Initial Assessment & Management of the Polytraumatized Patient

Ammar Karim, DO

Dignity Health

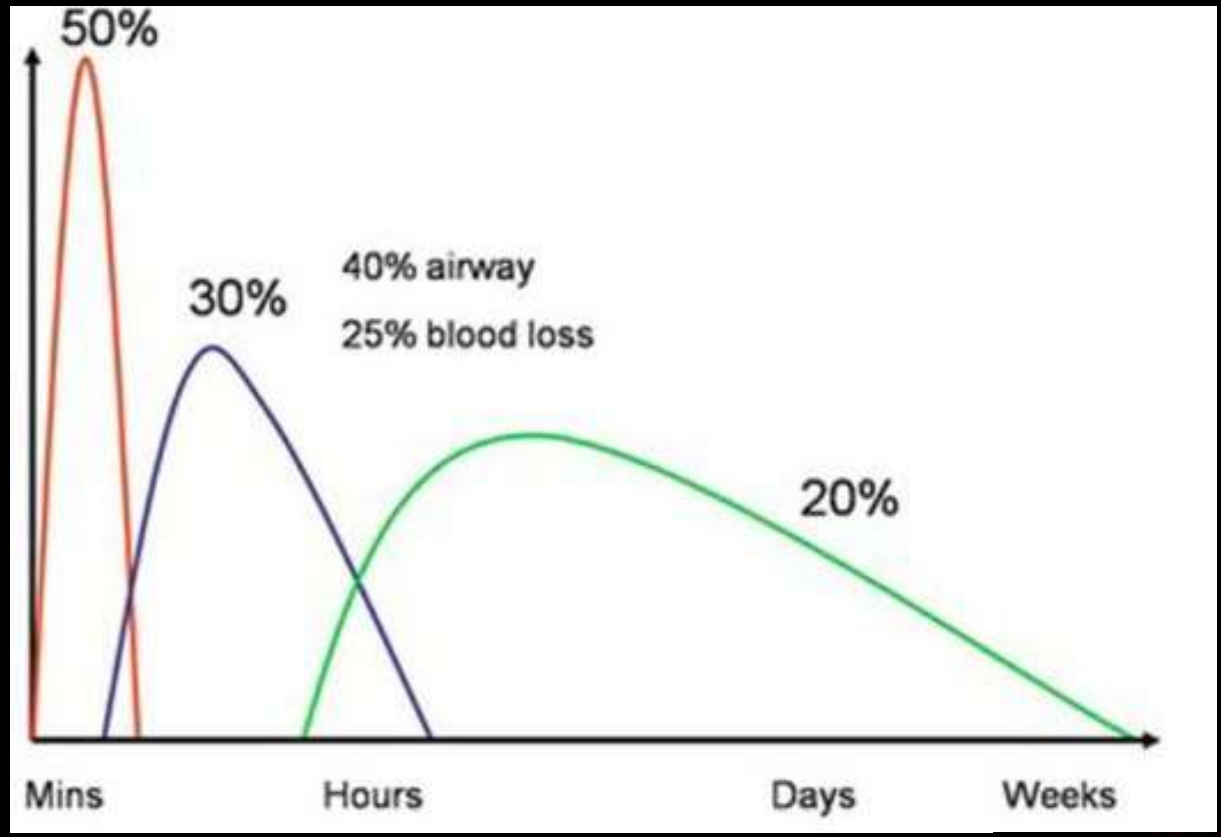
The Trauma Patient

- 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

Dignity Health

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



Dignity Health

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

Dignity Health

Orthopedic Goals 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, etc…
- 2) Timing of Intervention
  - ETC vs DCO vs EAC
  - Minimize “second hit”
- 3) Minimize complications
  - Early – Shock, ARDS/MODS
  - Late – Infection, immobility, thromboembolism, nonunion/malunion

Dignity Health

Evaluation of the Polytraumatized Patient

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

Dignity Health

Evaluation of the Polytraumatized Patient

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

- Cervical spine immobilization
- Protect airway/intubation

Dignity Health

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

Dignity Health

Evaluation of the Polytraumatized Patient

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

- Most commonly from hemorrhage
  - Pelvis ring injuries
    - Apply binder/sheet/traction
  - Femur fractures
    - Traction
  - Vascular injuries
    - Apply direct pressure
    - Temporize with tourniquet***
    - Reduce fracture/dislocation

Dignity Health

Evaluation of the Polytraumatized Patient

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

- Perform neurologic exam
- Determine Glasgow Coma Scale

Dignity Health

Evaluation of the Polytraumatized Patient

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

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

Dignity Health

Evaluation of the Polytraumatized Patient

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

Dignity Health

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

Dignity Health

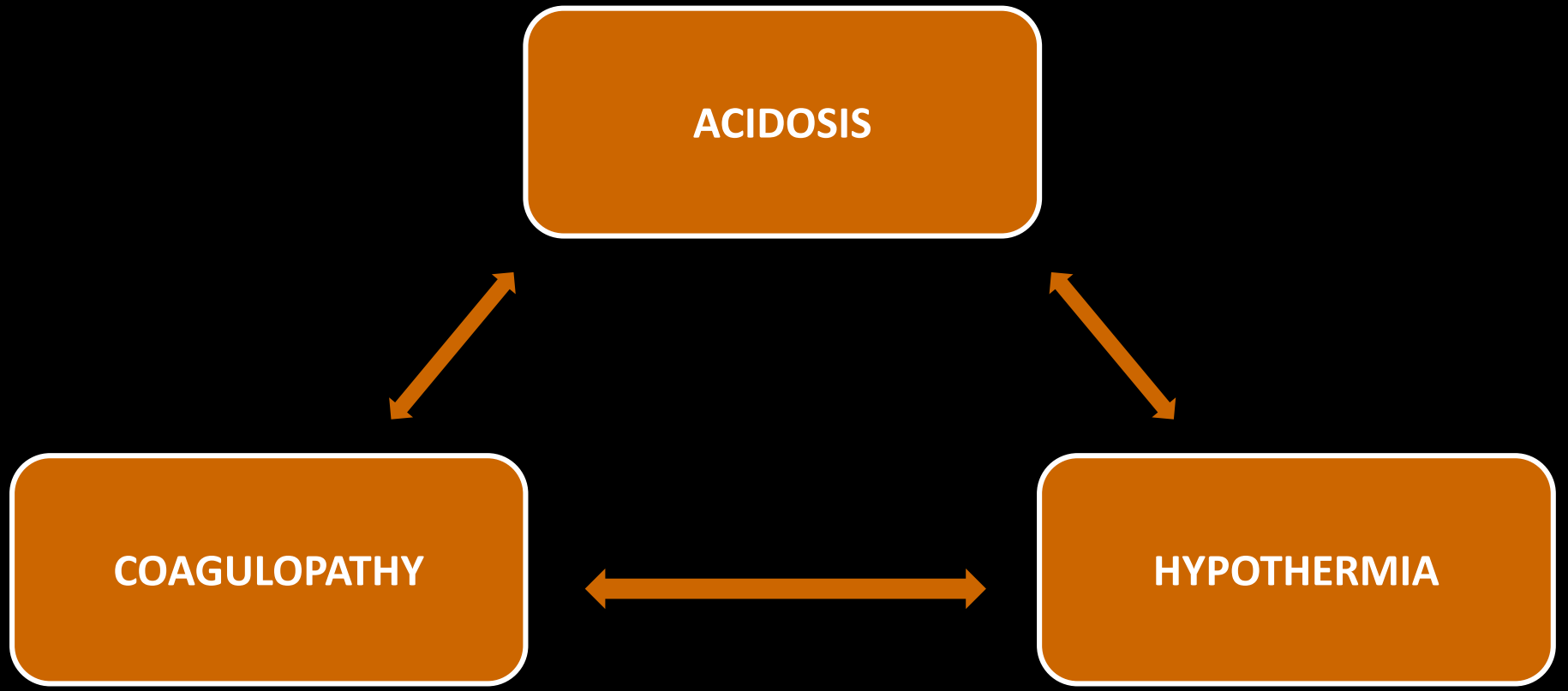
Classification of Hemorrhagic Shock

	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

Crystalloid **Crystalloid + Transfusion**

Dignity Health

Lethal Triad



Dignity Health

Blood Transfusion

- Type O (universal donor) or Cross-matched, type specific blood
- Balanced blood product administration
  - 1:1:1 ration of pRBC:plasma:platelets
  - Due to effects of lethal triad
  - pRBC restores tissue oxygenation and normalizes acidosis
  - Plasma and platelets reverses coagulopathy

Other Types of Shock

- Cardiogenic
  - Heart failure, dysrhythmia, valve dysfunction, tamponade
  - Diminished cardiac output
  - Hypotension and relative tachycardia
- Neurogenic
  - spinal cord injury, head injury – resultant loss of sympathetic tone
  - Hypotension and BRADYcardia
- Septic
  - Rarely seen early
  - Decreased systemic vascular resistance

The Physiological Response to Trauma

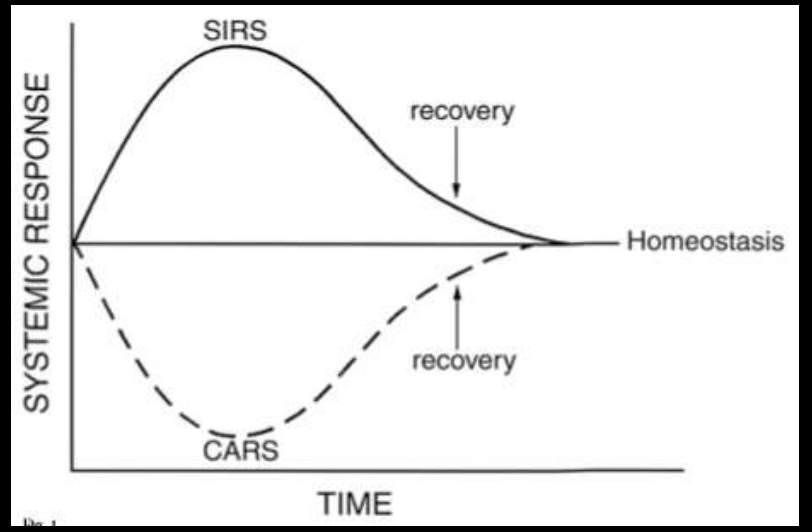
- Multiple injured patient will presents with a complex hyper-inflammatory injury response to trauma:
  - Inadequate cellular profusion
    - Shock/hemorrhage from femur fracture or pelvis
  - Severe soft tissue injury
    - Open fracture, mangled extremity
  - Proinflammatory cytokine response
    - IL-6, IL-8, etc…
    - leading to…

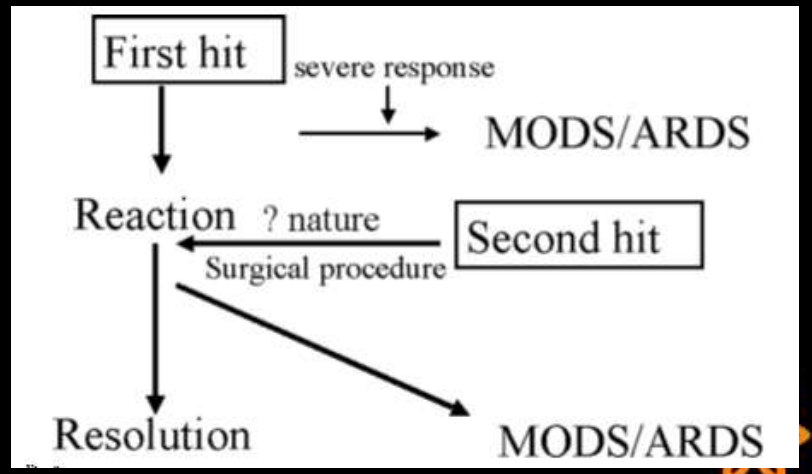
Dignity Health

Systemic Inflammatory Response Syndrome

- Hyperexagerrated response to trauma leading to:
  - ARDS
  - MODS

- "Second Hit" Phenomenon
  - Immune system is "primed" for activation after a secondary inflammatory event (ie, second trauma, major surgery involving blood loss, fluid shifts, etc)





Dignity Health

Prioritization of Orthopedic Injuries

- Life and limb threatening injuries first
  - Massive hemorrhage (ie, pelvis, long bone fractures)
  - Vascular compromise
  - Compartment syndrome

- Once patient has been resuscitated then consider urgencies
  - Open fracture debridement
  - Stabilization of fractures

Dignity Health

Timing of Fracture Fixation

- Early Total Care
- Damage Control Orthopedics
- Early Appropriate Care

Dignity Health

Timing of Fracture Fixation

- Early Total Care
  - Early DEFINITIVE stabilization of ALL fractures
  - Increase mobility and reduce morbidity and mortality
  - BUT patients have to be adequately resuscitated
  - If not resuscitated can lead to “second hit” phenomenon

Dignity Health

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

Dignity Health

Timing of Fracture Fixation

- Damage Control Orthopedics
  - Can’t ex fix everything!
    - Pelvis, acetabulum, spine
  - When is DCO indicated versus ETC?
  - How do we know when a patient is “adequately resuscitated”?

Dignity Health

Timing of Fracture Fixation

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

Timing of Fracture Fixation

Early Appropriate Care

Dignity Health

The Resuscitated Patient

- 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)
- 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)

Dignity Health

Patient Risk Stratification/Resuscitation

- Stable
  - Definitively fix early
- Borderline
  - Consider temporizing stabilization based on response to resuscitative measures
- Unstable
  - Not fit for surgical intervention, continue resuscitation
- Extremis

TABLE 9-5 Classification Systems for Clinical Patient Assessment

	Parameter	Stable (Grade I)	Borderline (Grade II)	Unstable (Grade III)	In Extremis (Grade IV)
Shock	Blood pressure (mm Hg)	100 or more	80–100	60–90	<50–60
	Blood units (2 h)	0–2	2–6	5–15	>15
	Lactate levels	Normal range	Around 2.5	>2.5	Severe acidosis
	Base deficit (mmol/L)	Normal range	No data	No data	>6–8
	ATLS classification	I	II–III	III–IV	IV
Coagulation	Platelet count (μg/mL)	>110	90–110	<70–90	<70
	Factor II and V (%)	90–100	70–80	50–70	<50
	Fibrinogen (g/dL)	1	Around 1	<1	DIC
	D-dimer	Normal range	Abnormal	Abnormal	DIC
Temperature		<33°C	33–35°C	30–32°C	30°C or less
Soft Tissue Injuries	Lung function; PaO_2/FiO_2	350–400	300–350	200–300	<200
	Chest trauma scores; AIS	AIS 1 or 2	AIS 2 or more	AIS 2 or more	AIS 3 or more
	Chest trauma score; TTS	0	I–II	II–III	IV
	Abdominal trauma (Moore)	< or = II	< or = III	III	III or > III
	Pelvic trauma (AO class.)	A type (AO)	B or C	C	C (crush, rollover abd.)
	Extremities	AIS I–II	AIS II–III	AIS III–IV	Crush, rollover extrem.

Dignity Health

Pape HC, Giannnoudis PV. Management of the Multiply Injured Patient. In Court-Brown C, Heckman JD, McQueen MM, et al (Eds.), Rockwood and Green's Fractures in Adults, 8th Edition. 2015

Orthopedic Considerations in the Trauma Patient

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

Dignity Health

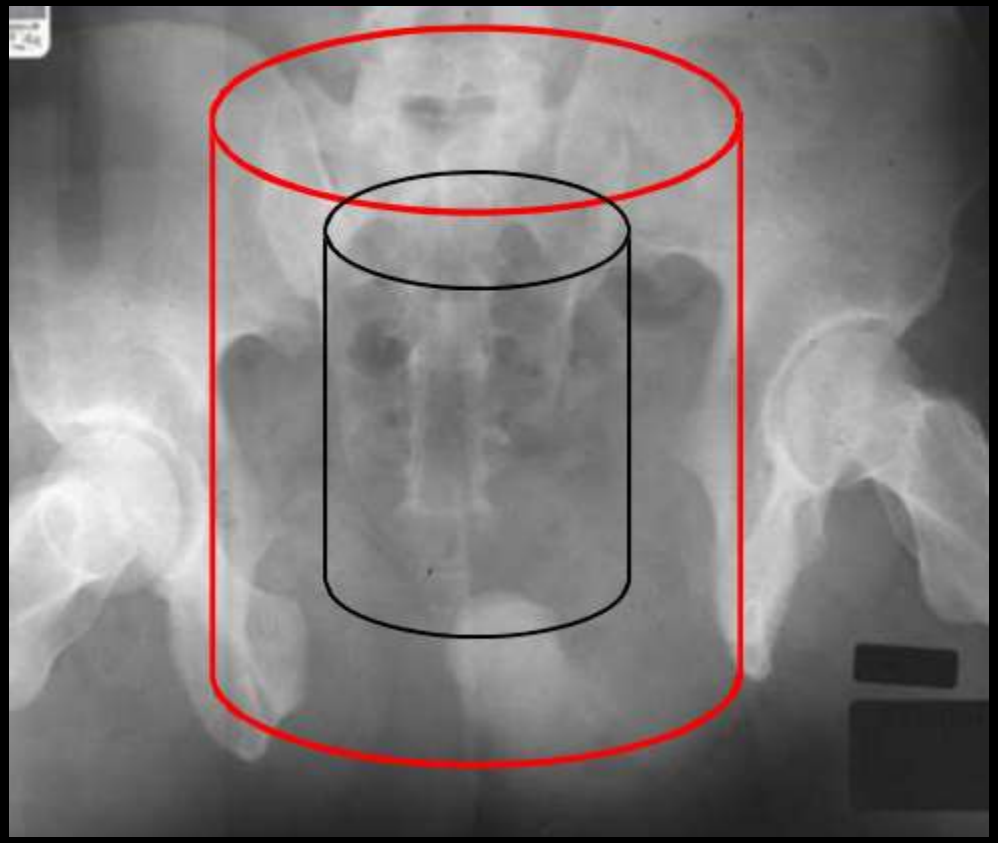
Hemodynamically Unstable Pelvis

- High energy injury
- High morbidity & mortality
- High transfusion requirement

Dignity Health

Hemodynamically Unstable Pelvis

- The volume of the true pelvis is a cylinder
  - 4/3π r3
- As the radius of the cylinder increases the volume increases by a power of 3 – massive potential for hemorrhage!



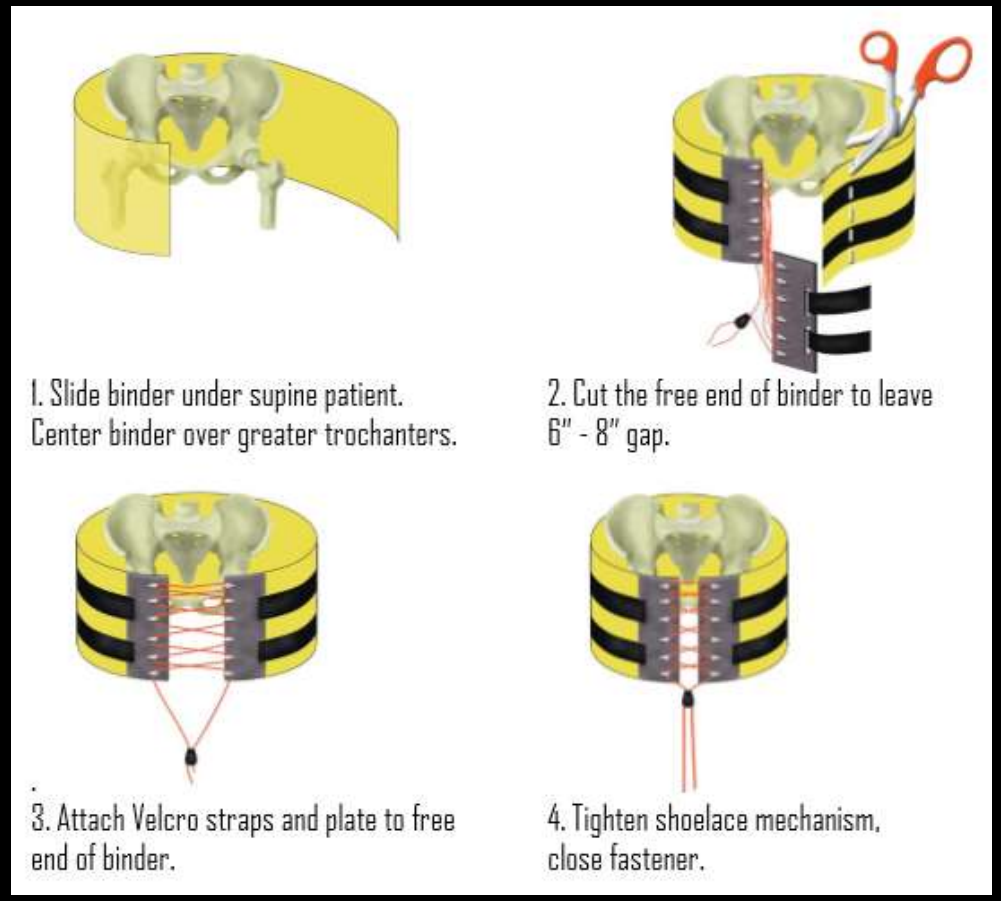
Dignity Health

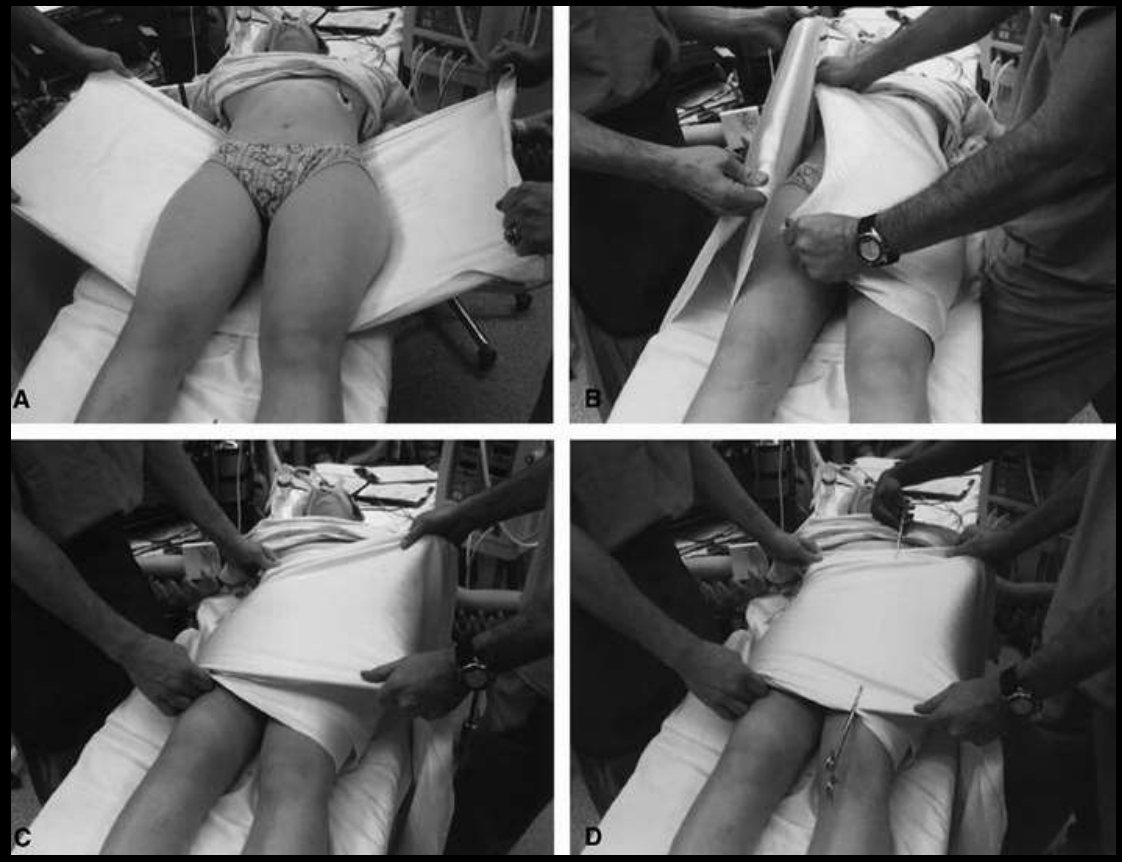
Hemodynamically Unstable Pelvis

- Need to reduce pelvic volume!
  - Pelvic Binders/Sheets – First line of treatment
  - Pelvic External Fixation
  - Don’t forget traction!

Dignity Health

Placing a Pelvic Binder/Sheet





Dignity Health

Pitfalls Pelvic Binders/Sheets

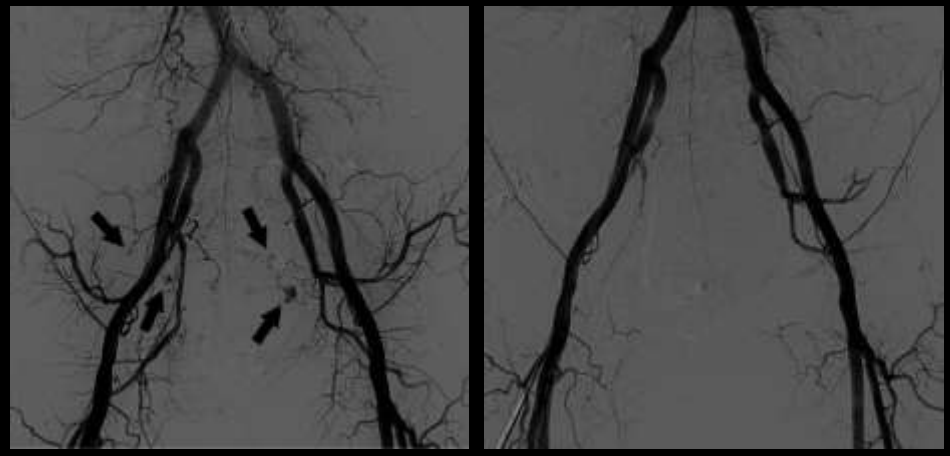
- Avoid prolonged use
  - Can lead to pressure necrosis of the skin if >24 hours
  - Check skin every 12 hrs after first 24 hrs

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

Dignity Health

Hemodynamically Unstable Pelvis

- Laparotomy with pelvic packing
  - Need to apply external fixator
  - Controls venous & arterial bleeding
- Angiography
  - Best works of arterial bleeding (~5-20%)
- REBOA
- Timing of these interventions vary based on institution…



Dignity Health

Long Bone Fractures

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

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/External Fixation vs Definitive Early Fixation?

Dignity Health

Open Fractures

Dignity Health

Open Fractures

Dignity Health

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**

Dignity Health

Open Fractures

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

Dignity Health

Open Fractures

- Operative Management:
  - Surgical Urgency
  - Operative debridement within 24 hours of ED arrival
    - Within 6 hours if grossly contaminated
    - ASAP if associated with 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.

Dignity Health

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
      - Type I: 3L
      - Type II: 6L
      - Type III: 9L
  - Surgical Stabilization & Coverage…
    - IMN vs Plate vs Ex-Fix
    - Primary vs Delayed Closure vs Flap Coverage

Dislocations with Neurovascular Compromise

- Knee dislocations most commonly associated with neurovascular injury

- 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

Dignity Health

Compartment Syndrome

- Surgical Emergency
- Occurs when the pressure in a fascial compartment increases above the level of the perfusion pressure of the limb
- High Energy Trauma
- Open Fractures
- Initial treatment
  - Release circumferential bandages/splints/casts
  - Elevate extremity at level of heart

Dignity Health

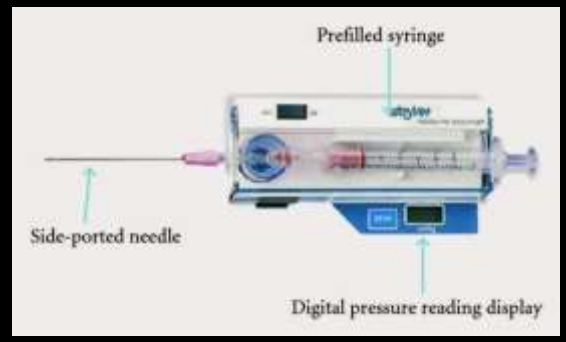
Compartment Syndrome

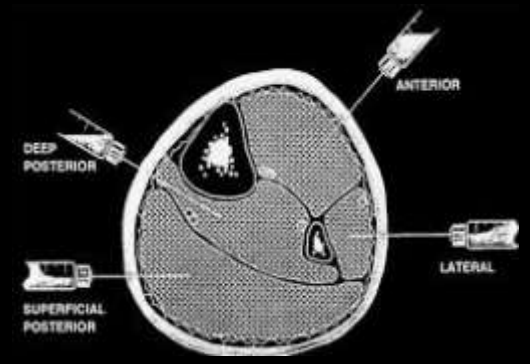
- Diagnosis
  - Clinical Diagnosis – ***"Six P's":***
    - Pain out of proportion to injury
    - Pain with passive stretch
    - Palpable swelling
    - Paresthesias
    - Paralysis
    - Pulselessness
  - Pediatrics – ***"Three A's":***
    - Agitation
    - Anxiety
    - Analgesia requirement increasing

Dignity Health

Compartment Syndrome

- Diagnosis
  - Clinical
  - 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*





Dignity Health

Compartment Syndrome

- Treatment
  - Emergent Fasciotomy
    - One Incision versus Two Incision

Dignity Health

Summary

- Care of the trauma patient is a team oriented algorithmic approach to management
- Life and limb >>> Everything else
- Continual reassessment
- Role of the orthopaedic surgeon in the timing and stabilization of major musculoskeletal injuries

Dignity Health

Thank You! Questions/Comments?

Dignity Health