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Assessment & Management of Orthopaedic Polytrauma

Yelena Bogdan, MD

The issues…

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Outline

- Evaluation of polytrauma
- Scoring systems
- Ortho urgencies and emergencies
- MOF, ARDS, physiologic response
- *Damage Control Orthopaedics* (DCO), evidence and modes
- Occult Hypoperfusion and Resuscitation
- *Early Appropriate Care*
- Timing of definitive fixation in DCO

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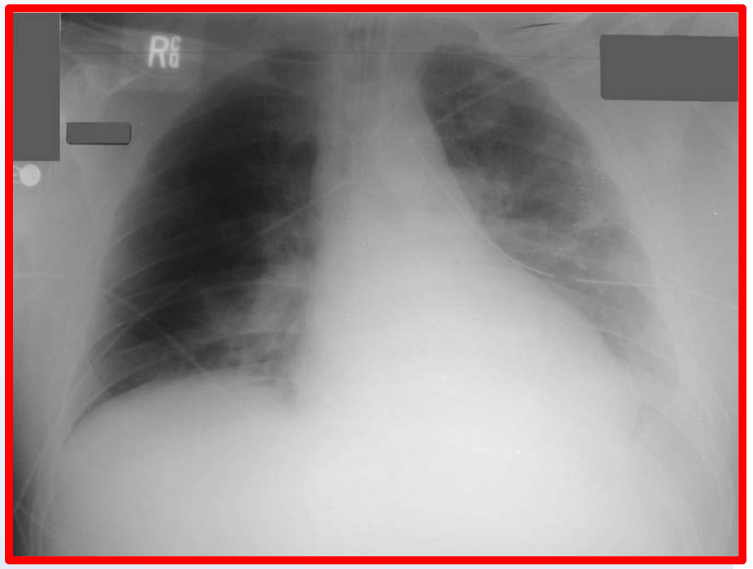
Evaluation of the polytrauma patient

ATLS

Primary Survey

- Airway
- Breathing
- Circulation
- Disability
- Exposure/Environmental Control



Secondary Survey

Tertiary Survey

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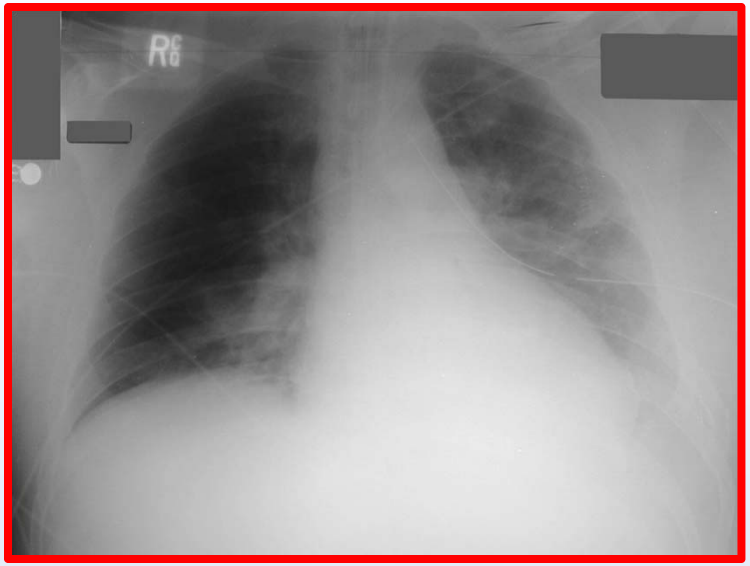

Secondary Survey

Tertiary Survey

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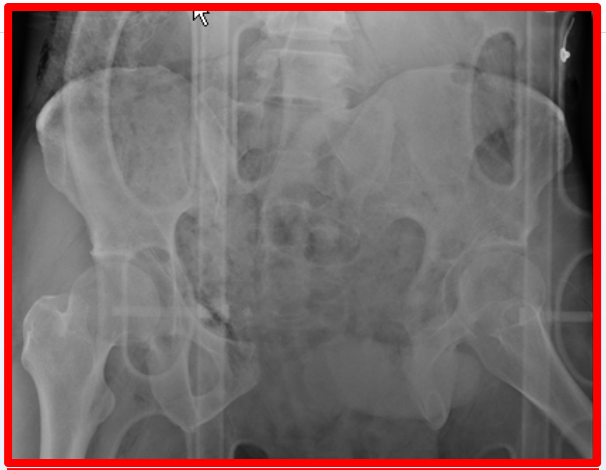
Evaluation of the polytrauma patient

Primary Survey

- Circulation
  - Clinical + radiographic (Pelvic X-Ray)
  - Sheet / binder if needed
  - Direct pressure to areas of obvious hemorrhage
  - Initiation of resuscitation



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Evaluation of the polytrauma patient

Primary Survey

- **Disability**
  - Neuro evaluation
    - Open Fx
    - Displaced Fx
    - Pelvis/Tab

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Evaluation of the polytrauma patient

Tertiary Survey

- Repeat physical exam
- Review of any additional labs and radiographs
- 12% injuries in polytrauma missed in first 24 hours
- Standardized tertiary survey has shown to decrease missed injuries by 36%

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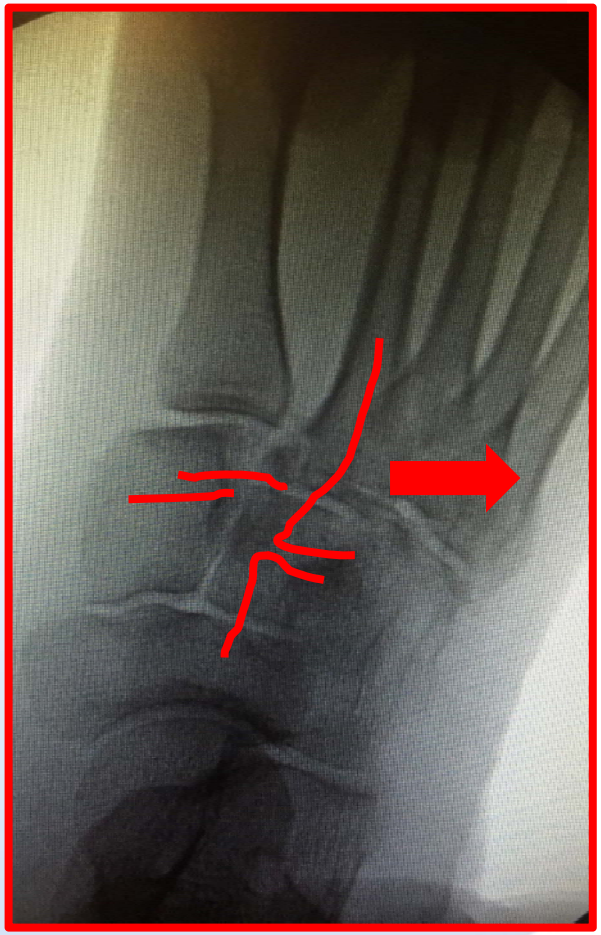
Chan RN, Ainscow D, Sikorski JM. Diagnostic failures in the multiple injured. *J Trauma*. 1980;20:684-687.
Biffl WL, Harrington DT, Cioffi WG. Implementation of a tertiary survey decreases missed injuries. *J Trauma.* 2003;54:3

Evaluation of the polytrauma patient

- **Tertiary Survey**
  - **Repeat physical exam**
  - **Review of any additional labs and radiographs**
  - **12% injuries in polytrauma missed in first 24 hours**
  - **Standardized tertiary survey has shown to decrease missed injuries by 36%**



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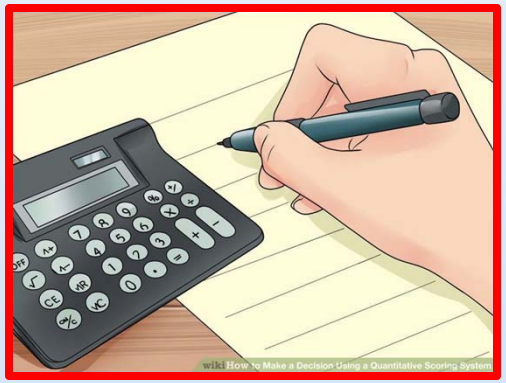
Scoring Systems

Glasgow Coma Scale

Abbreviated Injury Scale

Injury Severity Score

New Injury Severity Score



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Scoring Systems

Glasgow Coma Scale

Abbreviated Injury Scale

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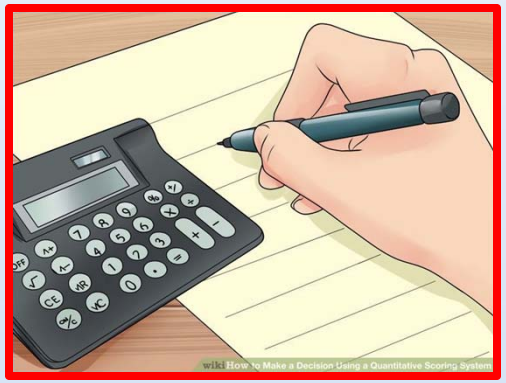
New Injury Severity Score



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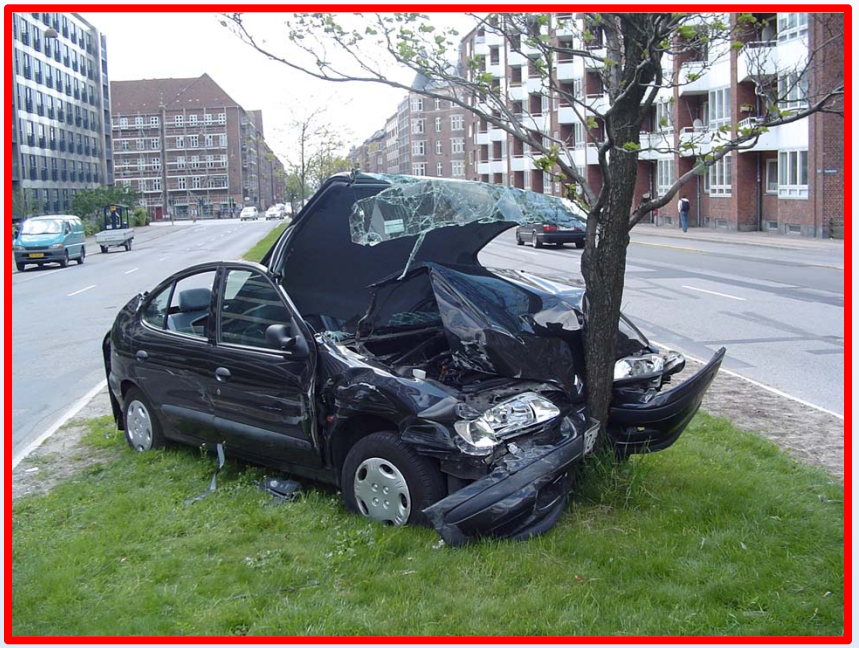
Abbreviated Injury Scale (AIS)

9 anatomic areas:

- Head
- Face
- Neck
- Thorax
- Abdomen
- Spine
- Upper Extremity
- Lower Extremity
- External



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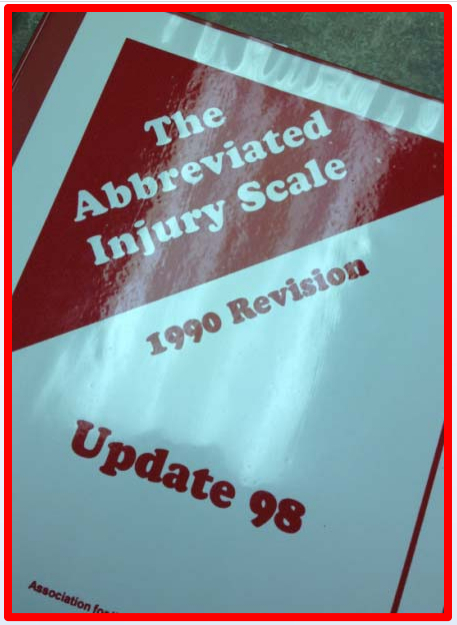
Abbreviated Injury Scale (AIS)

- Each area scored from 0 to 6
- Values 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

$$AIS^2 + AIS^2 + AIS^2$$

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Injury Severity Score (ISS)

- Highest Score: 75 (not survivable)
  - AIS of 5 in three anatomic areas
  - AIS of 6 in any anatomic area

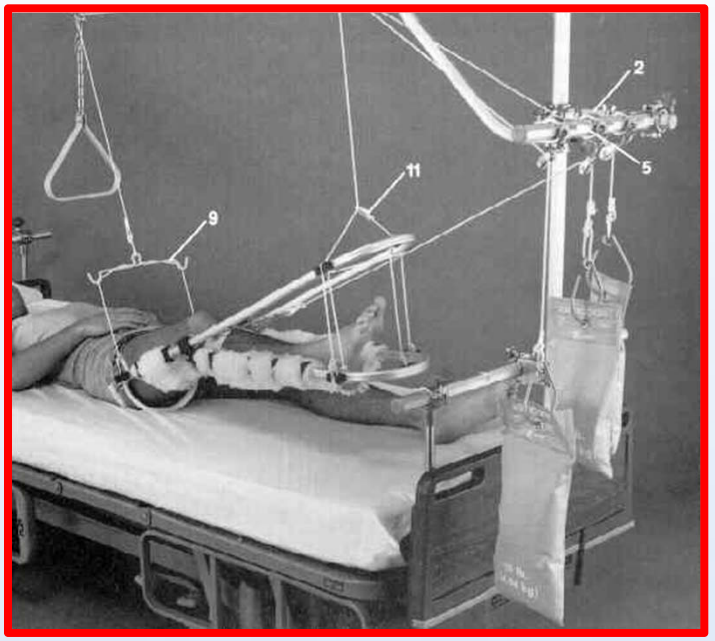
Injury Severity Score (ISS)

Defines polytrauma

- ISS ≥ 18

Correlates with:

- Morbidity
- Mortality
- Length of hospital stay



Injury Severity Score (ISS)

A problem with ISS…

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Injury Severity Score (ISS)

A problem with ISS… injuries within the same anatomic system are only counted once!

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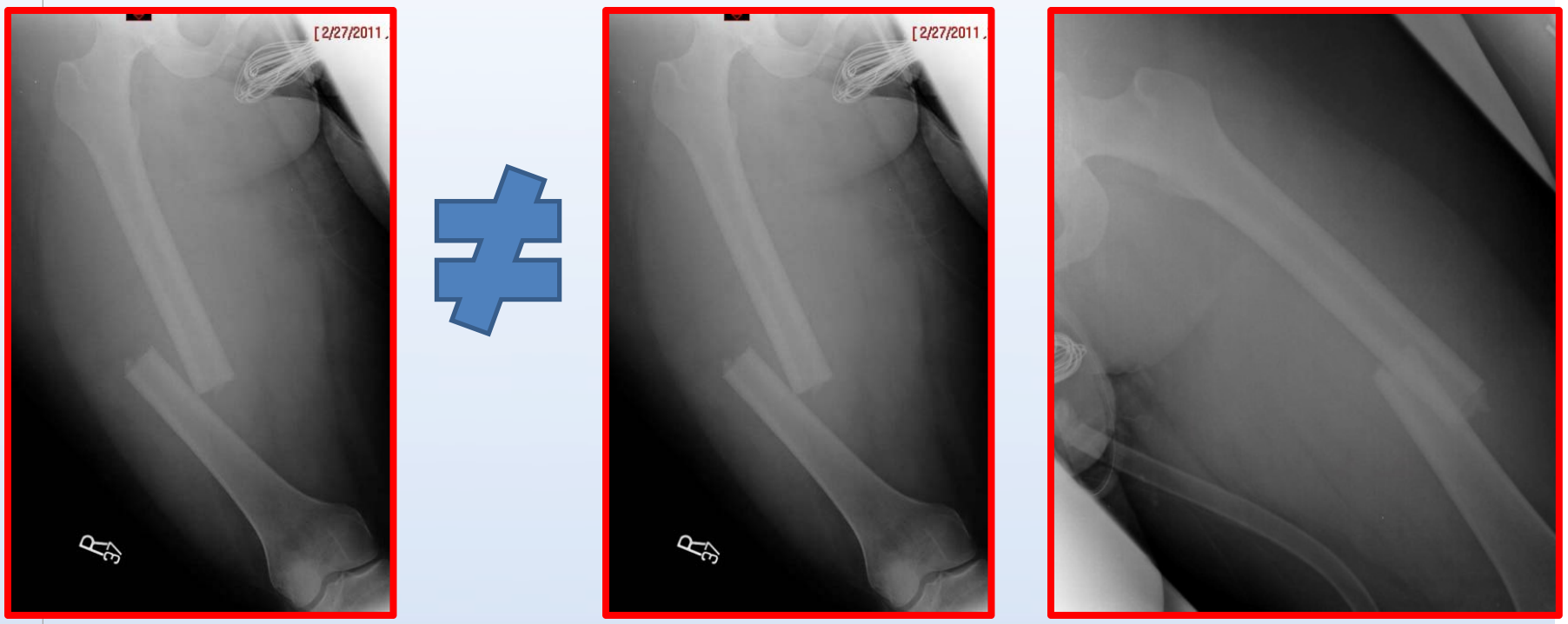
ISS and Bilateral Femur Fractures



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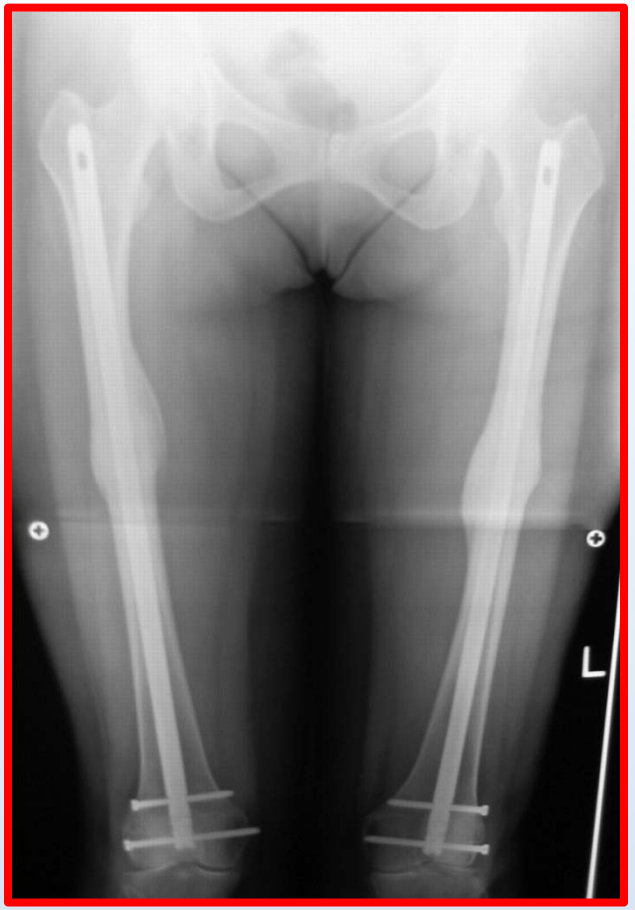
Bilateral Femur Fractures

- Independent risk factor for ARDS
- Historical mortality rates ~40%, recent 5.6%
- Treated with IMN at same setting



Cannada LK, Taghizadeh S, Murali J, et al. Retrograde intramedullary nailing in treatment of bilateral femur fractures. *J Orthop Trauma*. 2008;22:530-534.

Kobbe P, Micansky F, Lichte P et al. Increased morbidity and mortality after bilateral femoral shaft fractures: myth or reality in the era of damage control? *Injury*. 2013;44:221-225.

Life > Limb

- Orthopaedic urgencies and emergencies must be treated within overall context of polytraumatized pt's condition
- Care of orthopaedic injuries impacts mortality
- Early orthopaedic trauma involvement is essential

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Orthopaedic Urgencies and Emergencies

- Unstable pelvic fractures
- Fractures or dislocations with associated vascular injuries, neurologic injuries, soft tissue compromise
- Compartment syndrome
- Spine injury with deficit
- Joint dislocations associated with avascular necrosis
- Open fractures

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Unstable Pelvic Fractures

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

Manson T, O'Toole RV, Whitney A, et al. Young-Burgess classification of pelvic ring fractures: does it predict mortality, transfusion requirements, and non-orthopaedic injuries? *J Orthop Trauma.* 2010;24:603-609.

Fractures w/Vascular Injury

- Control Hemorrhage (pressure)
- Realign limb / Splint
  - Will often resolve issue
- Further eval (arteriogram)
- Ex-fix + vascular repair
  - Ortho first

Compartment Syndrome

Elevated tissue pressure within a closed fascial space

Reduces tissue perfusion→ischemia

Results in cell death→ necrosis

8 hrs- irreversible changes

True Orthopaedic Emergency

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Compartment Syndrome

Fractures

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Compartment Syndrome

Fractures

closed and open

2-10% tibia, 48% segmental, 53% medial knee fx dislocation

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Compartment Syndrome

- Fractures
  - closed and open
  - 2-10% tibia, 48%
    - segmental, 53% medial
    - knee fx dislocation
- Blunt trauma

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Compartment Syndrome

- Fractures
  - closed and open
  - 2-10% tibia, 48% segmental, 53% medial knee fx dislocation
- Blunt trauma
- Temp vascular occlusion

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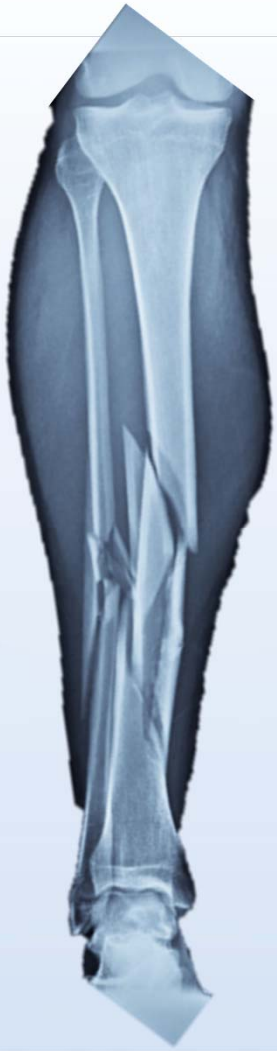
Compartment Syndrome

- Fractures
  - closed and open
  - 2-10% tibia, 48% segmental, 53% medial knee fx dislocation
- Blunt trauma
- Temp vascular occlusion
- Cast/dressing



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Compartment Syndrome

- Fractures
  - closed and open
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- Blunt trauma
- Temp vascular occlusion
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- Closure of fascial defects

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Compartment Syndrome

- Fractures
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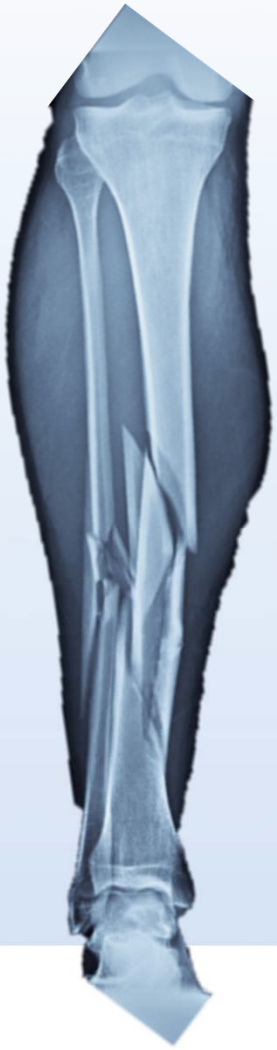

- Burns/Electrical
- Exertional states
- GSW
- IV/A-lines
- Hemophiliac/coag
- Intraosseous IV(infant)
- Snake bite
- Arterial injury

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Compartment Syndrome

Initial Treatment

- Remove splint/dressing
- Elevate
- Check pressures
  - Delta P= SBP-CP
  - <30 →bad
  - Obtunded
- Fasciotomy

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Dislocations

- Urgency depends on joint
- Knee, elbow, hip > ankle, shoulder
- Potential neurologic/vascular sequelae
- Initial treatment:
  - Emergent Reduction
  - Assessment of vascularity
    - Physical Exam
    - Ankle Brachial Index (ABI)
    - Arteriogram prn

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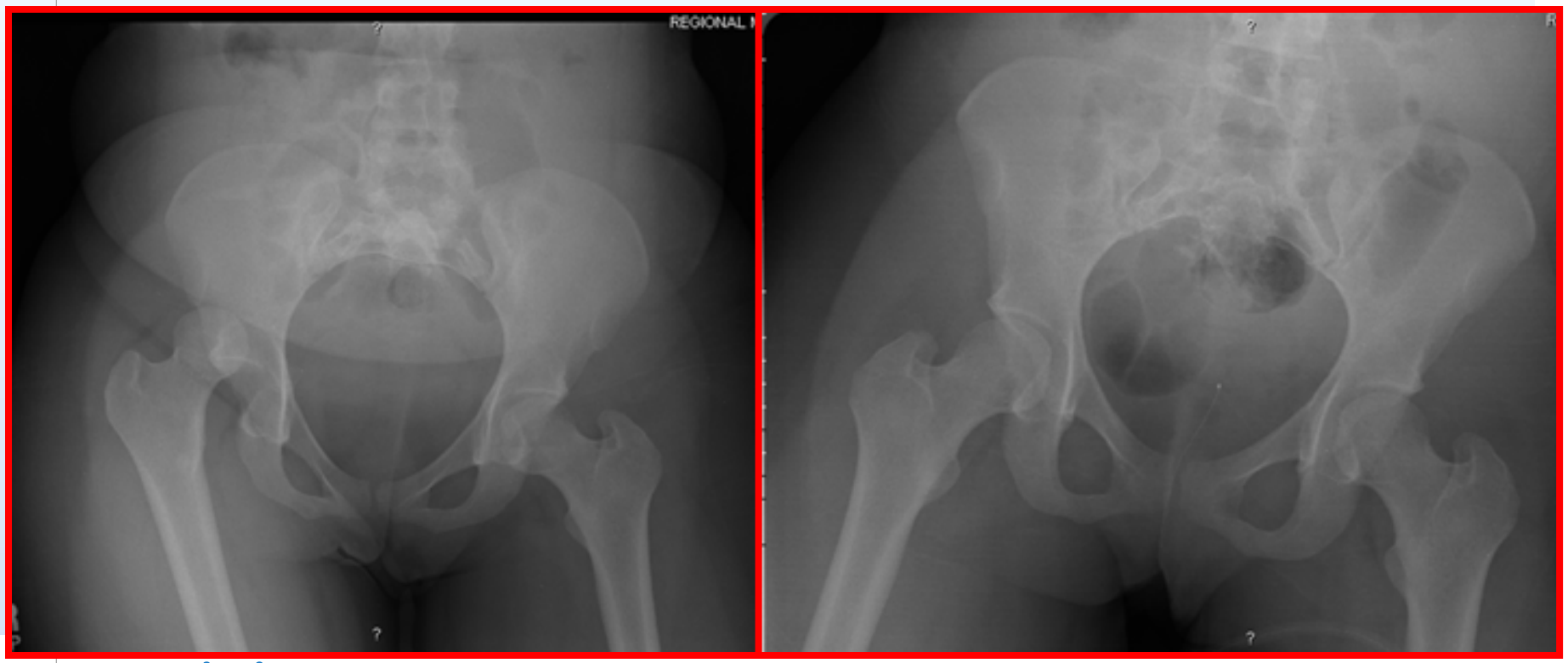
Dislocations

Can be associated with avascular necrosis

- Emergent Reduction
- Do this in the OR for a native hip! (risk FN fx)



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Dislocations

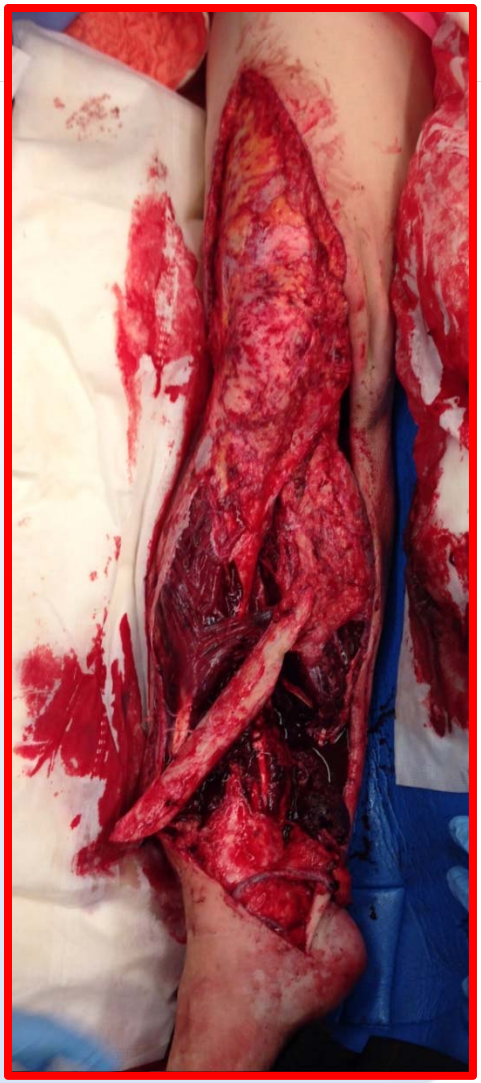
Associated with soft tissue compromise

- Emergent Reduction
- Still get Xrays first!

Why?

Open Fractures

- Break in skin and underlying soft tissues leads directly into and communicates with the fracture and its hematoma
- Wound in same limb segment as fracture
- Prognosis depends on contamination, associated injuries and…



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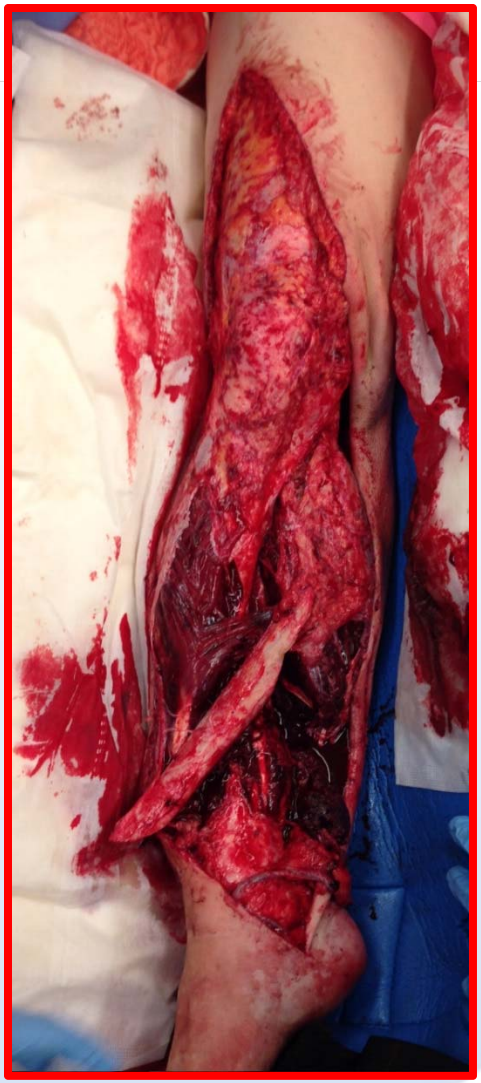
Open Fractures

- Break in skin and underlying soft tissues leads directly into and communicates with the fracture and its hematoma
- Wound in same limb segment as fracture
- Prognosis depends on contamination, associated injuries and…
- Classification: Gustilo and Anderson



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Open Fx: Type I

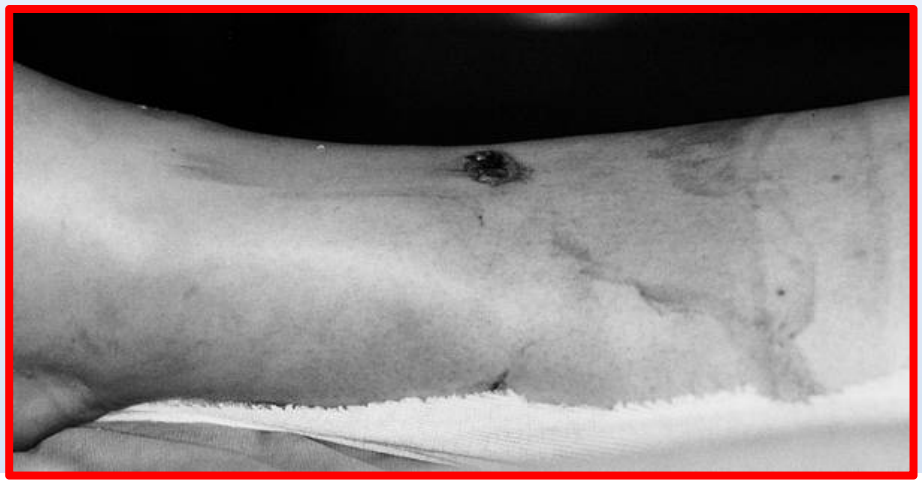
Low energy injury

<1 cm long (only one aspect of the classification)

Bone piercing from inside out

Typically low level of bacterial contamination

Minimal/no muscle damage



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Open Fx: Type II

- >1 to <10cm in length
- Moderate soft tissue damage (higher energy injury)
- Outside to inside pattern
- Some necrotic muscle, minimal/moderate debridement required
- None/minimal stripping, coverage without grafts / flaps

Open Fx: Type III

- High energy, outside to inside pattern
- >10cm w/ extensive muscle devitalization
- Fracture widely displaced or comminuted
- Extensive wound contamination
- Subtypes
  - IIIA- can be covered primarily
  - IIIB- needs flap coverage
  - IIIC- vascular injury requiring repair

Open Fx: Type III

Additional factors

- Close range shotgun, high velocity (>2000ft/s) gunshot
- Segmental fx
- Diaphyseal segmental loss
- Farmyard / other highly contaminated environment
- Associated compartment syndrome

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Open Fractures

The "Six Hour Rule"

- Timing of debridement generally has NOT been associated with infection
- OR ***ASAP*** after life threatening conditions treated and stabilized
- **Early administration of antibiotics→ decreased rates of infection**

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Lack WD, Karunakar MA, Angerame MR, et al. Type III open tibia fractures: immediate antibiotic prophylaxis minimizes infection. *J Orthop Trauma.* 2015;29:1-6.
Patzakis MJ, Wilkins J. Factors influencing infection rate in open fracture wounds. *Clin Orthop Relat Res*. 1989;246:36-40.

What are we trying to avoid?

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What are we trying to avoid?

- MOF
- ARDS

What are we trying to avoid?

- MOF
- ARDS

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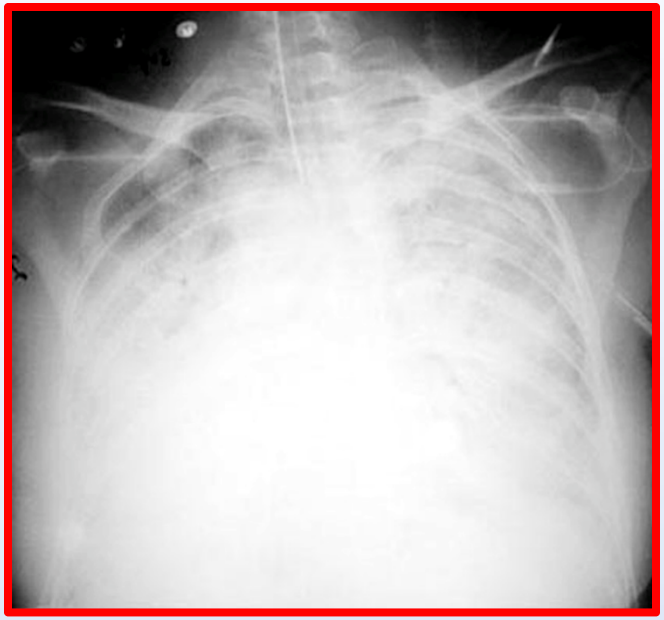
Acute Respiratory Distress Syndrome (ARDS)

- B/L infiltrates on CXR
- PaO2/FiO2 **< 200**
- High mortality
- May be related to **imbalance between proinflammatory and antiinflammatory mediators**



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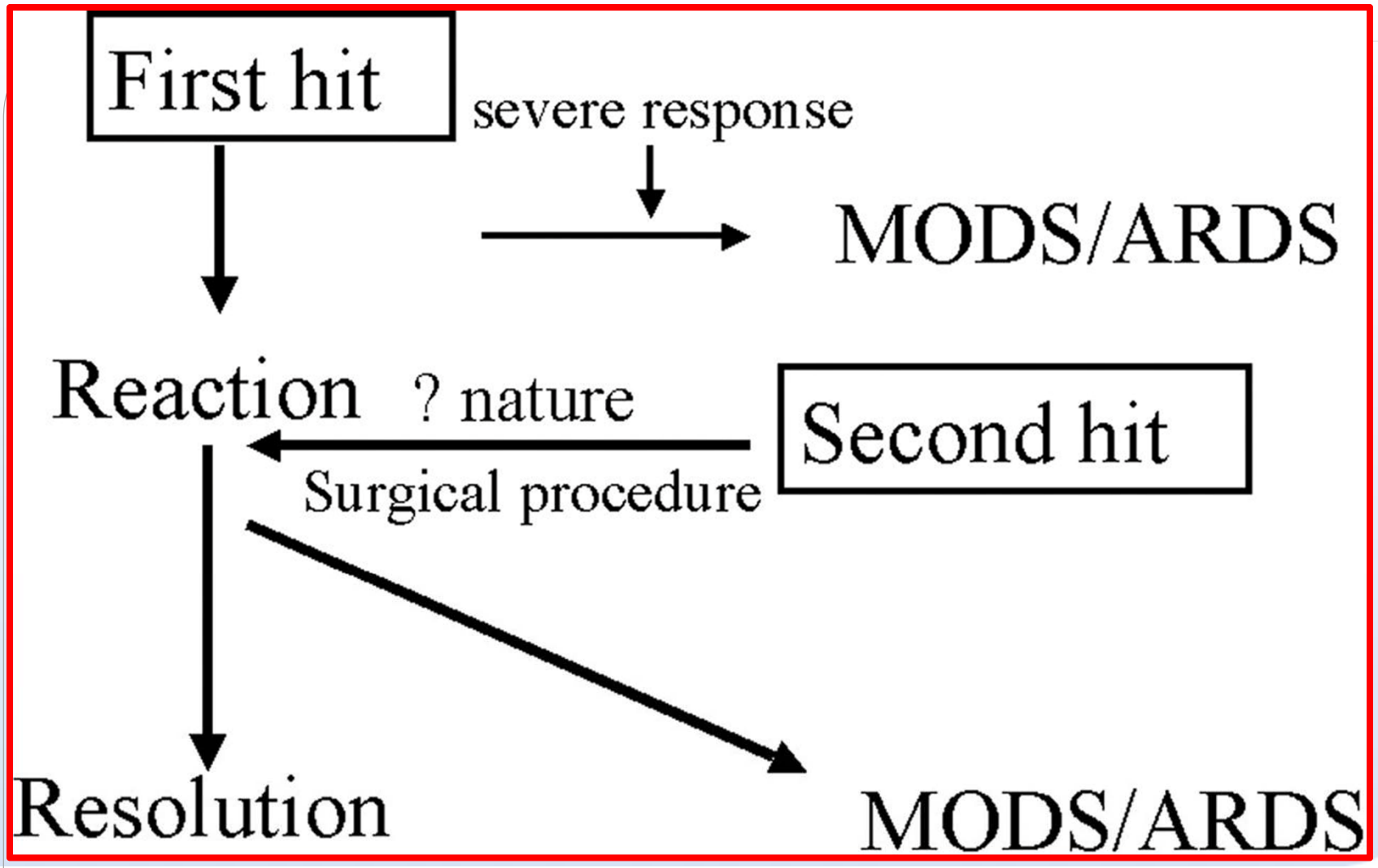
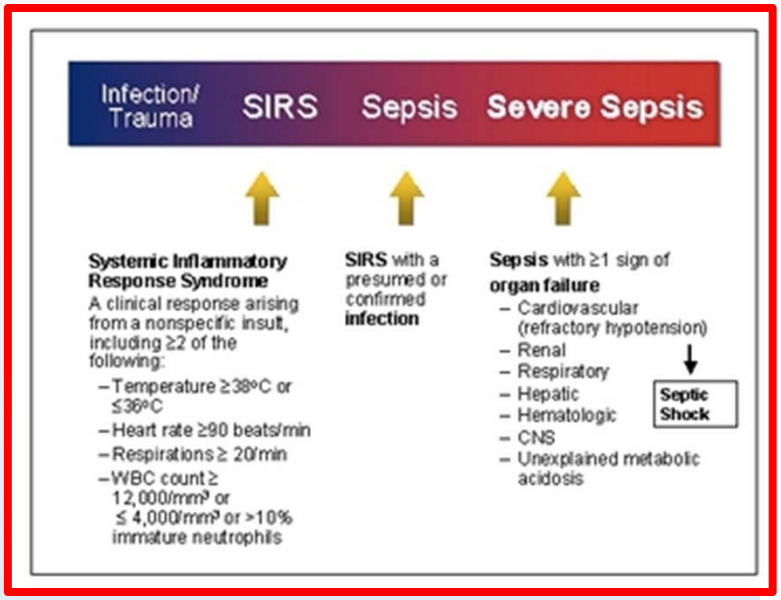
Physiologic Response



Physiologic Response

Systemic Inflammatory Response (SIRS)

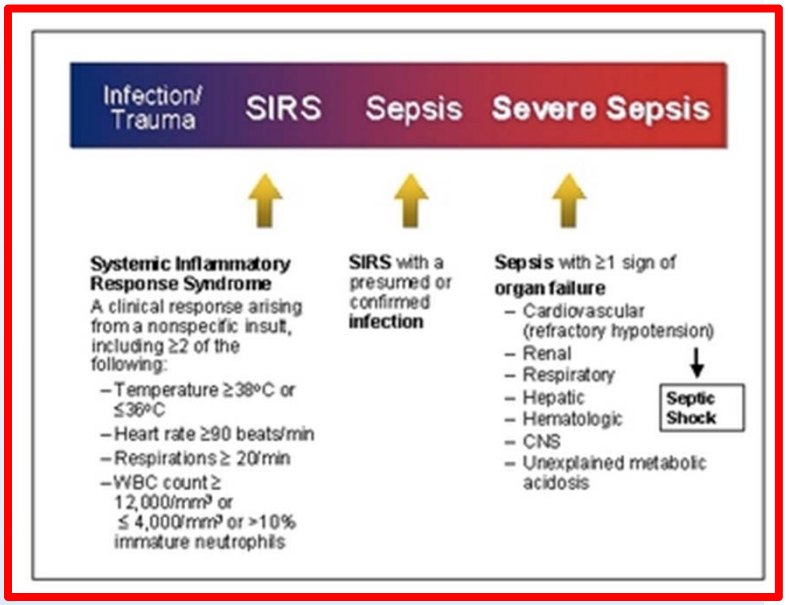
- Proinflammatory cytokine response (IL-6, IL-8, etc.)
- "Primed" PMNs
- Secondary tissue (lung) injury
- Predictive of ARDS



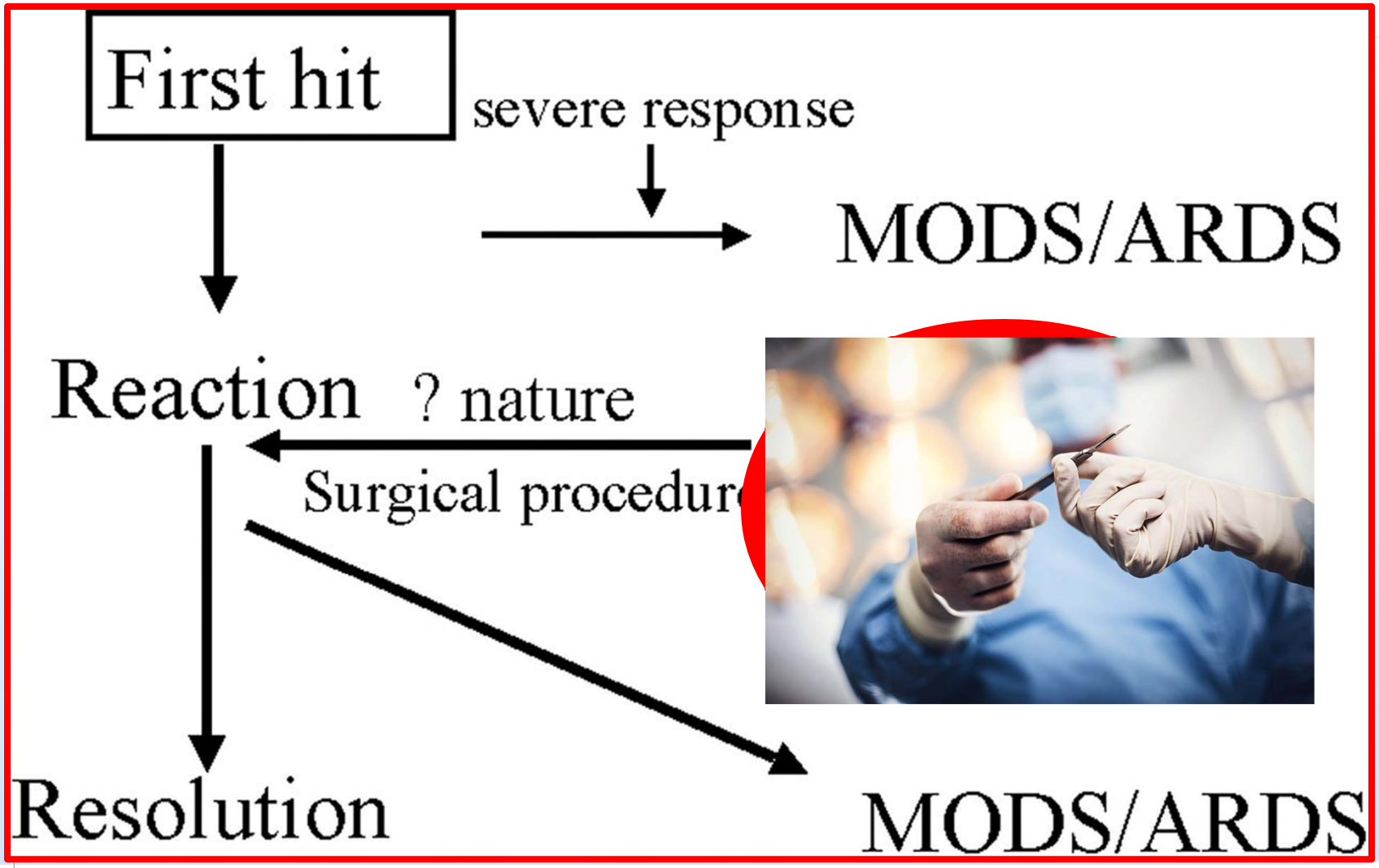
Physiologic Response

Systemic Inflammatory Response (SIRS)

- Components
  - Fever: T<34 or >38 (100.4 F)
  - Tachycardia: HR >90
  - Hyperventilation: RR > 20 (or PaCO2<33mmHg)
  - Leukocytosis: WBC <4,000 or >12,000



Physiologic Response



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Damage Control Orthopaedics (DCO)

- Approach to treating polytrauma pts
- Goal: minimize impact of “second hit”

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Damage Control Orthopaedics

Priorities

- Hemorrhage control
- Soft tissue management
- Provisional fracture stabilization

Definitive fixation delayed until physiology improved

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History of DCO

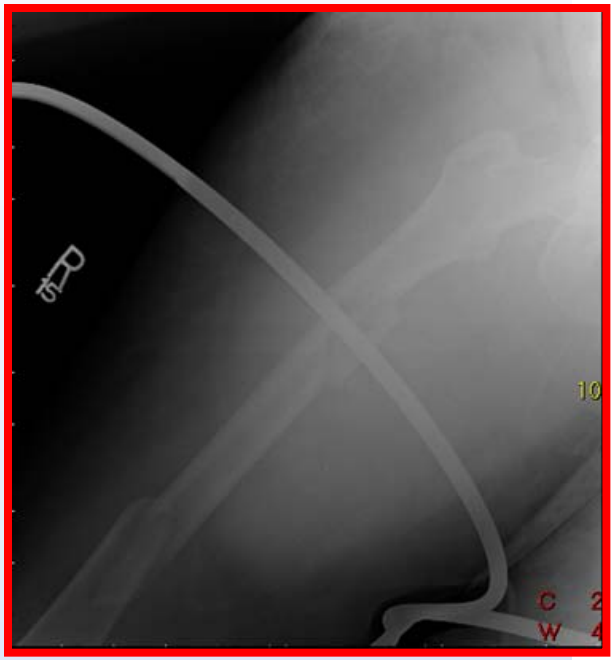
Bone et al JBJS 1989→
Early Total Care

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



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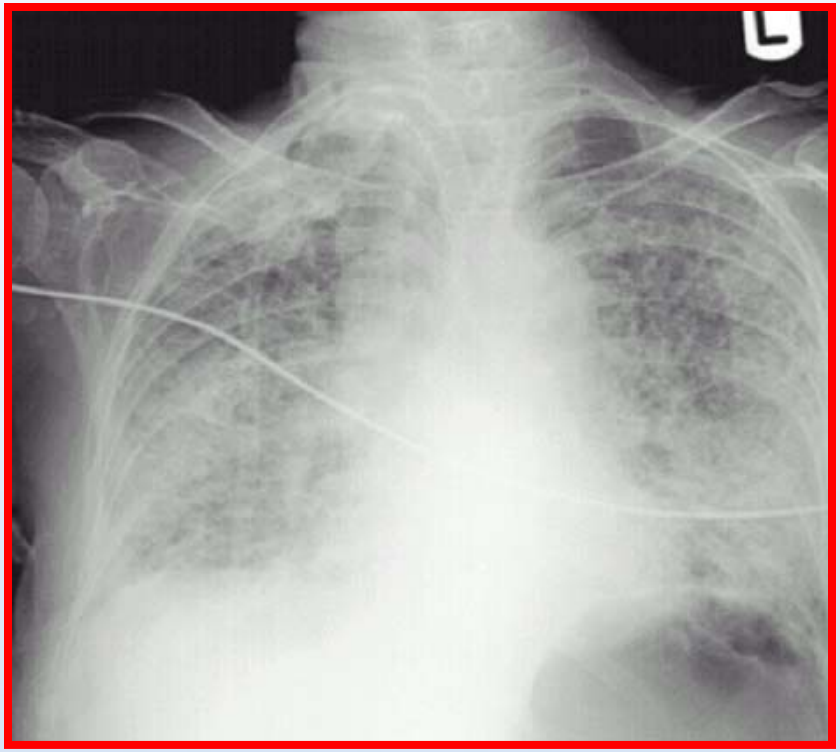
Bone LB, Johnson KD, Weigelt J, et al. Early versus delayed stabilization of femoral fractures. A prospective randomized study. *J Bone Joint Surg Am.* 1989

History of DCO

Early 1990's: complications associated with ETC begin to be described

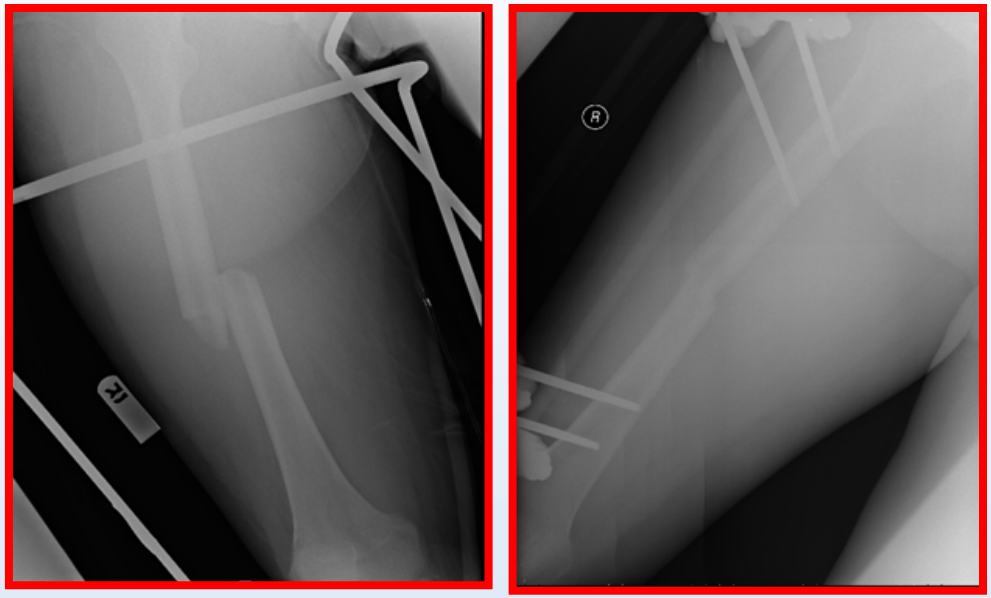
- ARDS
- MOF



History of DCO

Pape et al: ETC **may not** be appropriate in some pts

Alternative treatment strategy→



"Damage Control Orthopaedics"

Do some patients not tolerate ETC?

- Pape et al, 1993: retrospective study
- 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 (not stat sig)

Pape HC, Aufm'Kolk M, Paffrath T, et al. *J Trauma.* 1993;34:540-547.

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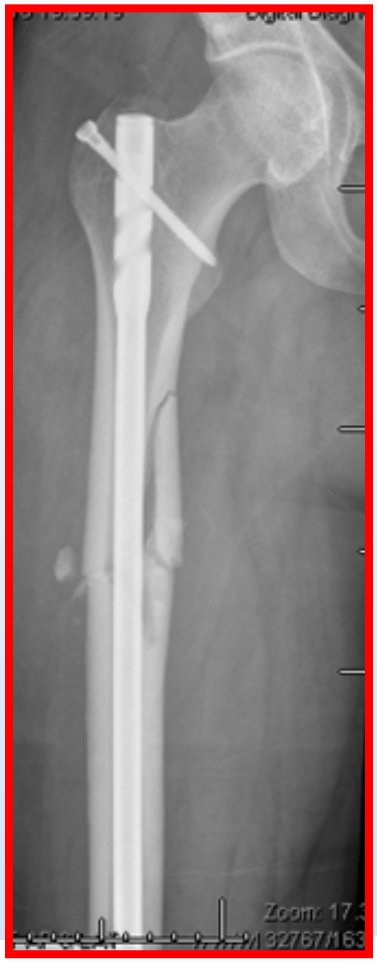
Intramedullary Nailing has physiologic effects…

- Blood loss
- Fluid loss
- Fat embolization
- Cytokine production
- Activation of coagulation system



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DCO: Does it work?

Pape et al, J Trauma 2002

- Reduction in rates of ARDS and MOF over time with increased usage of DCO

Pape HC, Hildebrand F, Pertschy S, et al. Changes in the management of femoral shaft fractures in polytrauma patients: from early total care to damage control orthopedic surgery. *J Trauma*;200253:452-462.

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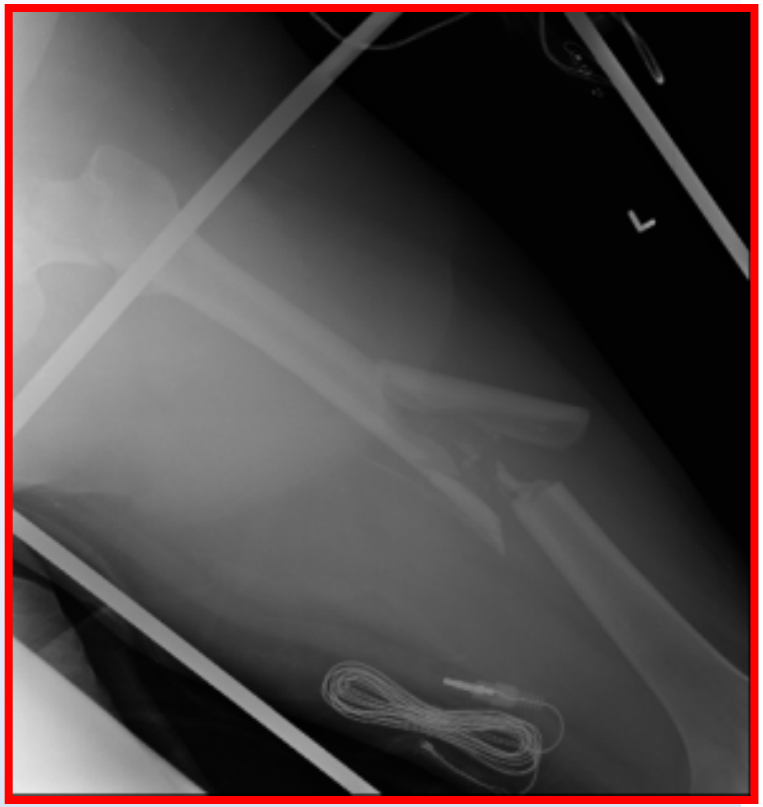
Modes of DCO

Retrospective review; sub-analysis of pts undergoing DCO

- 60 pts→ skeletal traction
- 19 pts→ external fixation

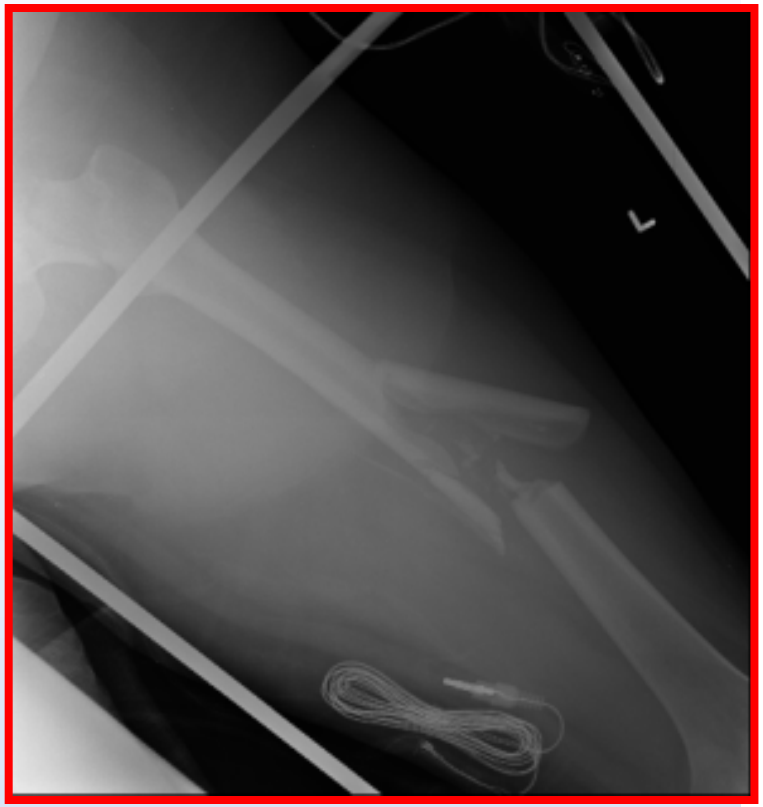


Scannell BP, Waldrop NE, Sasser HC, et al. Skeletal traction versus external fixation in the initial temporization of femoral shaft fractures in severely injured patients. *J Trauma.* 2010;68:633-640.

Modes of DCO

Results:

- No difference between external fixation and skeletal traction in:
  - ARDS
  - MOF
  - Pneumonia



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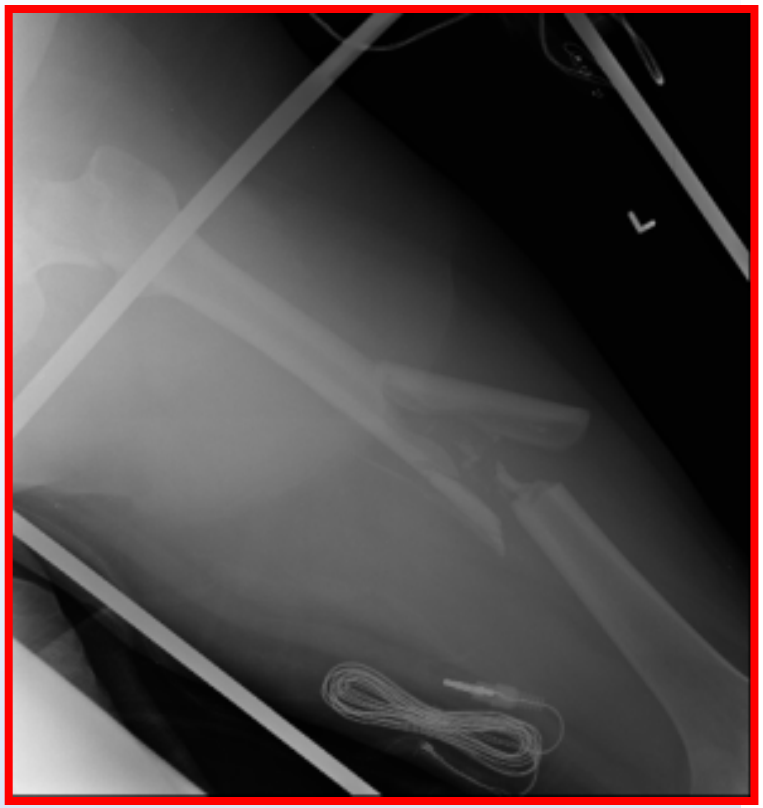
Scannell BP, Waldrop NE, Sasser HC, et al. Skeletal traction versus external fixation in the initial temporization of femoral shaft fractures in severely injured patients. *J Trauma.* 201

Modes of DCO

Problem with study:

- Small number of pts, particularly in external fixation group→possibility of Type II error



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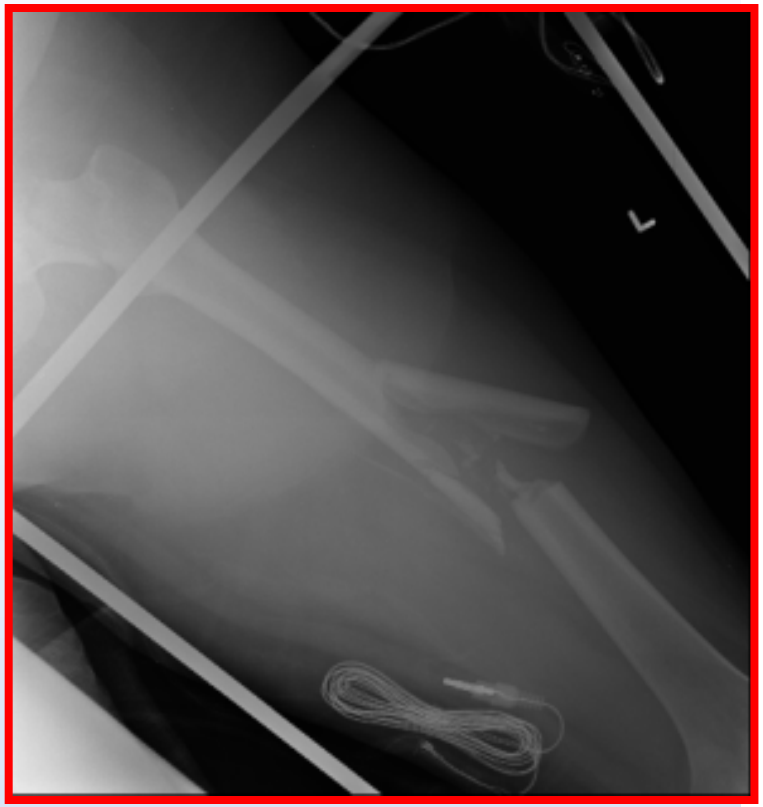
Modes of DCO

Concern with traction:

- Difficulty with pulmonary toilet?
- Increased narcotic requirements
- Increased risk FES (fat embolism)?



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Potential issues with overutilization of DCO

- Unnecessary delay in definitive treatment
- Longer ICU stays
- Longer time on ventilator
- Longer LOS
- Increased cost

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ETC vs DCO: When?

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Patient Risk Stratification

TABLE 9-5 Classification Systems for Clinical Patient Assessment

	Parameter	Stable (Grade I)	(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	2–8	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.

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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.

Borderline Patients

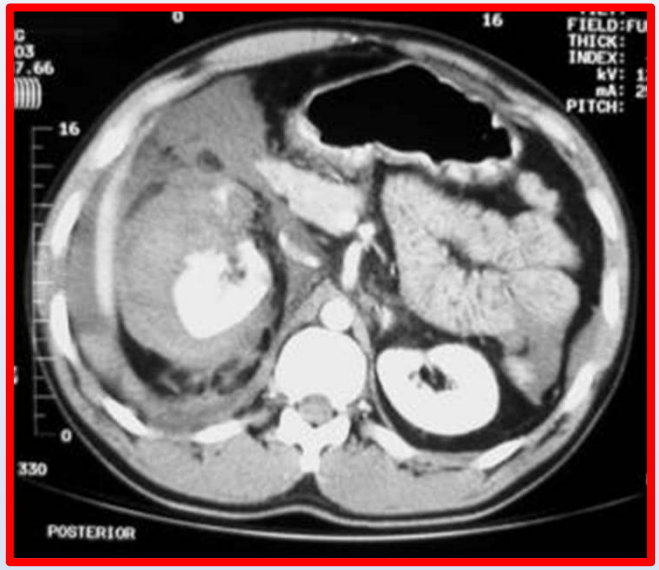
- Severe abdominal injury

(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

→ Benefited from delay



Morshed S, Miclau T, Bembom O, et al. *J Bone Joint Surg Am.* 2009;91:3-13.

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Level I Data?

Impact of the Method of Initial Stabilization for Femoral Shaft Fractures in Patients With Multiple Injuries at Risk for Complications (Borderline Patients)

Hans-Christoph Pape, MD, FACS, Dieter Rixen, MD,† John Morley, MD,‡ Elisabeth Ellingsen Husebye, MD,§ Michael Mueller, MD,¶ Clemens Dumont, MD,‖ Andreas Gruner, MD,‖ Hans Joerg Oestern, MD,** Michael Bayeff-Filoff, MD,†† Christina Garving,*** Dustin Pardini, PhD,‡‡ Martijn van Griensven, PhD,§§ Christian Krettek, MD, FRACS,¶¶ Peter Giannoudis, MD,‡ and the EPOFF study group*

- RCT comparing IMN (ETC) vs DCO in stable and borderline patients

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Pape HC, Rixen D, Husebye EE, et al. *Ann Surg.* 2007;246:491-

Level I Data?

Impact of the Method of Initial Stabilization for Femoral Shaft Fractures in Patients With Multiple Injuries at Risk for Complications (Borderline Patients)

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- Stable Patients
- →acute IMN associated with decreased ventilator time

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Pape HC, Rixen D, Husebye EE, et al. *Ann Surg.* 2007;246:491-

Level I Data?

Impact of the Method of Initial Stabilization for Femoral Shaft Fractures in Patients With Multiple Injuries at Risk for Complications (Borderline Patients)

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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)

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Pape HC, Rixen D, Husebye EE, et al. *Ann Surg.* 2007;246:491-

Reamed vs. Unreamed?

Reamed Versus Unreamed Intramedullary Nailing of the Femur: Comparison of the Rate of ARDS in Multiple Injured Patients

By The Canadian Orthopaedic Trauma Society

- RCT
- 322 femur fractures
- IMN within 24 hours

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Canadian Orthopaedic Trauma Society. Reamed versus unreamed intramedullary nailing of the femur: comparison of the rate of ARDS in multiple injured patients. *JOT.* 2006;20:

Reamed vs. Unreamed?

Reamed Versus Unreamed Intramedullary Nailing of the Femur: Comparison of the Rate of ARDS in Multiple Injured Patients

By The Canadian Orthopaedic Trauma Society

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

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Canadian Orthopaedic Trauma Society. Reamed versus unreamed intramedullary nailing of the femur: comparison of the rate of ARDS in multiple injured patients. *JOT.* 2006;20:

Now what?

Is there another way of looking at orthopaedic trauma resuscitation?

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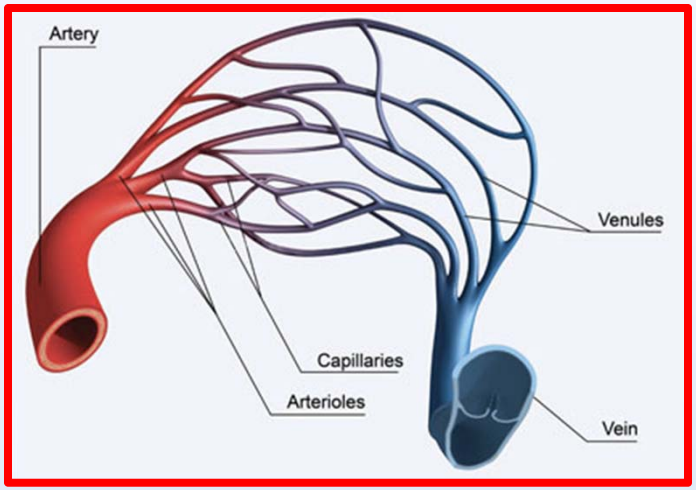
Evaluating Response to Resuscitation

Compensated Shock→

- Brain and heart perfused at expense of other organs
- Occult hypoperfusion exists



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Occult Hypoperfusion

Occult Hypoperfusion Is Associated with Increased Morbidity in Patients Undergoing Early Femur Fracture Fixation

Adam C. Crowl, MD, Jeffrey S. Young, MD, David M. Kahler, MD, Jeffrey A. Claridge, MD, David S. Chrzanowski, BS, and Michelle Pomphrey, RN

- Patients with ISS ≥ 18 + femur fracture stabilized within 24h
- No patients had clinical signs of shock:
  - Normotensive
  - Not Tachycardic
  - Adequate urine output

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Crowl AC, Young JS, Kahler DM, et al. Occult hypoperfusion is associated with increased morbidity in patients undergoing early femur fracture fixation. *J Trauma.* 2000;

Occult Hypoperfusion

Occult Hypoperfusion Is Associated with Increased Morbidity in Patients Undergoing Early Femur Fracture Fixation

Adam C. Crowl, MD, Jeffrey S. Young, MD, David M. Kahler, MD, Jeffrey A. Claridge, MD, David S. Chrzanowski, BS, and Michelle Pomphrey, RN

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

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Crowl AC, Young JS, Kahler DM, et al. Occult hypoperfusion is associated with increased morbidity in patients undergoing early femur fracture fixation. *J Trauma.* 2000;

Resuscitation and *Early Appropriate Care*

Timing of Orthopaedic Surgery in Multiple Trauma Patients: Development of a Protocol for Early Appropriate Care

Heather A. Vallier, MD, Xiaofeng Wang, PhD, Timothy A. Moore, MD, John H. Wilber, MD, and John J. Como, MD

When is patient's physiology appropriate for definitive care?

- pH ≥7.25
- Base excess ≥-5.5
- Lactate <4.0

Definitive care proceeds when any of these has been achieved

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Vallier HA, Wang X, Moore TA et al. Timing of orthopaedic surgery in multiple trauma patients: development of a protocol for early appropriate care. *J Orthop Trauma*. 2013; 2
Nahm NJ, Moore TA, Vallier HA. Use of two grading systems in determining risks associated with timing of fracture fixation. *J Trauma Acute Care Surg*. 2014; 77:268-279.

Resuscitation and *Early Appropriate Care*

- Included femur fractures, axially unstable injuries (pelvis, acetabulum, spine)
- Compared to historical cohort
- Patients treated with EAC within 36 hours:
  - 1.5% ARDS
  - 0.37% MOF
  - 1.5% Mortality
  - Shorter ICU and total LOS, ventilation time

Vallier *et al. Journal of Orthopaedic Surgery and Research* (2015) 10:155
DOI 10.1186/s13018-015-0298-1

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RESEARCH ARTICLE Open Access

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Complications are reduced with a protocol to standardize timing of fixation based on response to resuscitation

Heather A. Vallier[1*], Timothy A. Moore[1,2], John J. Como[3], Patricia A. Wilczewski[3], Michael P. Steinmetz[4], Karl G. Wagner[5], Charles E. Smith[5], Xiao-Feng Wang[1] and Andrea J. Dolenc[1]

Vallier HA, Moore TA, et al. Complications are reduced with a protocol to standardize timing of fixation based on response to resuscitation. *J Orthop Surg Res*. 2015;10:155.

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“Normalizing lactate”

Resuscitation Before Stabilization of Femoral Fractures Limits Acute Respiratory Distress Syndrome in Patients With Multiple Traumatic Injuries Despite Low Use of Damage Control Orthopedics

Robert V. O'Toole, MD, Michael O'Brien, MD, Thomas M. Scalea, MD, Nader Habashi, MD, Andrew N. Pollak, MD, and Clifford H. Turen, MD

- 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” to <2.5 →parameter used to demonstrate adequate resuscitation

O'Toole RV, O'Brien M, Scalea T, et al. Resuscitation before stabilization of femoral fractures limits acute respiratory distress syndrome in patients with multiple traumatic injuries despite low use of damage control orthopedics. *J Trauma.* 2009;67:1013-1021.

“Normalizing lactate”

Resuscitation Before Stabilization of Femoral Fractures Limits Acute Respiratory Distress Syndrome in Patients With Multiple Traumatic Injuries Despite Low Use of Damage Control Orthopedics

Robert V. O'Toole, MD, Michael O'Brien, MD, Thomas M. Scalea, MD, Nader Habashi, MD, Andrew N. Pollak, MD, and Clifford H. Turen, MD

Results:

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

Compare extremely favorably to published series by Pape, Brundage, Bosse, Charash, Bone

O'Toole RV, O'Brien M, Scalea T, et al. Resuscitation before stabilization of femoral fractures limits acute respiratory distress syndrome in patients with multiple traumatic injuries despite low use of damage control orthopedics. *J Trauma.* 2009;67:1013-1021.

Measures of Resuscitation

Stable hemodynamics

No hypoxemia

Lactate

- **< 2.5** mmol/L (Crowl et al)
- **< 4.0** mmol/L (Vallier et al)
- "normalizing," 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 (>1cc/kg/hr)

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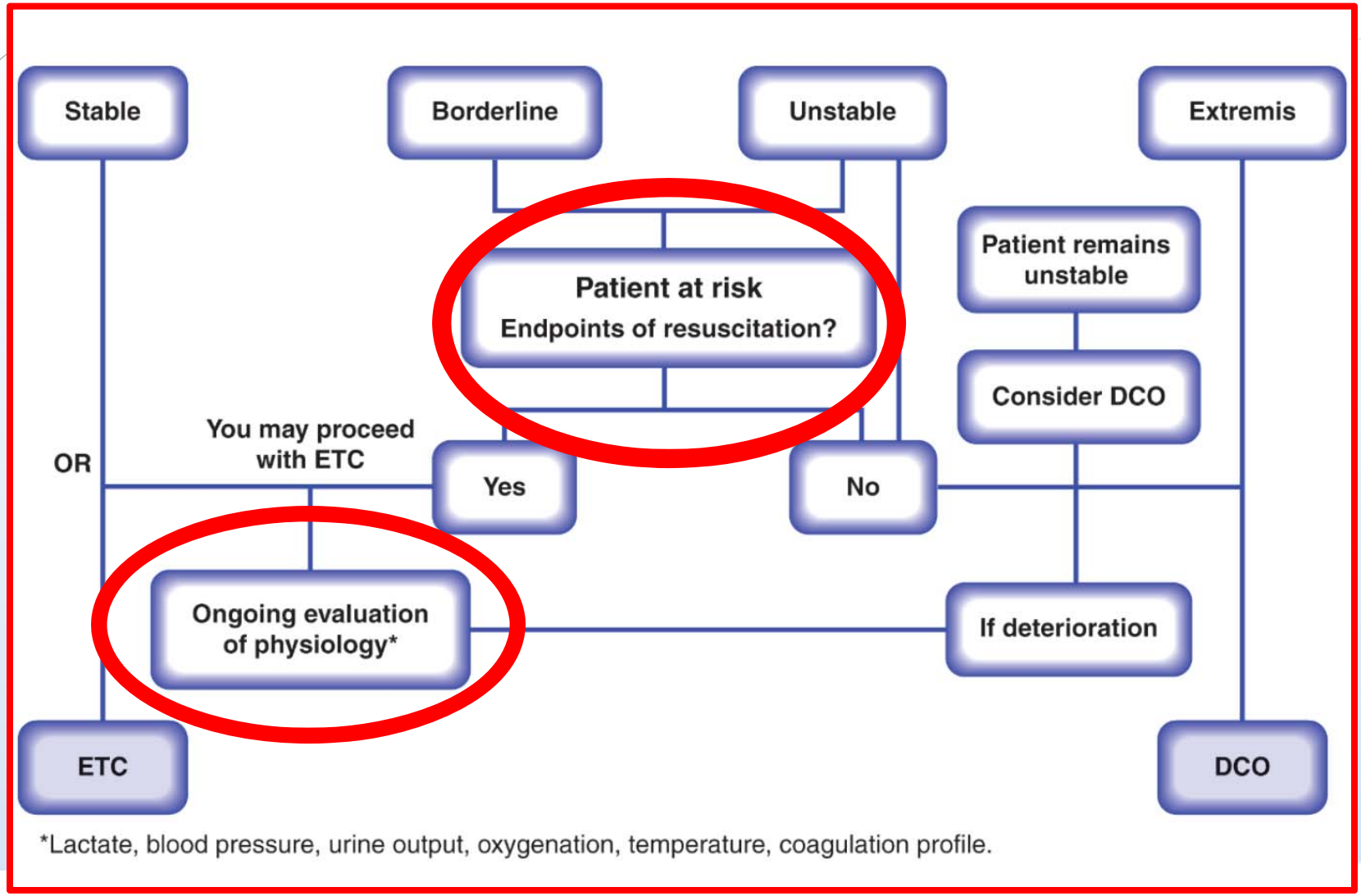
Algorithm: ETC vs DCO



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.

Timing of definitive treatment in DCO

Major Secondary Surgery in Blunt Trauma Patients and Perioperative Cytokine Liberation: Determination of the Clinical Relevance of Biochemical Markers

Hans-Cristoph Pape, MD, Martijn van Griensven, PhD, John Rice, MD, Axel Gänsslen, MD, Frank Hildebrand, MD, Stefan Zech, MD, Markus Winny, MD, Ralf Lichtinghagen, MD, and Christian Krettek, MD

- Polytrauma pts managed with DCO followed by later definitive fixation
- Patients who converted @2-4 days were compared to those @5-8 days
- MODS 46% in early group versus 16% in late group

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Pape HC, van Griensven M, Rice J, et al. Major secondary surgery in blunt trauma patients and perioperative cytokine li determination of the clinical relevance of biochemical markers. *J Trauma.* 2001;50:989-1000.

Timing of definitive treatment in DCO

Alterations in the Systemic Inflammatory Response after Early Total Care and Damage Control Procedures for Femoral Shaft Fracture in Severely Injured Patients

Paul John Harwood, MB, ChB, Peter V. Giannoudis, MD, Martijn van Griensven, MD, Christian Krettek, MD, and Hans-Christoph Pape, MD

- Retrospective review: ISS>20 + femur fx
- N=174, initial ex-fix vs early IMN
- Ex fix group more severely injured
- SIRS score, modified Marshall multi-organ dysfunction score

Harwood JH, Giannoudis PV, van Griensven M, et al. Alterations in the systemic inflammatory response after early total care and damage control procedures for femoral shaft fracture in severely injured patients. *J Trauma.* 2005;58:446-454.

Timing of definitive treatment in DCO

Alterations in the Systemic Inflammatory Response after Early Total Care and Damage Control Procedures for Femoral Shaft Fracture in Severely Injured Patients

Paul John Harwood, MB, ChB, Peter V. Giannoudis, MD, Martijn van Griensven, MD, Christian Krettek, MD, and Hans-Christoph Pape, MD

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

Harwood JH, Giannoudis PV, van Griensven M, et al. Alterations in the systemic inflammatory response after early total care and damage control procedures for femoral shaft fracture in severely injured patients. *J Trauma.* 2005;58:446-454.

Timing of definitive treatment in DCO

Majority of pts treated with DCO should probably wait until at least **post injury day 5** before definitive treatment

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Summary

- Evaluation of polytrauma patient guided by ATLS.
- Identifying and treating orthopaedic urgencies and emergencies in the initial evaluation is critical in minimizing M&M.
- Knowledge of scoring systems necessary in managing polytrauma.

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Summary

Identifying patients w/occult hypoperfusion necessary to minimize M&M.

Knowledge of *Damage Control Orthopaedics* and when to implement methods of DCO is critical.

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Summary

- Majority of polytrauma pts with femur fx benefit from treatment within the first 36 hrs
- Further research will help clarify which patients can tolerate acute IMN and which patients should be treated with DCO

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Thank You

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