Assessment, management and decision making in the treatment of polytrauma patients with head injury, DCO

Heather A. Vallier, M.D.
Professor of Orthopaedic Surgery
C.L. Nash Professor of Orthopaedic Education
Case Western Reserve University
The MetroHealth System

2016

Trauma is a public health problem

- Leading cause of death and disability in people <45 y/o
- Number of injured people increases each year (more surviving)
  - Better vehicle safety
  - Better transport systems
  - Better critical care

Trauma is a public health problem

- > $500B annual expenses to treat injury in US (direct + indirect costs)

- More costly than heart disease, cancer, cerebrovascular disease combined

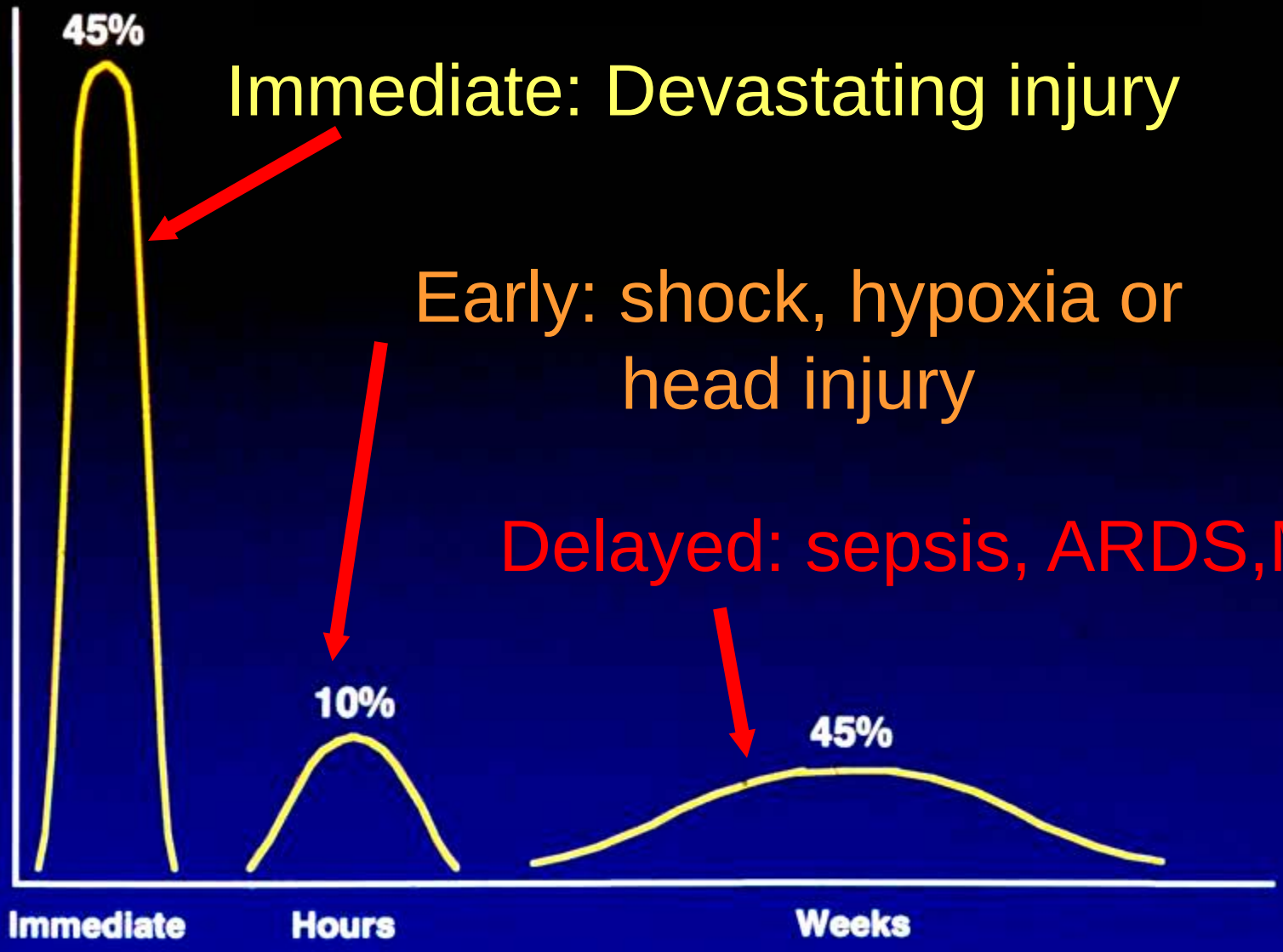
Trauma centers save lives

- Algorithm-based care
- Triage and transport patient to anticipated level of care
- Some regions have developed systems with multiple hospital business entities:
  - e.g. Maryland: 1st statewide EMS system, Shock Trauma Center level 1 model
  - e.g. Northern Ohio Trauma System: one level 1, two level 2, 13 non-trauma ctrs
  - Mortality decreased, although # trauma centers in the area decreased

Mortality after trauma

- **Immediate:** severe brain injury, transection great vessels, other major hemorrhage
- **Early (minutes to hours):** Brain injury (epidural/subdural bleed), hemo/pneumothorax, diaphragm rupture, pelvis/long bones fxs
- **Delayed (days):** sepsis, multiple organ failure

Trauma Deaths



Immediate: Devastating injury

Early: shock, hypoxia or head injury

Delayed: sepsis, ARDS,MOF

Mortality after trauma

- Trauma centers mitigate early and delayed mortality

- Damage control tactics may improve early mortality (control hemorrhage) and delayed mortality (minimize systemic inflammation and organ failure)

ATLS principles

- Advanced Trauma Life Support

Treat the greatest threat to life first

- Primary survey: Resuscitation simultaneously
- Secondary survey: Provisional and definitive care
- Tertiary survey

Primary survey

- A Airway
- B Breathing
- C Circulation
- D Disability/neurological
- E Exposure/environmental

Potential adjuncts to primary survey

- Chest XR
- AP pelvis XR
- Foley catheter
- gastric tube
- FAST: Focused abdominal ultrasound

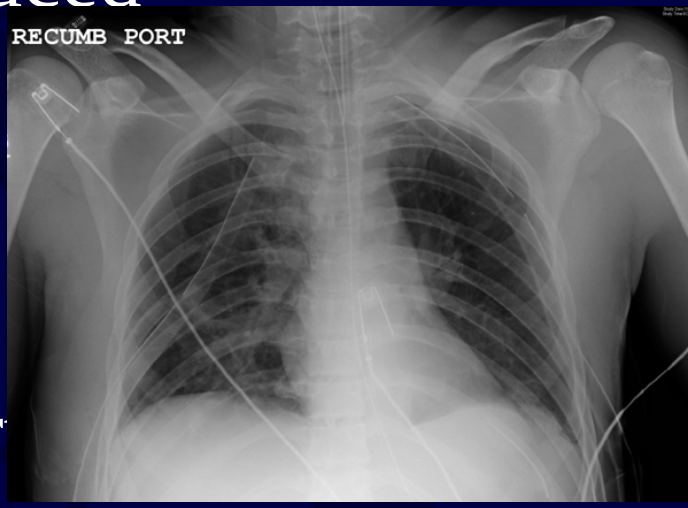
Airway

- Maintain C spine precautions
- Chin lift/jaw thrust
- Establish and protect airway
  - oral, nasal, or surgical

Lateral C spine XR is no longer included in ATLS protocol

Breathing

- Assess breathing and oxygenation
- Identify and treat sources of reduced oxygenation:
  - Tension pneumothorax → needle decompression
  - Pneumothorax → chest tube inser
- Perform ABG



Breathing

- Establish mechanical ventilation when pt unable to breathe adequately or unable to protect airway
  - e.g. vomiting, seizure, combative, severe face/neck injury w/swelling and bleeding
- Hyperventilation for severe head injury

Circulation

- Hemorrhagic shock is most common type
- Assess wounds, abdomen, pelvis stability, peripheral pulses
- CONTROL BLEEDING
  - direct pressure
  - compressive dressings
  - tourniquets

Hemorrhagic shock

	Class 1	Class 2	Class 3	Class 4
Blood loss (mL)	Up to 750	750-1500	1500-2000	>2000
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 (mmHg)	Normal	Decreased	Decreased	Decreased
Respiratory rate	14-20	20-30	30-40	>35
Urine output (mL/hr)	>30	20-30	5-15	Negligible
Mental status	Slightly anxious	Mildly anxious	Confused	Lethargic

Other types of shock

- **Cardiogenic**: heart failure, acute MI, pericardial tamponade
- **Neurogenic**: spinal cord injury, closed head injury
- **Septic** (rare early in trauma)

Resuscitation

- Begins immediately, continues during primary and secondary surveys
- Establish 2 large bore IVs
- 2L lactated Ringers
- If no improvement in hypotension, consider transfusion

Disability

- Neurological exam
- Glasgow Coma Scale

Glasgow Coma Scale

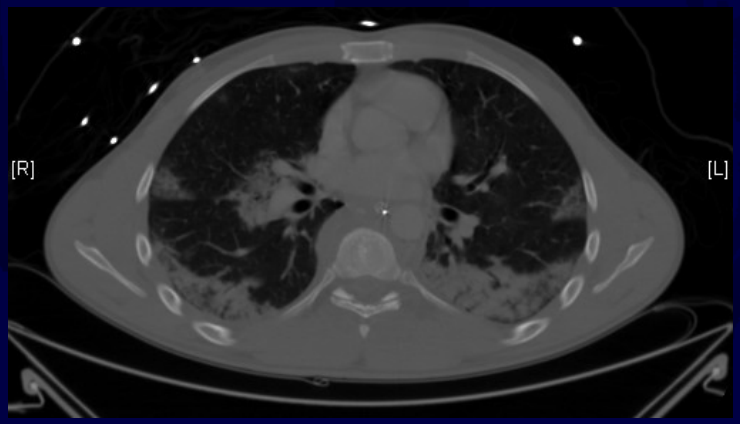
Clinical parameter	Points
Eye Opening (E)	
Spontaneous	4
To speech	3
To pain	2
None	1
Motor Response (M)	
Obeys commands	6
Localizes pain	5
Normal flexion (withdrawl)	4
Abnormal flexion (decorticate)	3
Extension (decerebrate)	2
None (flaccid)	1
Verbal Response (V)	
Fully oriented	5
Disoriented/confused conversation	4
Inappropriate words	3
Incomprehensible words	2
None	1

Exposure

- Remove clothing
- Normalize temperature: heating or cooling blankets, warmed fluids as indicated

Secondary survey

- Complete head to toe survey
- Additional radiography: plain XR and CT
- Laboratory tests



Tertiary survey

- Complete head to toe survey
- Important for orthopaedic surgeons to avoid missing injuries
- Repeated as needed when mental status normalizes

Key points for orthopaedic surgeons

Pelvis fractures can be life-threatening

- Assess pelvic stability
- Assess/dress open wounds
- Apply sheet or binder for diastasis
- Perform retrograde urethrogram prior to foley catheter if blood at urethral meatus or high riding prostate

Key points for orthopaedic surgeons

- **Multiple long bone fractures generate massive hemorrhage**
  - Femur fx: 750-1500cc
  - Tibia fx: 300-750cc
- Open fractures will bleed more and may have had large blood loss prior to arrival

Orthopaedic emergencies

- **Dysvascular extremity** → reduce fx/disloc and reassess, emergent provisional stability and revascularization
- **Compartment syndrome** → fasciotomy
- **Cauda equina syndrome** → decompression
- **Open fractures** → iv abx <6hr, debridement
- **Dislocations** → reduction (open if closed reduction not possible)

Basic management of injuries to other systems

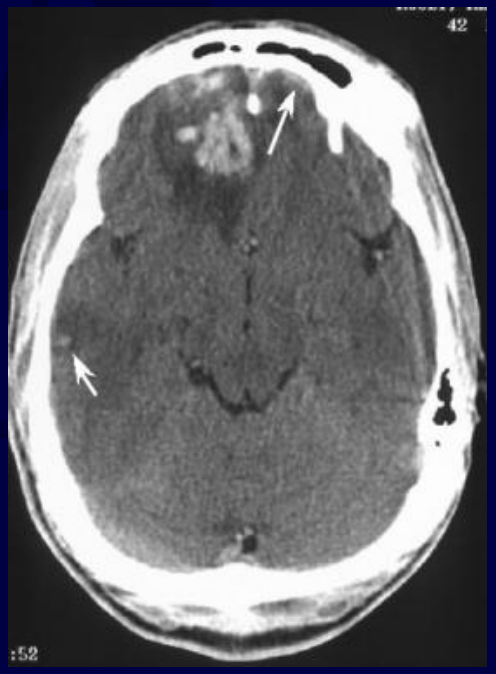
- Head injury
- Chest injury
- Abdominal injury

Head injury

- Keep brain perfused and oxygenated
- Reverse Trendelenberg position
- Maintain cerebral perfusion pressure > 70mmHg and ICP < 20mmHg

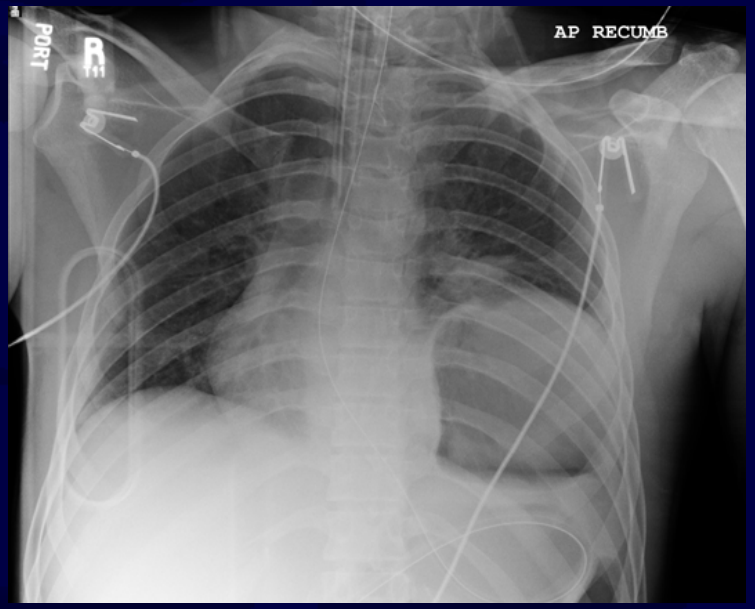
(CPP = MAP – ICP)

- iv mannitol
- hyperventilation
- fluid restriction



Chest injury

- Most chest injuries are minor
- Some are life-threatening:
  - Tension pneumothorax
  - Hemo/pneumothorax
  - Pericardial tamponade
  - Aortic injury
  - Diaphragm rupture
  - Tracheal rupture



Abdominal injury

- Most common site of occult hemorrhage
- Exploratory laparotomy indicated for penetrating trauma or uncontrolled hemorrhage after blunt trauma
- In presence of pubic diastasis, perform pelvic ex fix prior to exploratory laparotomy to prevent further diastasis

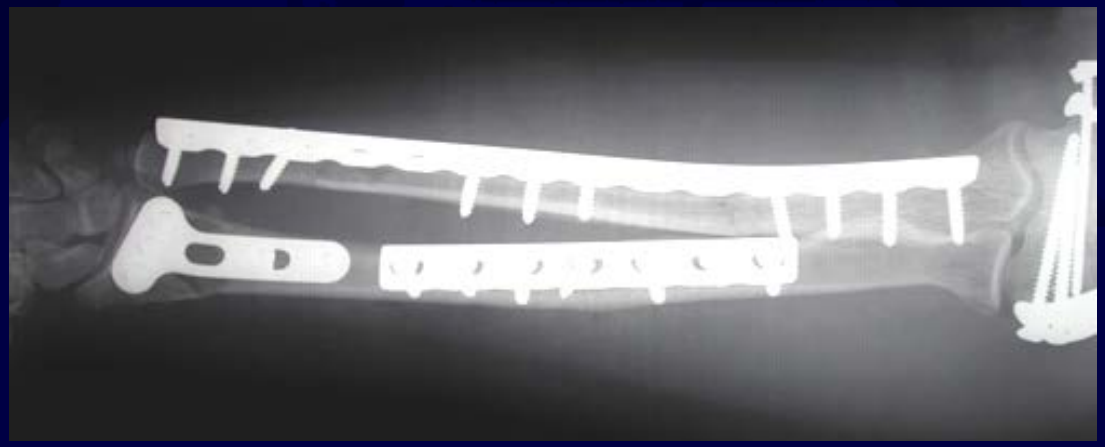
Timing of axial and femoral fracture fixation

- These injuries have associated bleeding (reduction and fixation will control)
- These injuries require recumbency and bedrest until stabilized (associated pulmonary and thrombotic risks)
- These injuries produce more pain/narcotic requirements until stabilized

Early definitive fixation may be considered standard of care in stable patients

Early total care

- Stabilization of all fractures
- Definitive, not provisional
- Can be dangerous in under-resuscitated patients

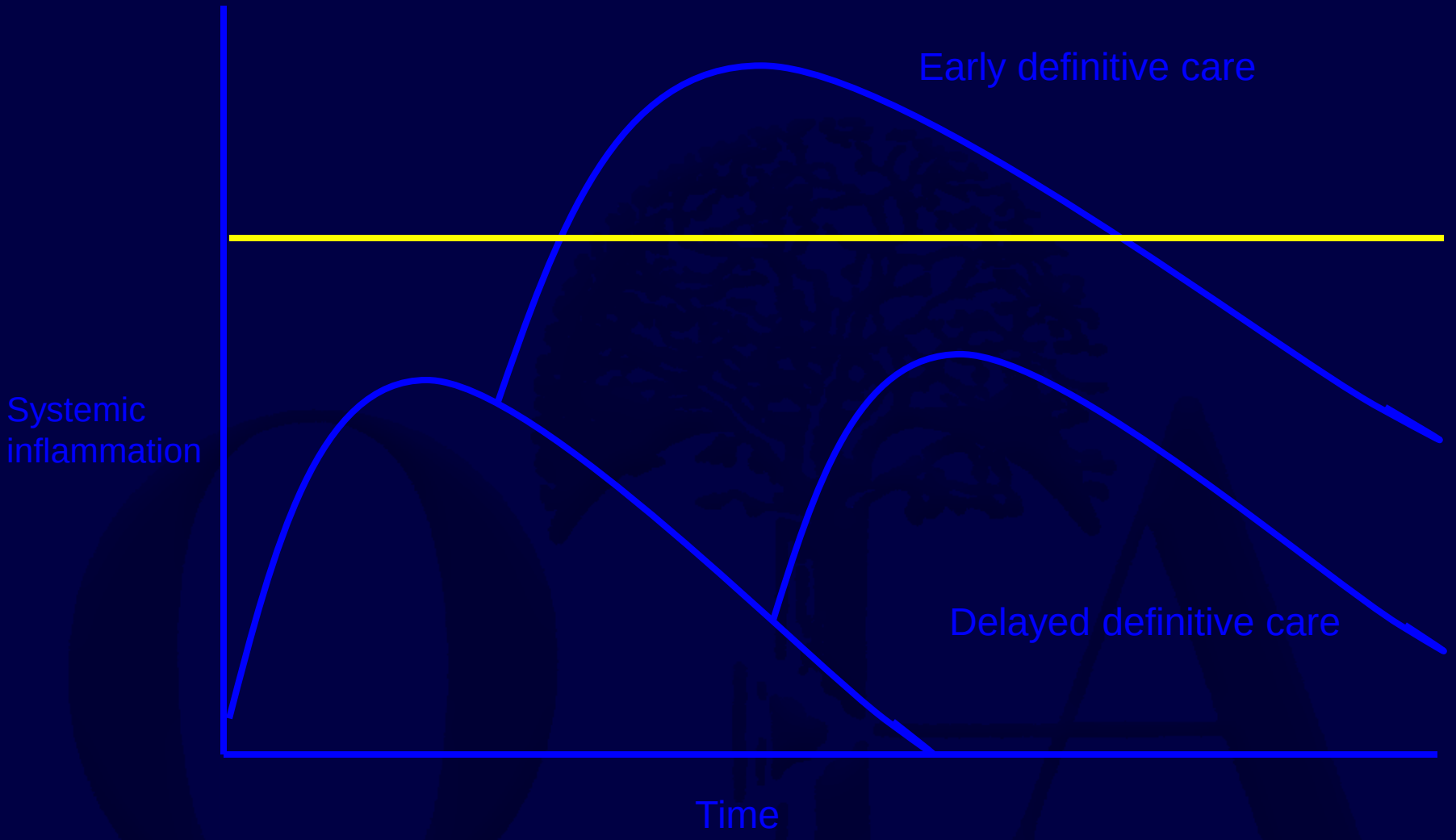


Damage control orthopedics

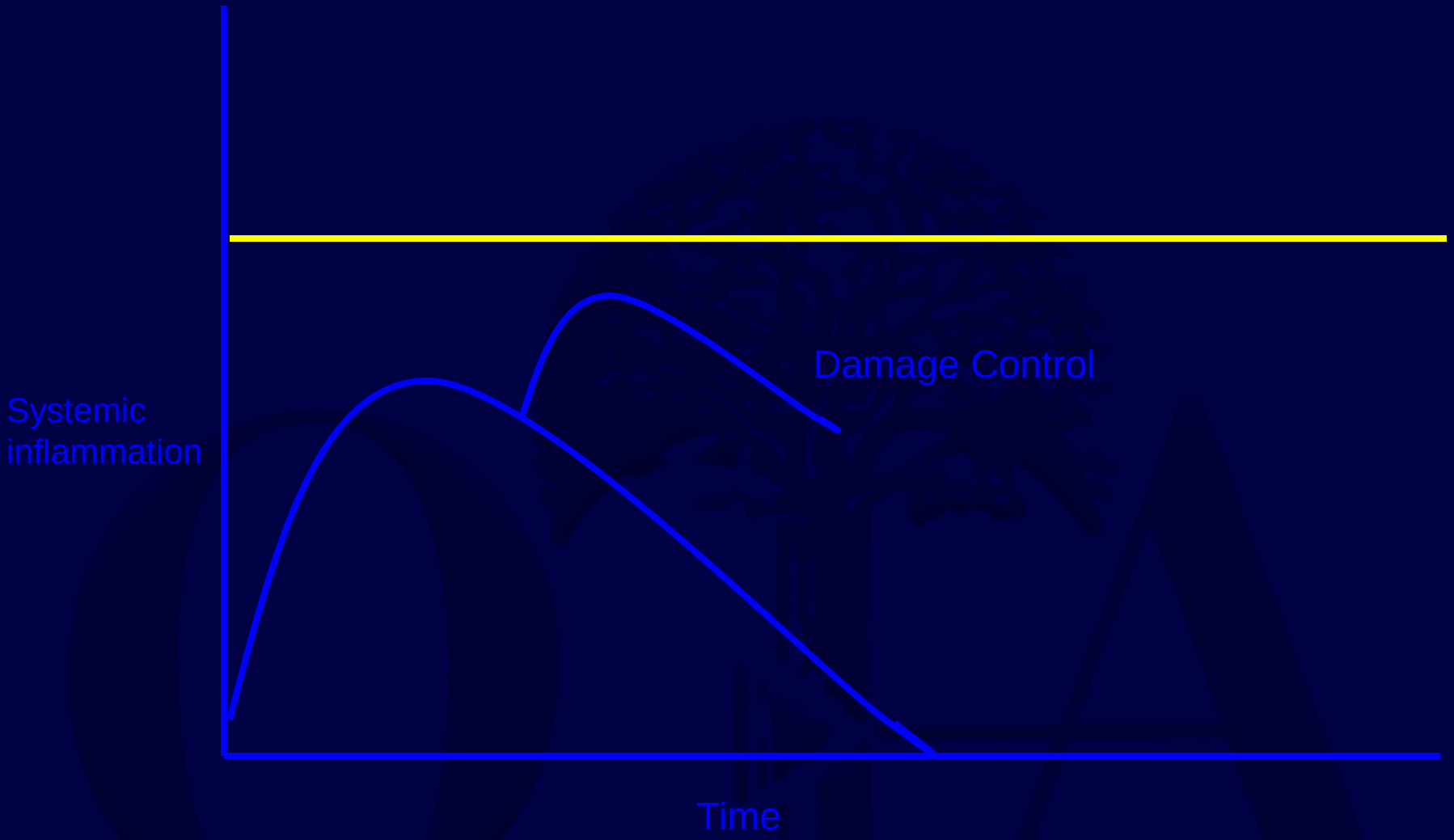
- Provisional fixation of fractures to allow for improved physiology
- Provide stability and minimal soft tissue damage with little surgical bleeding
- Avoid “second hit” of major orthopedic procedure until patient is resuscitated

Inflammation

- Cytokines and inflammatory mediators cause tissue hypoxia and PMN activation
- PMN activation generates endothelial damage and vascular permeability
- Coupled with hemorrhage from injury (hypo-volemia and hypoxia) can be life-threatening
- Systemic inflammatory response syndrome (SIRS)



Surgery creates additional trauma while treating the injury!



DCO minimizes inflammation to prevent exceeding a threshold level for SIRS and organ failure

Unresolved issues with DCO

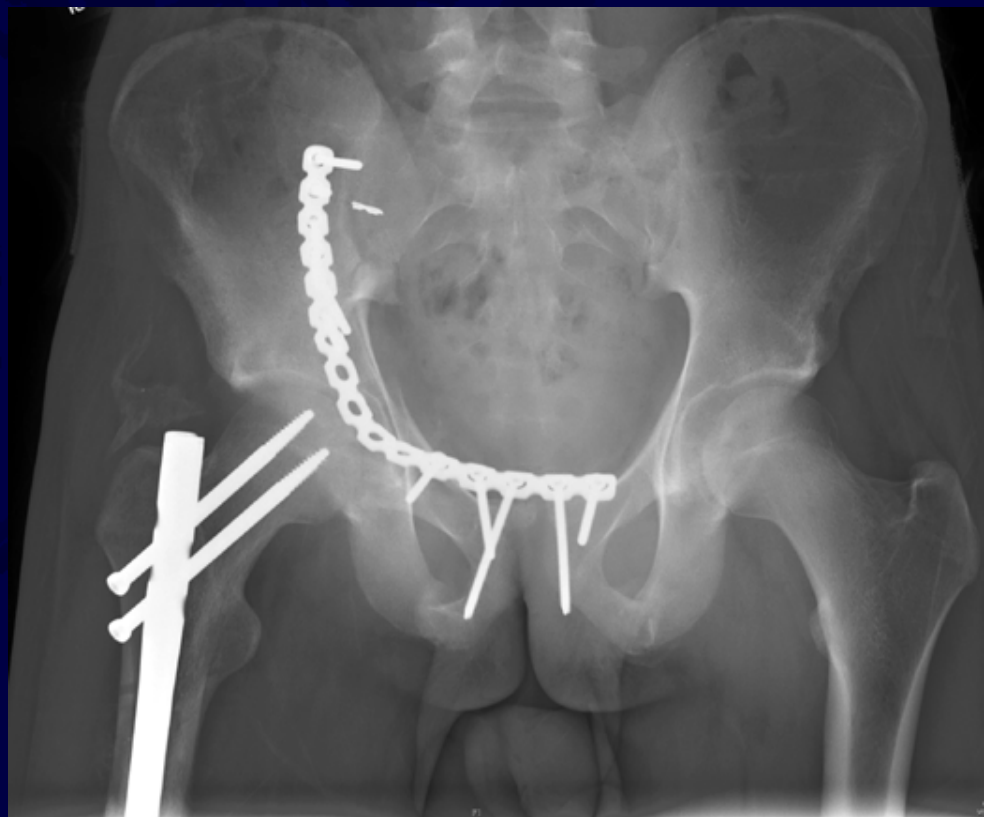
- What about injuries other than the femur?
  - Spine, pelvis, acetabulum
  - Some fractures are not amenable to external fixation

- When to use DCO?
  - Which parameters?
  - Problems w/inflammatory markers
  - Which injury types are predictive?

When is DCO cost effective?

Unresolved issues with DCO

- What to do when ex fix is not an option?
- Which injury types warrant delay?



Indications for DCO

- Persistent hemodynamic instability
- Persistent metabolic acidosis
- Severe head injury with CPP <70 mmHg; ICP >20 mmHg
- Spinal cord injury with evolving neuro deficit (reduction/fixation of spine may be higher priority)
- Cardiac dysfunction

Indications for definitive fixation

- Adequate resuscitation
  - lactate <4.0, base excess ≥-5.5, pH ≥7.25
- Coagulopathy corrected

- Early definitive fixation (within 36 hours) of axial (pelvis/spine), femoral shaft, proximal femur, and acetabulum fractures in stable patients reduces complications, length of stay and costs

Summary

- Trauma care is algorithm-based, follows ATLS guidelines, and requires continuous reassessment of pt

- Ortho emergencies: massive hemorrhage from fxs (pelvis, multiple long bones), dysvascular limb, compartment syndrome, open fxs, dislocations

Summary

- Early definitive fixation of axial and femoral fxs (within 36 hr) is safe and advantageous in stable pts (lactate <4.0)

- DCO indications: head injury with CPP <70mmHg, myocardial demise, persistent metabolic acidosis/hemodynamic instability