injury
  - GOLDEN HOUR
- 20% within days to weeks
  - multi system organ failure and infection are leading causes



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Treatment Approach for the Trauma Patient

- Team Approach
- Care is primarily quarterbacked by the general surgery trauma team
- Multidisciplinary input:
  - Neurosurgery
  - Vascular Surgery
  - Emergency Medicine
  - Anesthesia
  - Radiology
  - Orthopedic Surgery

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Orthopedic Priorities for the Trauma Patient

- 1) Resuscitation
  - Stabilize the musculoskeletal injuries of the polytraumatized patient
  - Pain relief, improve fracture alignment and stability, mobility, and function
  - Splints, traction, binders, operative fixation

- 2) Timing of Surgical Intervention
  - Definitive fixation or “Damage Control”
  - Minimize “second hit phenomenon”

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Evaluation of the Polytraumatized Patient

- American College of Surgeons – Advanced Trauma Life Support
  - Primary Survey
    - Treat greatest threats to life first
  - Secondary Survey
    - Complete head to toe exam
    - Additional studies (xrays, CT scans, labs)
  - Tertiary Survey
    - Repeat 2nd survery prn (ie, changing mental status)

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Evaluation of the Polytraumatized Patient

- ATLS
  - Primary Survey
    - Airway
    - Breathing
    - Circulation
    - Disability
    - Exposure
- Cervical spine immobilization
- Protect airway/intubation

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Evaluation of the Polytraumatized Patient

- ATLS
  - Primary Survey
    - Airway
    - Breathing
    - Circulation
    - Disability
    - Exposure

- Identify sources of diminished breathing/oxygenation:
  - Tension pneumothorax
  - Hemothorax
  - Flail chest/multiple rib fractures

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Evaluation of the Polytraumatized Patient

- ATLS
  - Primary Survey
    - Airway
    - Breathing
    - Circulation
    - Disability
    - Exposure

- Hemorrhagic Shock (Ortho causes)
  - Pelvis ring injuries
    - Apply binder/sheet/traction
  - Femur fractures
    - Traction
  - Vascular injuries
    - Apply direct pressure
    - Temporize with tourniquet***
    - Reduce fracture/dislocation

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Evaluation of the Polytraumatized Patient

- ATLS
  - Primary Survey
    - Airway
    - Breathing
    - Circulation
    - Disability
    - Exposure

- Perform neurologic exam
- Determine Glasgow Coma Scale

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Evaluation of the Polytraumatized Patient

- ATLS
  - Primary Survey
    - Airway
    - Breathing
    - Circulation
    - Disability
    - Exposure

- Remove clothing
- Normalize temperature
  - Warm/Cool as needed

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Evaluation of the Polytraumatized Patient

- Basic Principles of Resuscitation
  - Starts IMMEDIATELY and SIMULTANEOUSLY with assessment
  - Two large bore (14 gauge) IV's
  - 2L crystalloid administration
  - Simultaneous administration of blood product and search for hemorrhage
  - Determine "classification" of hemorrhage/shock

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Classification of Hemorrhagic Shock

	Class 1	Class 2	Class 3	Class 4
Blood loss (mL)	Up to 750	750–1,500	1,500–2,000	>2,000
Blood loss (% of volume)	Up to 15%	15–40%	30–50%	>40%
Heart rate	<100	>100	>129	>140
Blood pressure	Normal	Normal	Decreased	Decreased
Pulse pressure (mm Hg)	Normal	Decreased	Decreased	Decreased
Respiratory rate	14–20	20–30	30–40	>40
Urine output (mL/hr)	>30	20–30	5–15	Negligible
Mental status	Slightly anxious	Mildly anxious	Confused	Lethargic

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Crystalloid **Crystalloid + Transfusion**

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Blood Transfusion

- Balanced blood product administration
  - 1:1:1 ration of pRBC:plasma:platelets
  - pRBC restores blood volume, tissue oxygenation, and normalizes acidosis
    - Does not restore clotting factors and platelets → Coagulopathy → more hemorrhage
  - Plasma and platelets reverses coagulopathy

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The Physiological Response to Trauma

- Complex HYPER-INFLAMMATORY injury response:
  - Hemorrhage → ↓ cellular profusion → Anaerobic metabolism → ↑Lactate
    - Shock/hemorrhage from femur fracture or pelvis
    - Systemic Acidosis
  - Severe soft tissue injury → Release of pro-inflammatory mediators
    - Open fracture, mangled extremity
  - Over expression of pro-inflammatory cytokines (IL-6, IL-8) → ….

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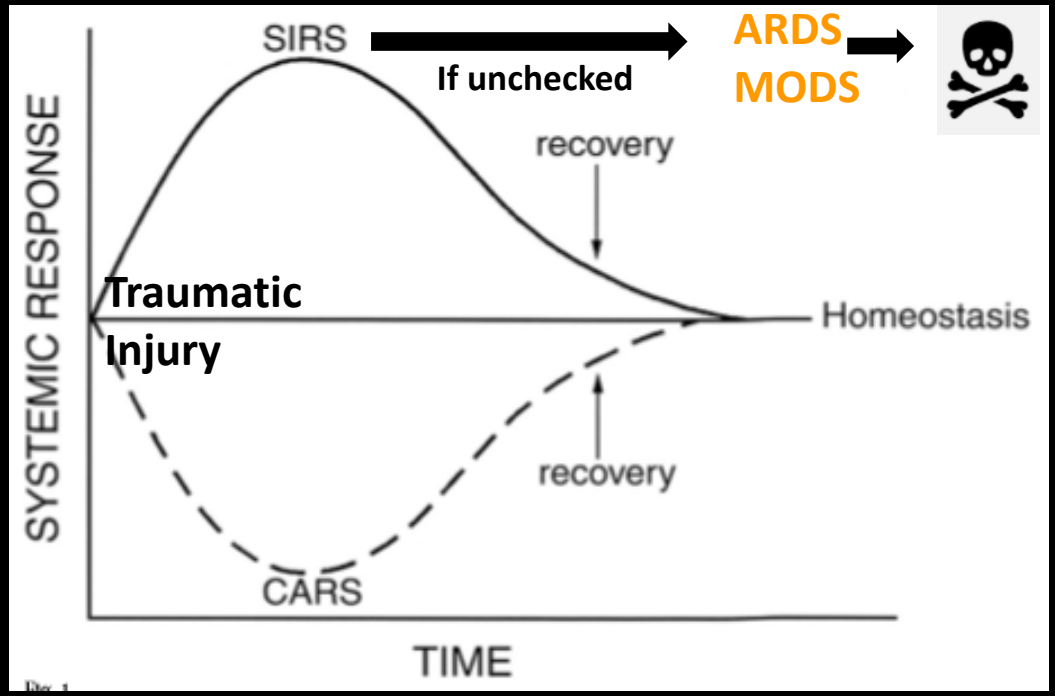
Systemic Inflammatory Response Syndrome

- If the initial trauma, hemorrhage, & tissue damage so severe…
- Uncheck by compensatory anti-inflammatory response and…
- Passes innate inflammatory threshold:
  - Acute Respiratory Distress Syndrome → DEATH
  - Multi Organ Dysfunction Syndrome → DEATH



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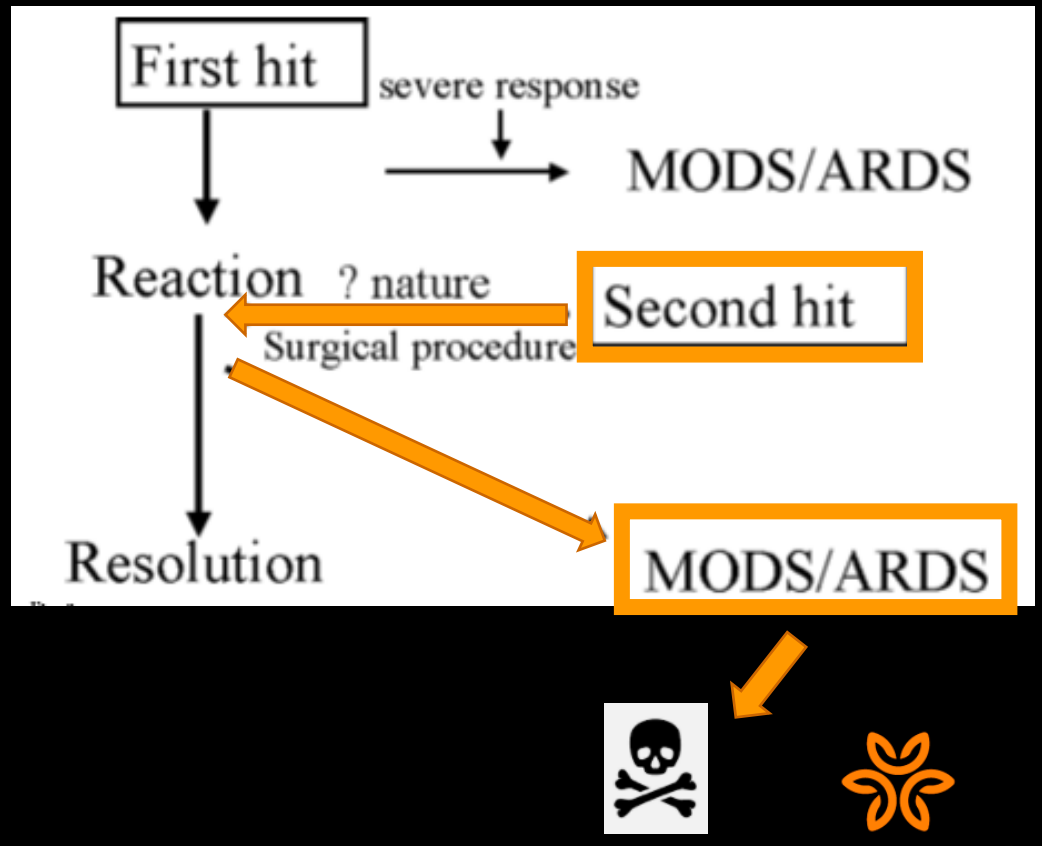
Systemic Inflammatory Response Syndrome

- "Second Hit" Phenomenon
  - Immune system "primed" for activation after the initial trauma (ie, "first hit")
  - But NOT above threshold for ARDS/MODS
  - The second hit (in this case major orthopedic surgery) then elevates the inflammatory storm above the threshold for ARDS and MODS



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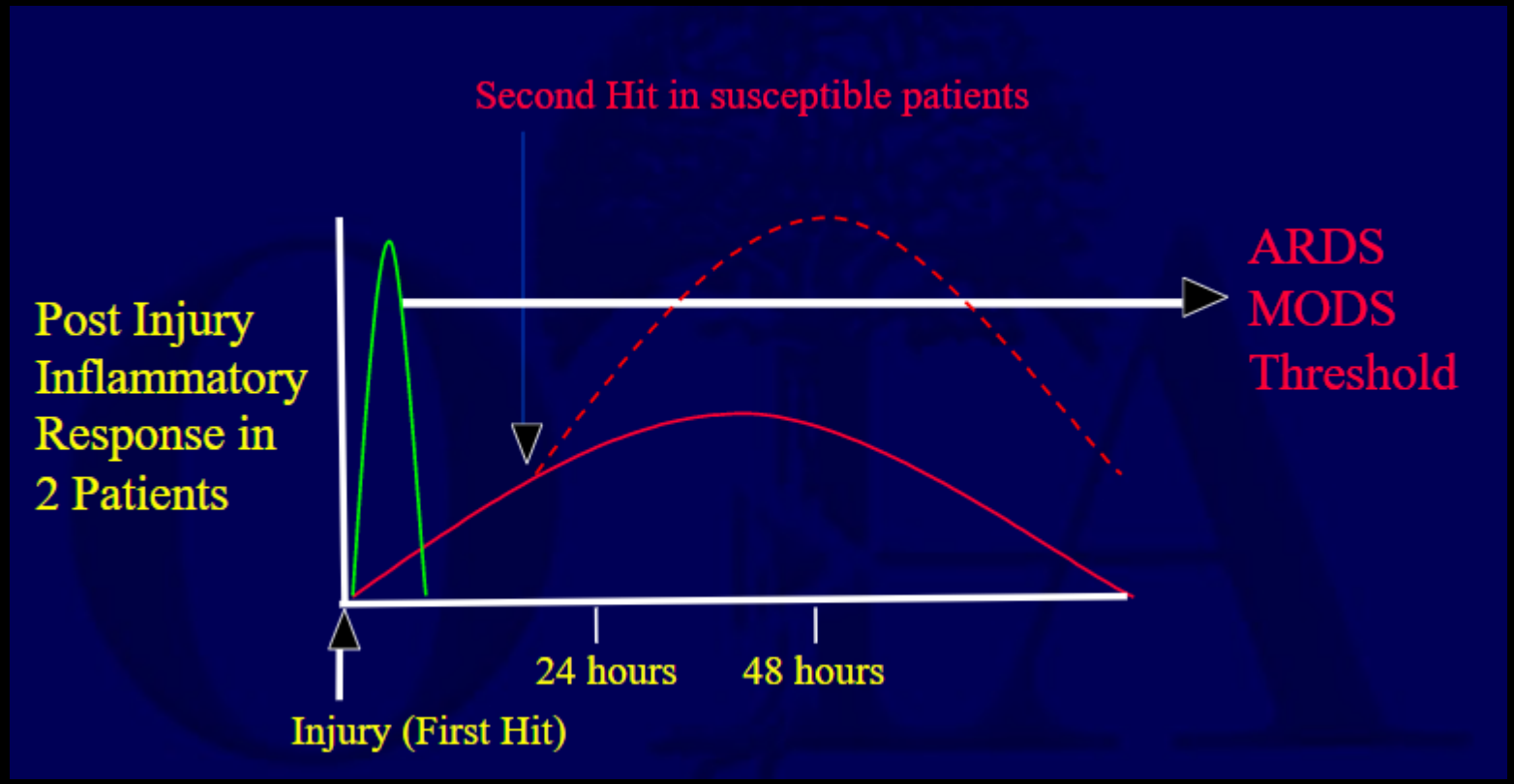
Second Hit Phenomenon



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Timing and Management of Fracture Fixation

- Essential to time the surgical management of trauma patients in order to avoid “second hit”

- Three philosophies of orthopedic trauma care:
  - Early Total Care
  - Damage Control Orthopedics
  - Early Appropriate Care

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Timing of Fracture Fixation

- Early Total Care
  - Early DEFINITIVE stabilization of ALL fractures within 24 hrs
  - Increase mobility and reduce morbidity and mortality
  - Often long surgical procedures with increased hemorrhage, inflammation, and emboli (ie IMN)
  - If patient not resuscitated can lead to “second hit” phenomenon

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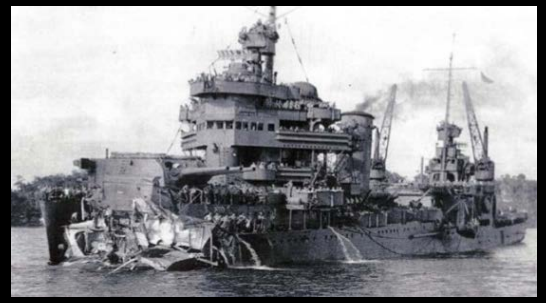
Timing of Fracture Fixation

- Damage Control Orthopedics
  - PROVISIONAL stabilization of fractures with less invasive methods – external fixator, unreamed nails
  - Provides skeletal stability to mitigate hemorrhage and inflammatory mediator release
  - Minimizes the “second hit” by reducing initial surgical insult
    - Reduced blood loss
    - Shorter surgeries



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Timing of Fracture Fixation

- Indications for Damage Control Orthopedics
  - Under resuscitated patient
  - Persistent hemodynamic instability
  - Persistent acidosis (pH < 7.25; Lactate >2.5)
  - Severe head injury (CPP < 70 mmHg; ICP > 20 mmHg)
  - Spinal cord injury with evolving neurologic deficit

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Timing of Fracture Fixation

- Early Appropriate Care
  - The majority of trauma patients can be treated safely within 36 hours
  - **Reduces complications, length of stay, and costs**
  - **This can be done safely in the ADEQUATELY RESUSCITATED PATIENT**
  - **How do we define adequately resuscited?**

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The Resuscitated Patient (safe for EAC)

- Stable hemodynamics
- No hypoxemia
- Base Deficit
  - <5.5 (Vallier et al)
- Serum Bicarbonate
  - SB>24.7; SB>26.4 (Morshed et al)
- pH > 7.25 (Vallier et al)
- Coagulopathy corrected
- Normothermia
- Normal UOP (>1cc/kg/hr)

- 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)

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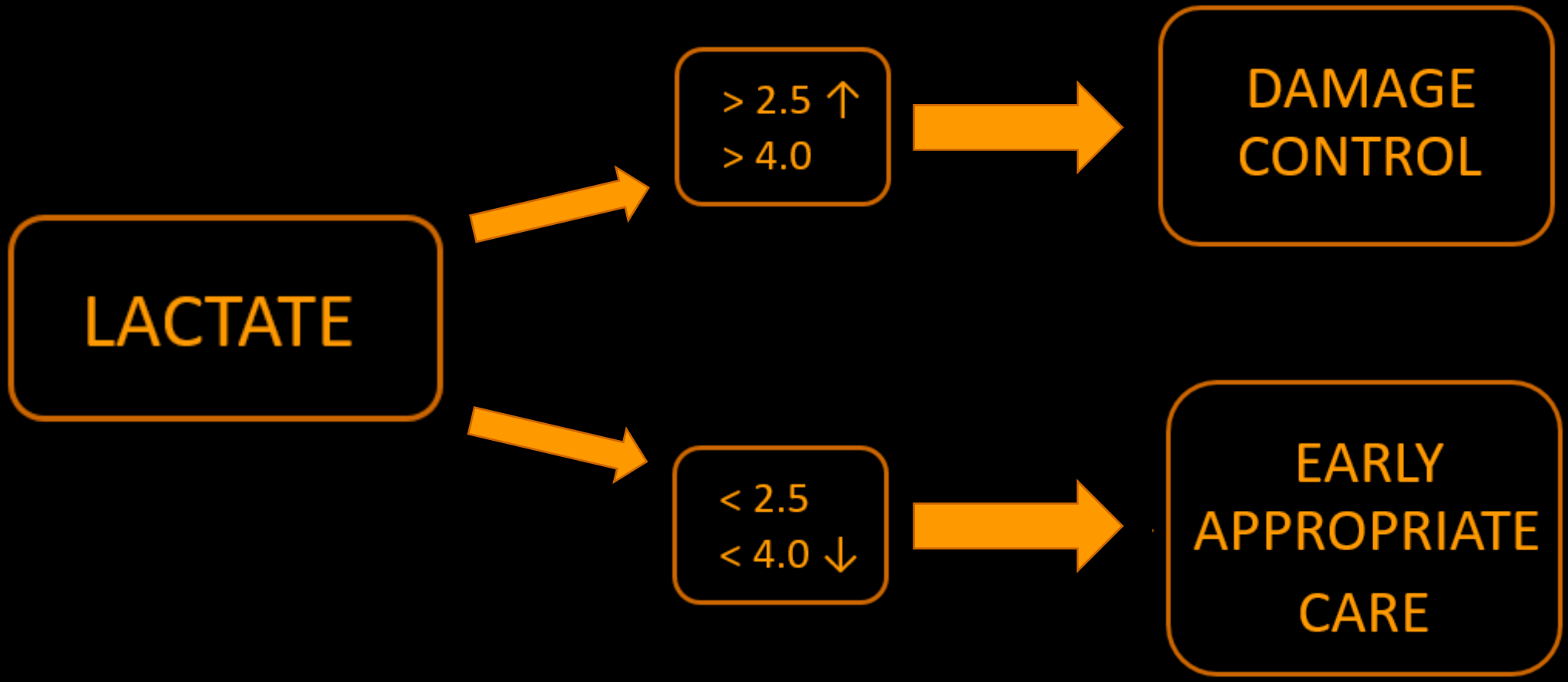
Timing of Fracture Fixation



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Orthopedic Considerations in the Trauma Patient

- Hemodynamically Unstable Pelvis Fractures
- Long Bone Fractures
- Open Fractures
- Dislocations with Neurovascular Compromise
- Compartment Syndrome

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Hemodynamically Unstable Pelvis

- “Open book”, but can be any pelvic ring injury
- High energy injury
- High morbidity & mortality
- High transfusion requirement

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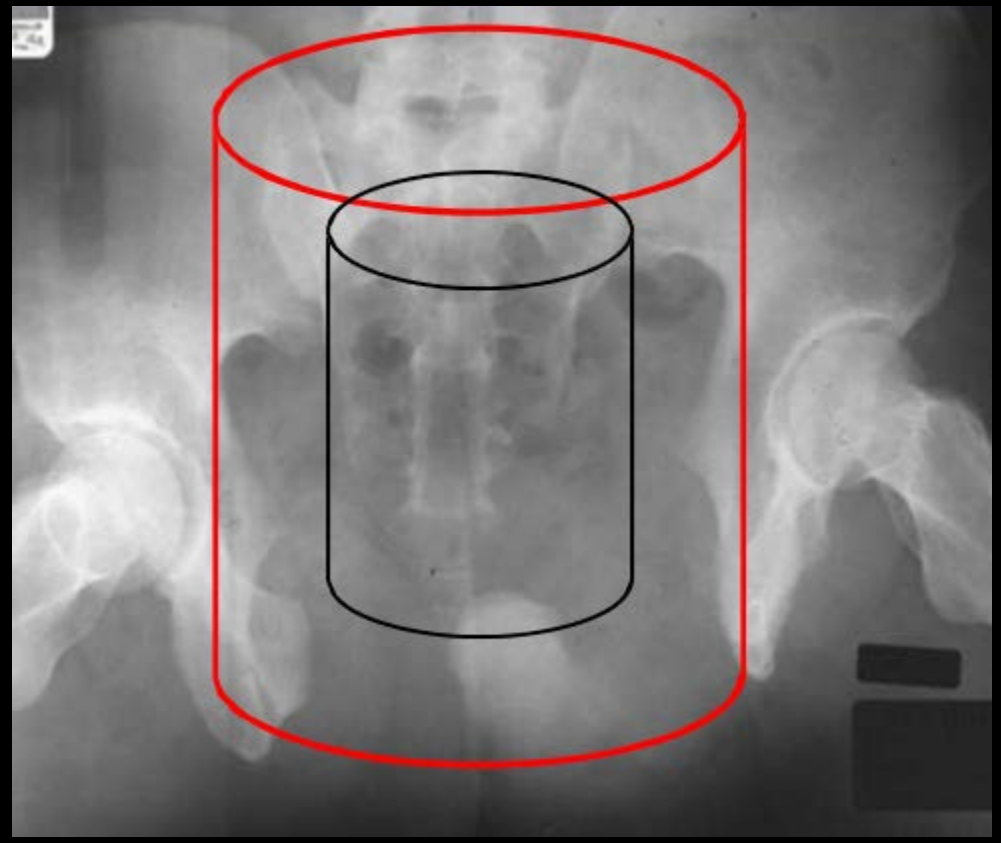
Hemodynamically Unstable Pelvis

- Think of the pelvic ring as a cylinder
- The volume of a cylinder related to radius
  - 4/3π r3
- As the radius of the cylinder increases (ie, open book pelvis)
  the volume increases by a power of 3 – massive potential space for hemorrhage!



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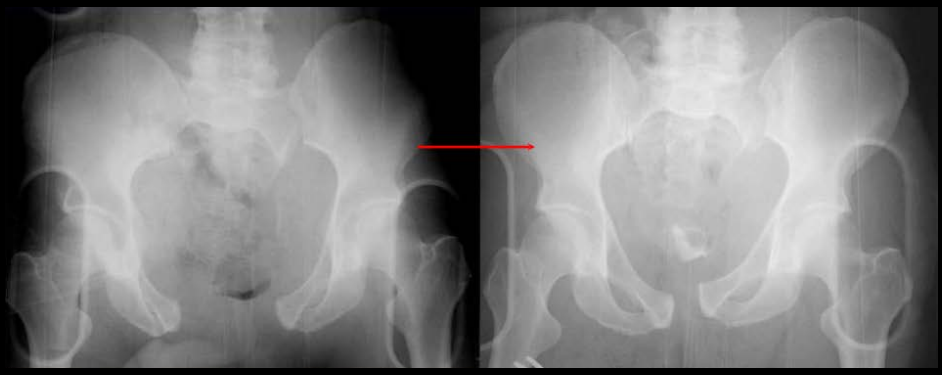
Hemodynamically Unstable Pelvis

- Treat hemorrhage by reducing pelvic volume!
  - Pelvic Binders/Sheets – First line of treatment
  - Pelvic External Fixation
  - Traction



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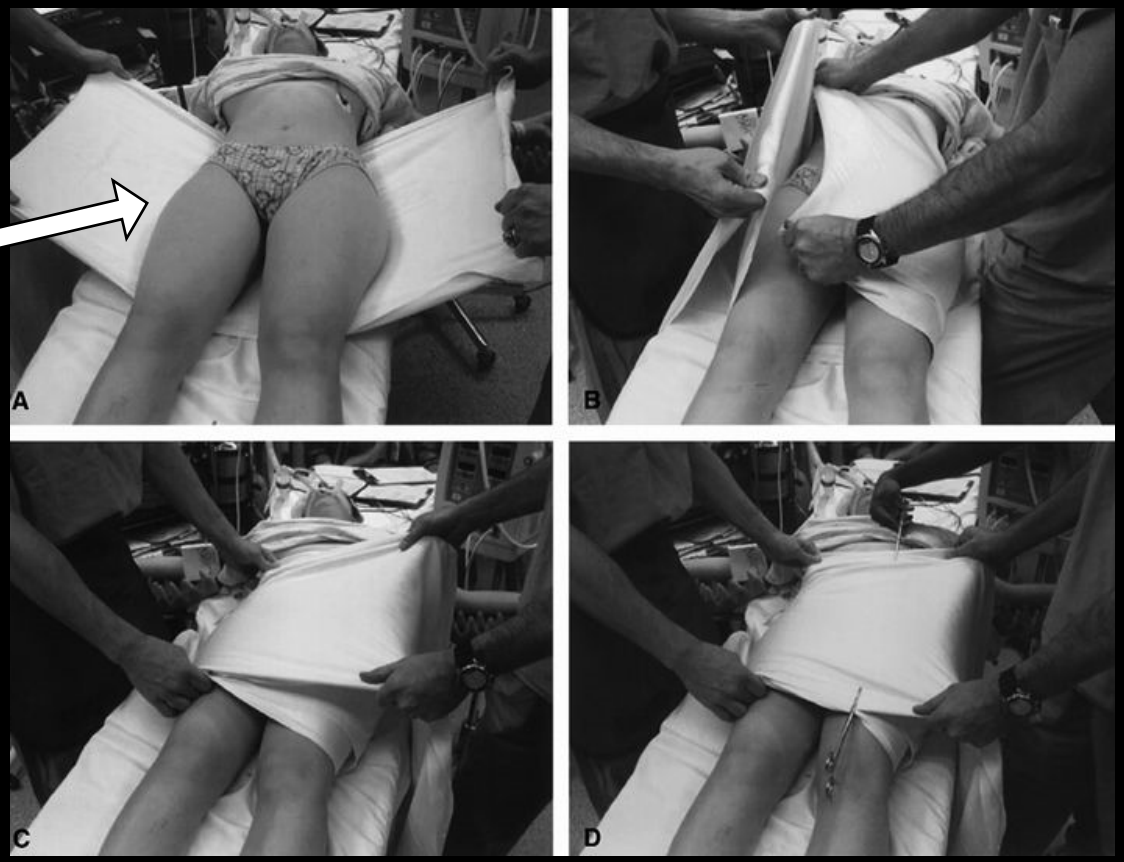
Placing a Pelvic Binder/Sheet

Centered around greater trochanters



Avoid prolonged use
- Can lead to pressure necrosis of the skin if >24 hours
- Check skin every 12 hrs after first 24 hrs

Avoid use in traumatized skin, such as burn patients
- Consider early external fixation instead

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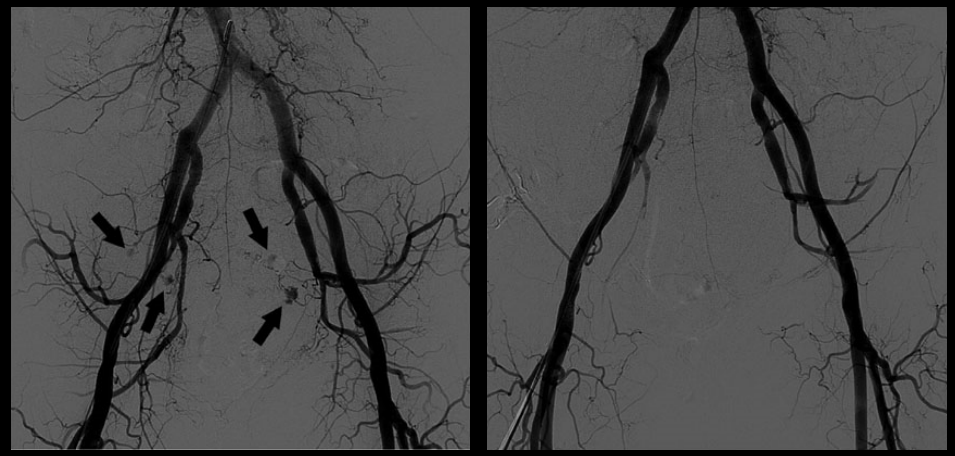
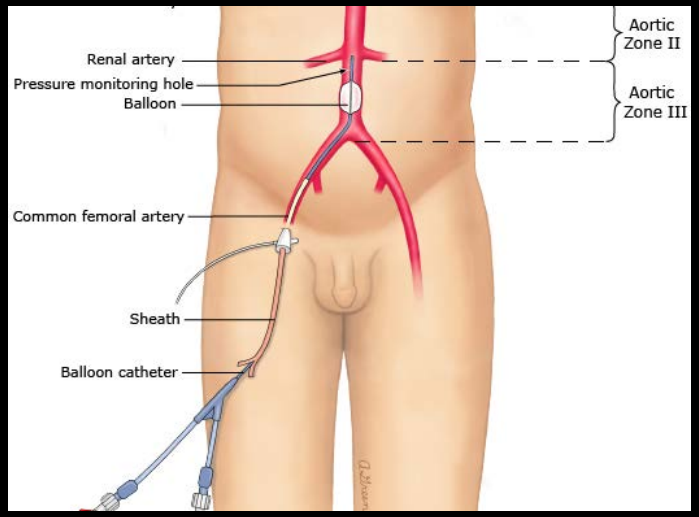
Hemodynamically Unstable Pelvis

- Laparotomy with pelvic packing
  - Need to apply external fixator
  - Controls venous & arterial bleeding
- Angiography
  - Works best for arterial bleeding (~5-20%)
- Resuscitative Endovascular Balloon Occlusion of Aorta (REBOA)
- Timing of these interventions vary based on institution…





Long Bone Fractures

- Can lead to massive hemorrhage and shock
- Femur – 1200 cc blood loss
- Humerus/Tibia – 750 cc
- Bilateral femur fractures
  - Mortality rates up to 25%

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Long Bone Fractures

- Need to be stabilized in the initial period
  - Diminish pain and inflammatory cascade
  - Align and stabilize bone
  - Obtain hemostatic force to tamponade hemorrhage
- Skeletal Traction (Femur and Pelvis)
- Splinting (Tibia, Humerus, Forearm)
- Damage Control vs Early Appropriate Care

Open Fractures

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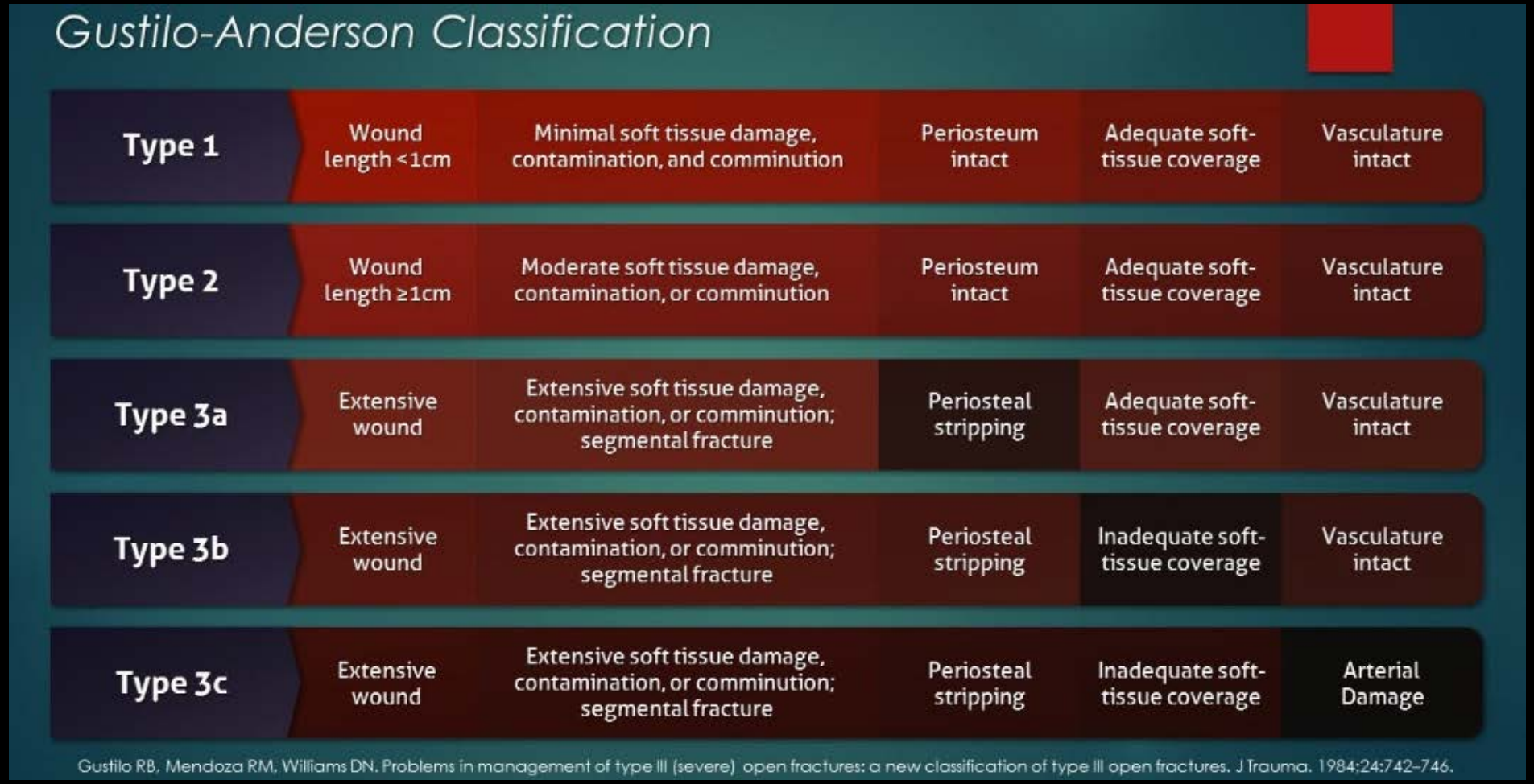
Open Fractures



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Classification - Open Fractures (OTA-OFC)

Skin	1. Laceration with edges that approximate. 2. Laceration with edges that do not approximate. 3. Laceration associated with extensive degloving.
Muscle	1. No appreciable muscle necrosis, some muscle injury with intact muscle function. 2. Loss of muscle but the muscle remains functional, some localized necrosis in the zone of injury that requires excision, intact muscle-tendon unit. 3. Dead muscle, loss of muscle function, partial or complete compartment excision, complete disruption of a muscle-tendon unit, muscle defect does not reapproximate.
Arterial	1. No major vessel disruption. 2. Vessel injury without distal ischemia. 3. Vessel injury with distal ischemia.
Contamination	1. None or minimal contamination. 2. Surface contamination (not ground in). 3. Contaminant embedded in bone or deep soft tissues or high-risk environmental conditions (eg, barnyard, fecal, dirty water).
Bone loss	1. None. 2. Bone missing or devascularized bone fragments, but still some contact between proximal and distal fragments. 3. Segmental bone loss.

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Open Fractures

- Initial Management:
  - Early antibiotics & tetanus within 1 hour of hitting the ED doors!
    - Type I & II – First generation cephalosporin (Ancef 1-2 gm q8h x 24 h final definitive washout)
      - Clindamycin or Vancomycin can also be used if allergies exist
    - Type III – Ancef + Aminoglycoside* (for gram neg – Gentamycin 1mg/kg)
      - Controversial due to risk of nephrotoxicity and ototoxicity
      - **Consider Ceftriaxione**

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Open Fractures

- Emergency Room Management:
    - Irrigate gross contaminants at bedside
    - Take clinical photos if possible
    - Cover wound with moist sterile dressing
    - Re-align and splint fracture

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Open Fractures

- Operative Management:
  - Surgical Urgency
  - Operative debridement within 24 hours of ED arrival
    - Within 6 hours if grossly contaminated
    - ASAP if associated with massive soft tissue damage or vascular injury necessitating repair

Prodromidis AD, Charalambous CP. The 6 hour rule for surgical debridement of open tibial fractures: a systematic review and meta-analysis of infection and nonunion rates. Journal of Orthop Trauma. 2016 Jul; 30(7):397-402. doi: 10.1097/BOT.0000000000000573.

Rozell JC1, Connolly KP, Mehta S. Timing of Operative Debridement in Open Fractures. Orthop Clin North Am. 2017 Jan; 48(1):25-34. doi: 10.1016/j.ocl.2016.08.006.

Duyos OA, Beaton-Comulada D, et al. Management of Open Tibial Shaft Fractures: Does the Timing of Surgery Affect Outcomes? J Am Acad Orthop Surg. 2017 Mar;25(3):230-238. doi: 10.5435/JAAOS-D-16-00127.

Andrew N. Pollak, MD, Alan L. Jones, et al. The Relationship Between Time to Surgical Débridement and Incidence of Infection After Open High-Energy Lower Extremity Trauma. J Bone Joint Surg Am. 2010 Jan; 92(1): 7–15. doi: 10.2106/JBJS.H.00984

Srour M, Inaba K, Okoye O, Chan C, Skiada D, Schnüriger B, Trump M, Lam L, Demetriades D. Prospective evaluation of treatment of open fractures: effect of time to irrigation and debridement. JAMA Surg. 2015 Apr;150(4):332-6. doi: 10.1001/jamasurg.2014.2022.

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Open Fractures

- Operative Management:
  - Aggressive surgical debridement is key
    - Removes necrotic and contaminated tissue and debris that is nidus for infection
    - Allows accurate classification of fracture type
  - Irrigation
    - Low pressure irrigation is preferred over high pressure pulse lavage
    - Plain saline shown to be most effective irrigating agent
    - 3L of saline are used for each successive Gustilo type
  - Surgical Stabilization & Coverage…
    - IMN vs Plate vs Ex-Fix
    - Primary vs Delayed Closure vs Flap Coverage

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Dislocations with Neurovascular Compromise

- Knee dislocations most commonly associated with neurovascular injury
  - Tethering of the popliteal artery proximally and distally
  - Common peroneal nerve around the fibula

- Emergent closed reduction!
  - If unsuccessful then open reduction

- Thorough neurovascular exam after reduction:
  - Evaluate posterior tibial and dorsalis pedis pulses
    - May still be present secondary to collateral circulation
  - Perform ankle-brachial index (ABI)
    - If > 0.9 → observe patient
    - If < 0.9 → angiography and/or exploration, consult vascular

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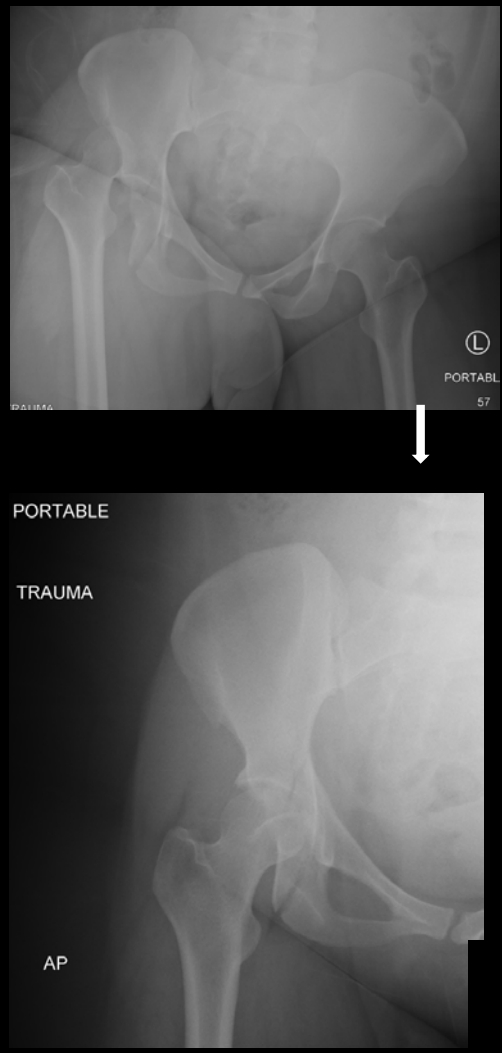
Dislocations with Neurovascular Compromise

- Hip Dislocations
  - Sciatic nerve injury

- Emergent reduction is indicated
  - Risk of avascular necrosis (5-40%)
    - Increased risk the longer time to reduction
    - *Hip must be reduced within 6-12 hours*

  - Must have post reduction CT scan:
    - Incarcerated Bone Fragments within joint
    - Check for incongruent reduction
    - Check for other fractures such as femoral head

- Knee immobilizer versus skeletal traction



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Compartment Syndrome

- Surgical Emergency
- Occurs when the pressure in a fascial compartment increases above the level of the perfusion pressure of the limb leading to ischemia of the limb
- High Energy Trauma
- Can occur in open Fractures
- Initial treatment
  - Release circumferential bandages/splints/casts
  - Elevate extremity at level of heart
  - But mainly need to go to OR ASAP → fasciotomies

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Compartment Syndrome

- Diagnosis
  - Clinical Diagnosis – ***"Six P's":***
    - Pain out of proportion to injury
    - Pain with passive stretch
    - Palpable swelling
    - Paresthesias
    - Paralysis
    - Pulselessness
  - Pediatrics – ***"Three A's":***
    - Agitation
    - Anxiety
    - Analgesia requirement increasing

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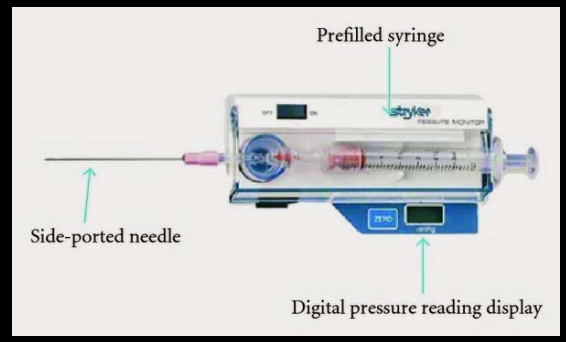
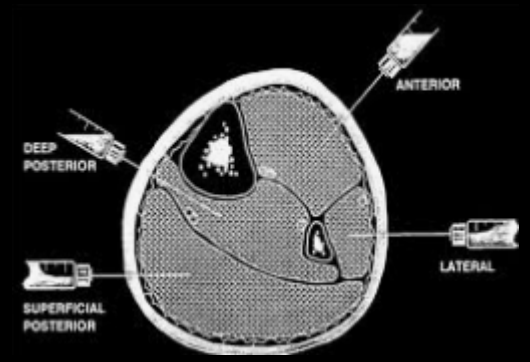
Compartment Syndrome

- Diagnosis
  - If obtunded, altered mental status, or distracting injury:
    - Intracompartmental pressure monitoring
      - Anterior (Most common)
      - Lateral
      - Superficial Posterior
      - Deep Posterior (Most commonly missed!)
  - *Delta P* – compartment pressure minus the patients diastolic blood pressure
    - Should be *>30 mmHg*





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Compartment Syndrome

- Treatment
  - Emergent Fasciotomy
    - One Incision versus Two Incision

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Summary

- Initial management of trauma patient → ATLS, resuscitation
- Physiologic response to trauma → 1st hit, 2nd hit, SIRS, ARDS/MODS
- Timing of orthopedic interventions → DCO, ETC, EAC
- Orthopedic considerations in the trauma patient

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Thank You! Questions/Comments?

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