Polytrauma patients: when is it safe to operate?

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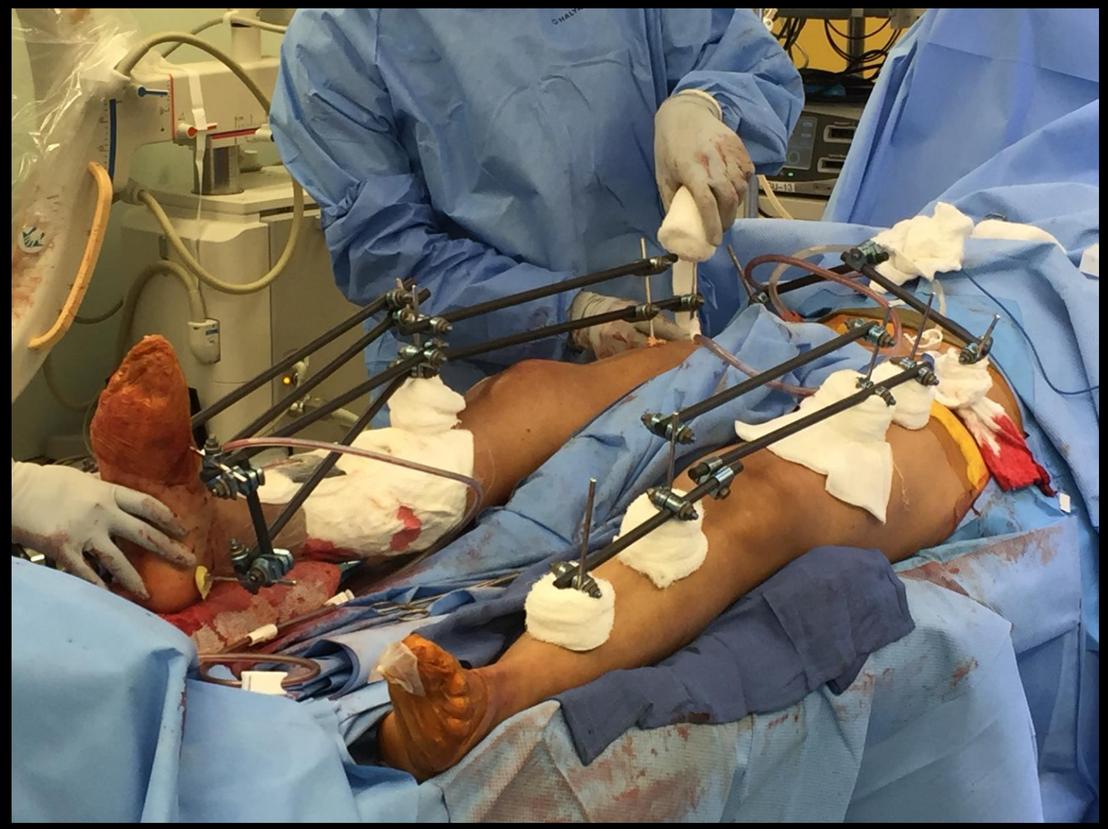
San Francisco Trauma Course 2022



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Key Learning Points

- Your decisions will affect **survival**
- Recognize important endpoints of **resuscitation**
- **Differentiate** patients that benefit from early definitive care from those requiring a damage control approach

30 year old man, 3 story fall

<u>Associated Injuries:</u>
Subarachnoid Bleed
Bilateral hemothorax

<u>Physiology:</u>
Hypotensive
Base Deficit 6.5 mmol/L
Persistent Hypoxemia

What and when?

Polytrauma and Injury Severity Scoring

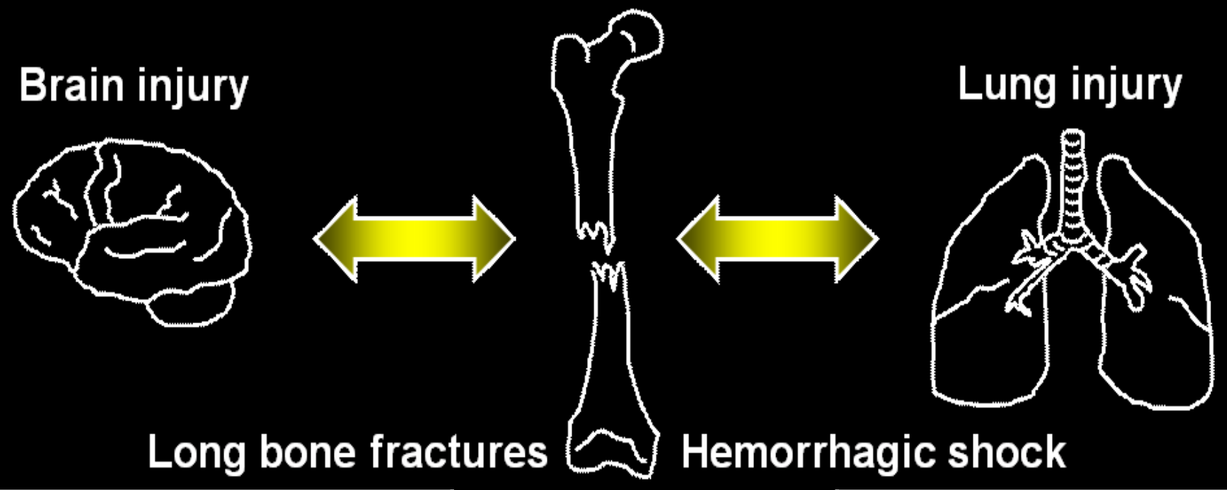
- Abbreviated Injury Score (AIS)
  - Head & Neck
  - Face
  - Chest
  - Abdomen
  - Pelvis/Extremity
  - Skin
- Scored from 1-6 (minor to unsurvivable)

Patient Example:

Femur Fracture = 3	9
Pelvis Fracture = 3	
Wrist Fracture = 3	
Hemothorax = 3	9
Subarachnoid bleed =3	9

27

Complications



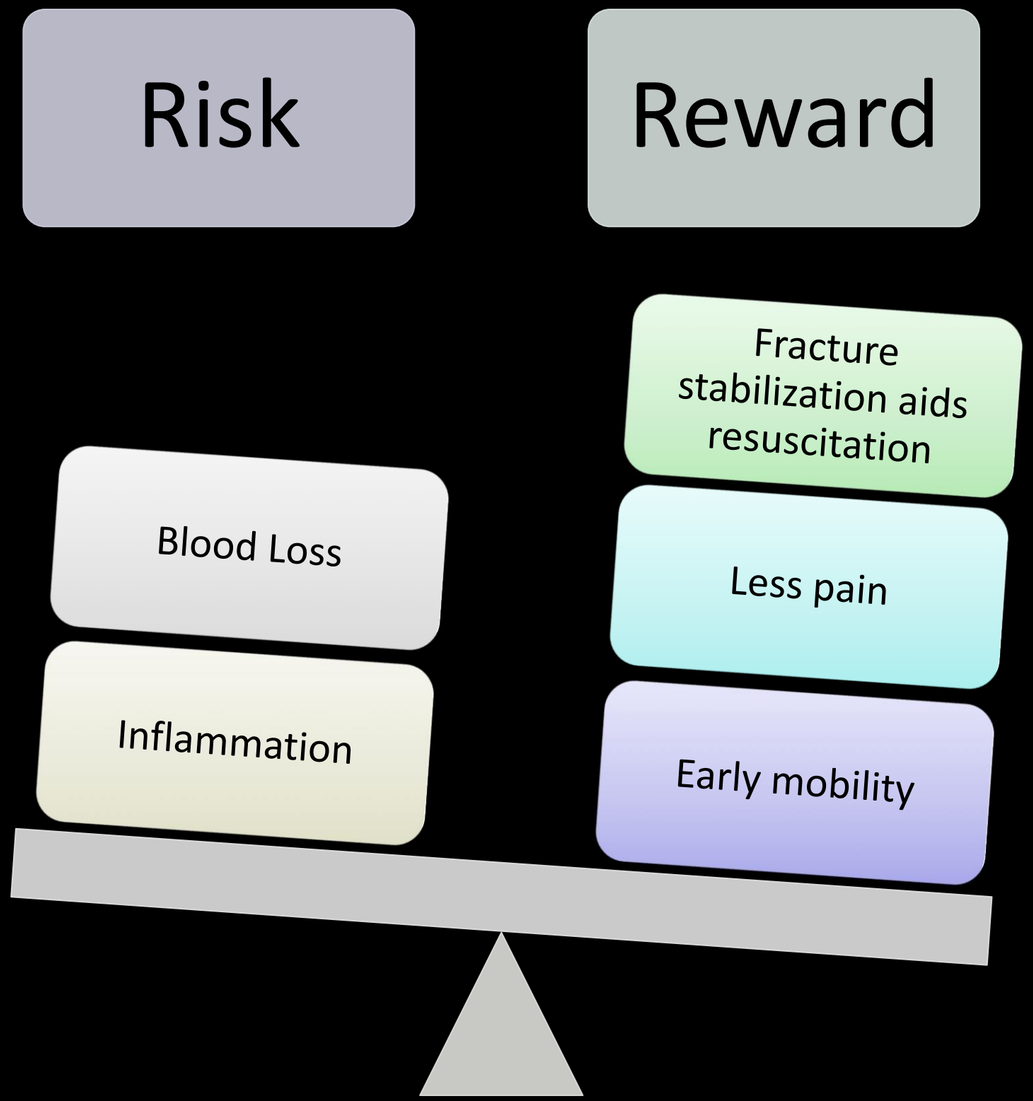
Fat Embolism Syndrome

Snow-storm infiltration on CXR
PO2 < 60mmHg
Skin Petechia
Aberrance of Consciousness
Progressive Anemia
Tachypnea
Thrombocytopenia

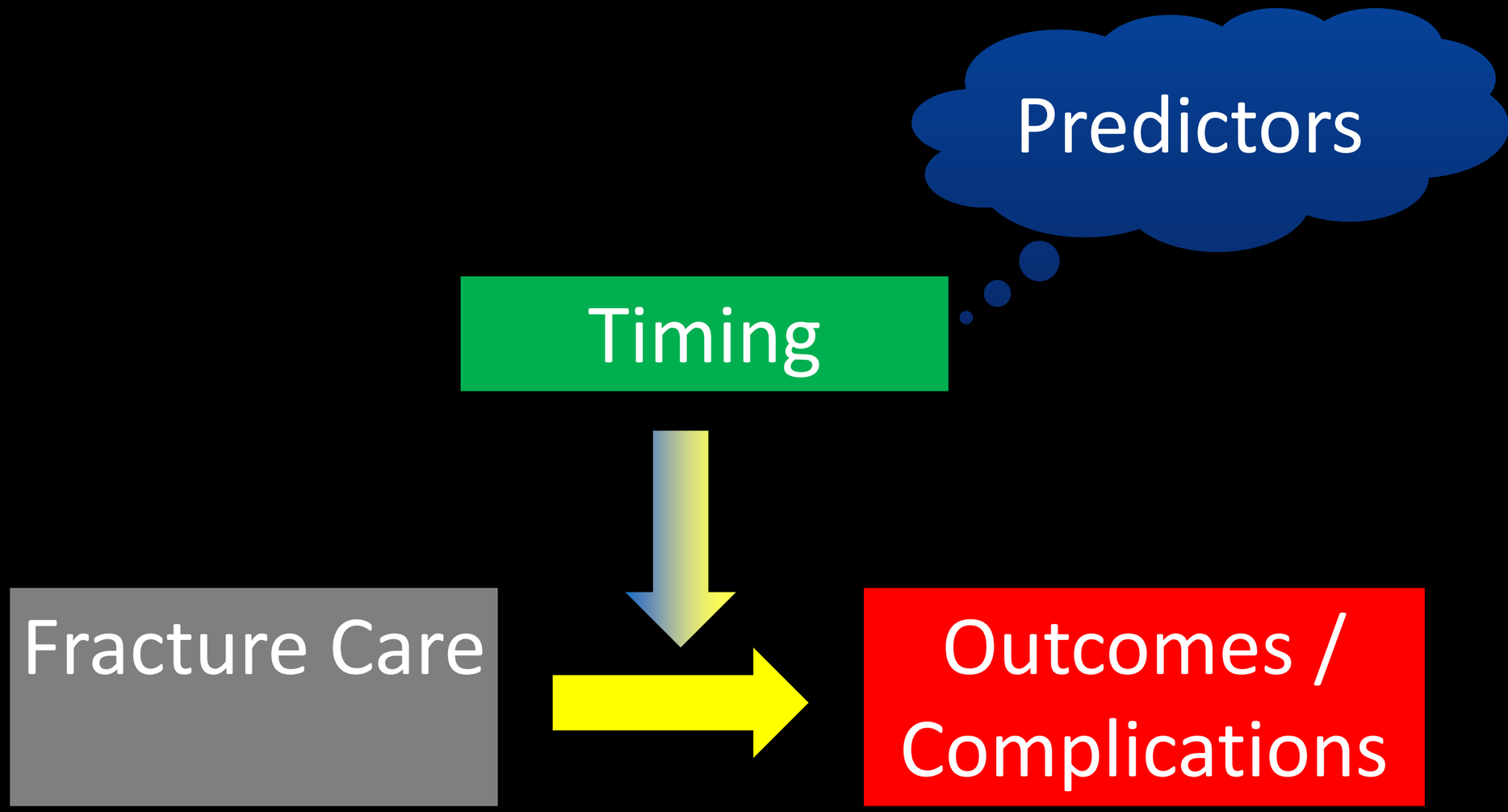
Adult Respiratory Distress Syndrome (ARDS)

Acute Onset
Bilateral Infiltrates on CXR
No Left Heart Failure
ALI - PaO2/FiO2 <300
ARDS - PaO2/FiO2 <200

Why we intervene



Central Question



Era 1: Early Total Care

Early Surgical Treatment Reduced Complications

E.B. Riska 1976

- Reduced rates (4.5% vs. 22%) of Fat Embolus Syndrome (FES)

K.D. Johnson 1985

- 5-fold decrease in ARDS

Bone 1989

- 83 patients “randomized”, 10-fold increase in pulmonary complications

“Too sick not to treat” - S.T. Hansen

“Delayed femur fixation *increased* the incidence of pulmonary complications” - S.W. Behrman

Patient Example

- HD #2: Lactate 4.1, requiring greater vent and pressor support

→ Ex-fix Femur and pelvis

- HD #5: ARDS

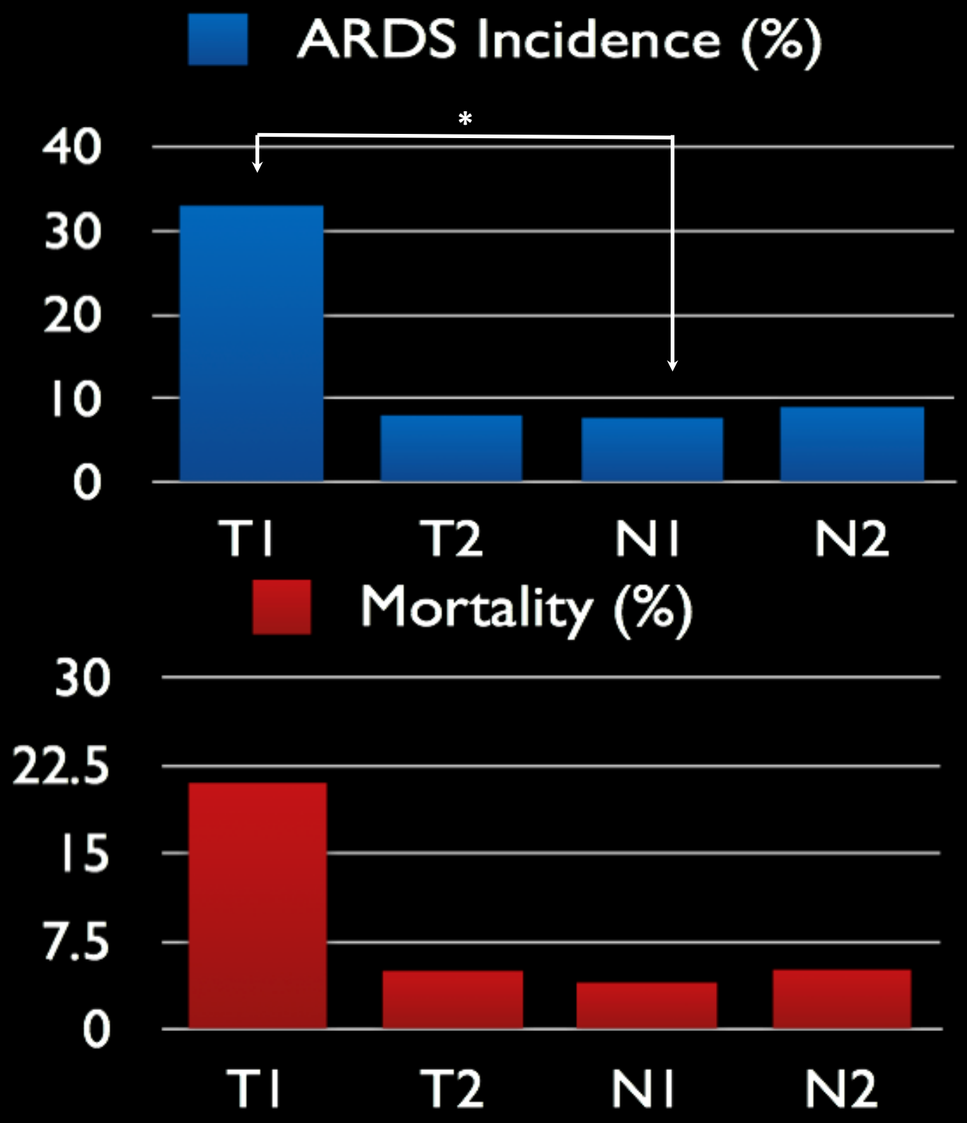
“Too sick to operate ! ! !”

Era 2: Damage Control Orthopaedics

“Borderline” patient and early fixation

- 106 patients with mid-shaft femoral fractures and ISS> 18
- Treatment Groups
  - T1 - Chest Injury <24 hrs
  - T2 - Chest Injury >24 hrs
  - N1 - No Chest Injury <24 hrs
  - N2 - No Chest Injury >24 hrs

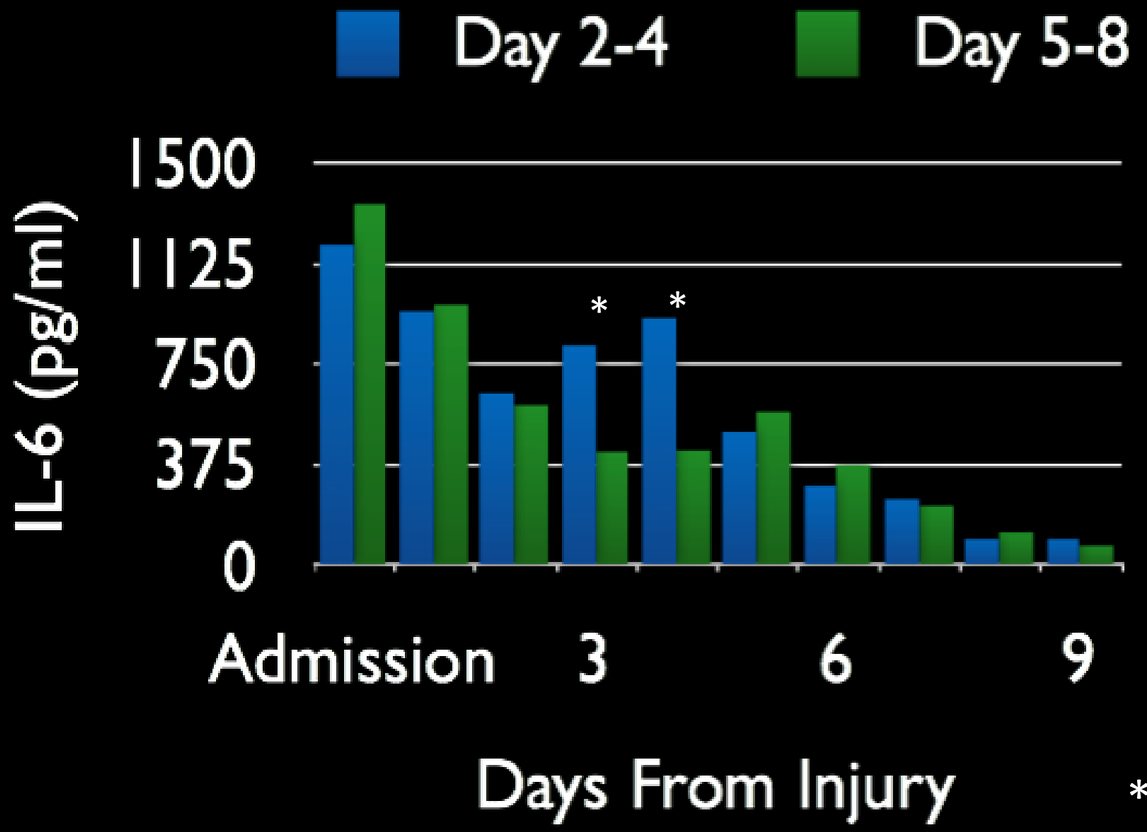
Pape 1993



* p<0.05

Two event model of post-injury multi-organ failure

Two event model of post-injury multi-organ failure



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Pape 2001

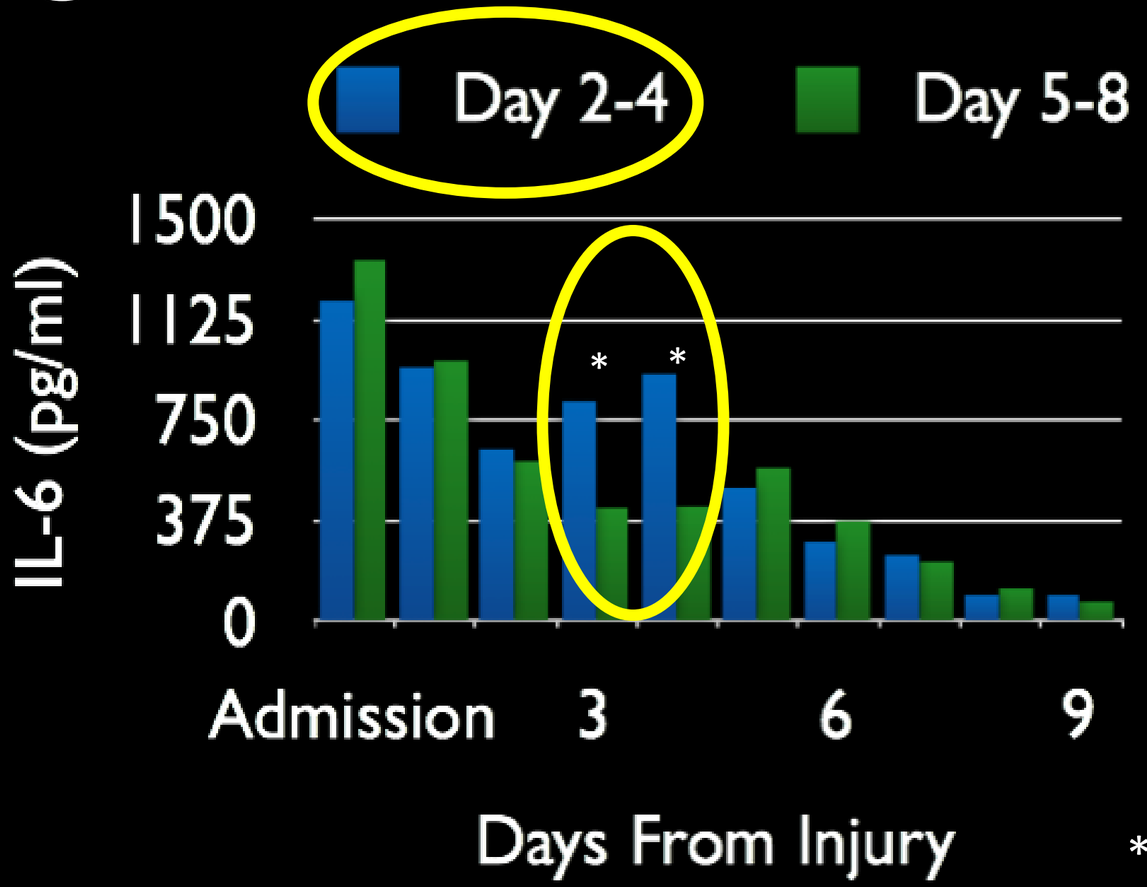
Two event model of post-injury multi-organ failure

First Hit: Injury

(Primed)

Second Hit

(Activated)



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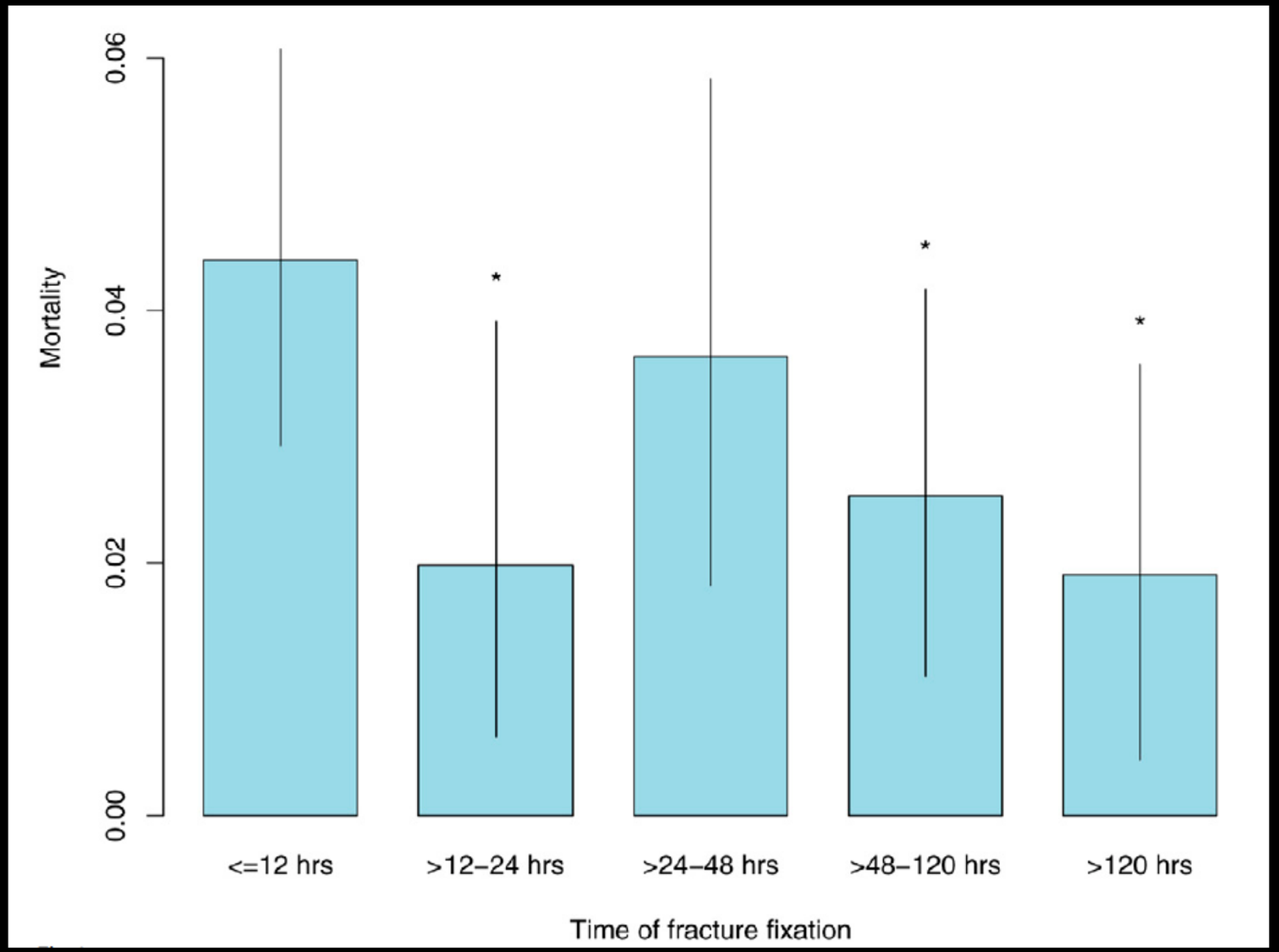
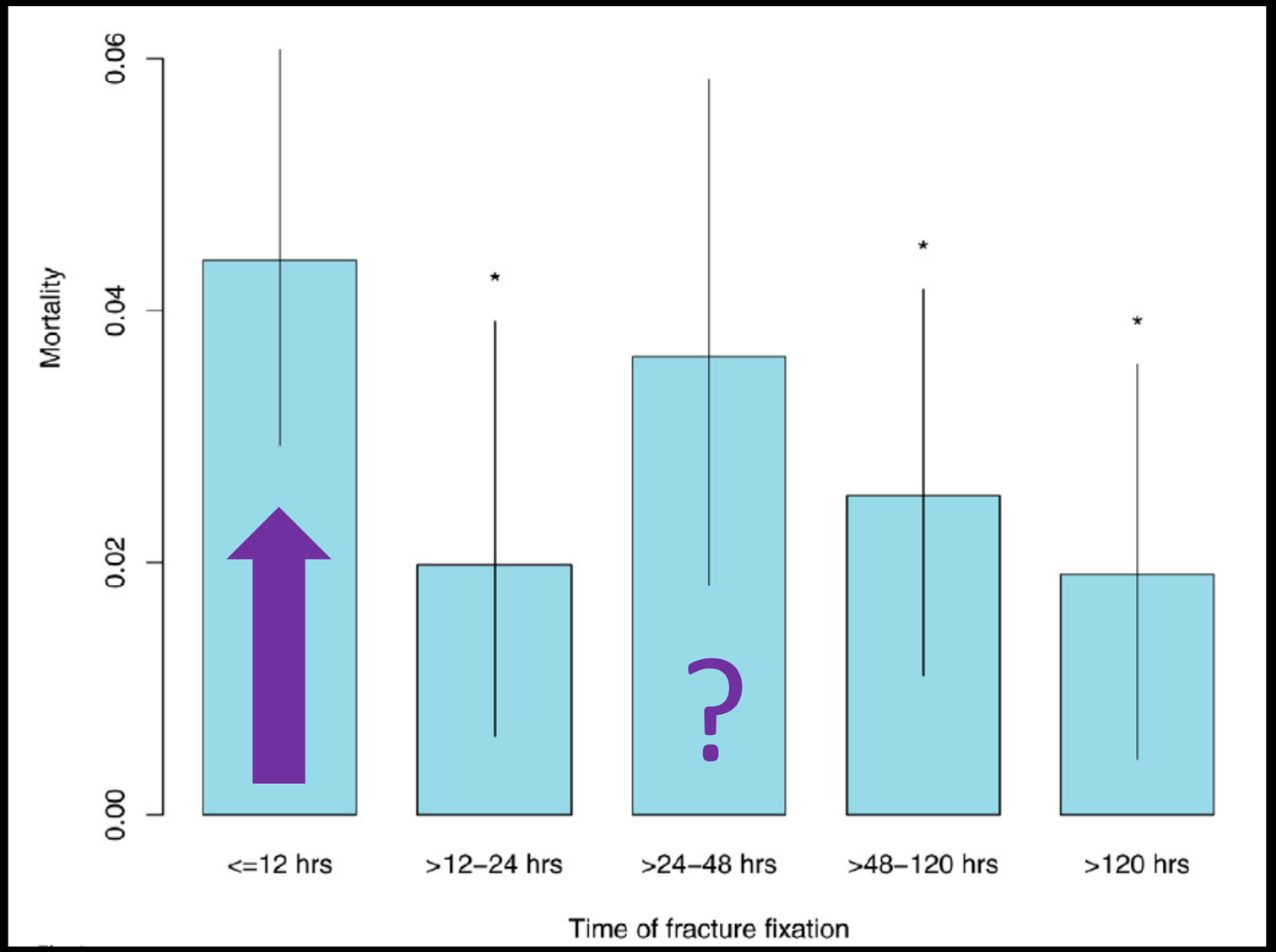
Pape 2001

3069 femur fractures, ISS > 15



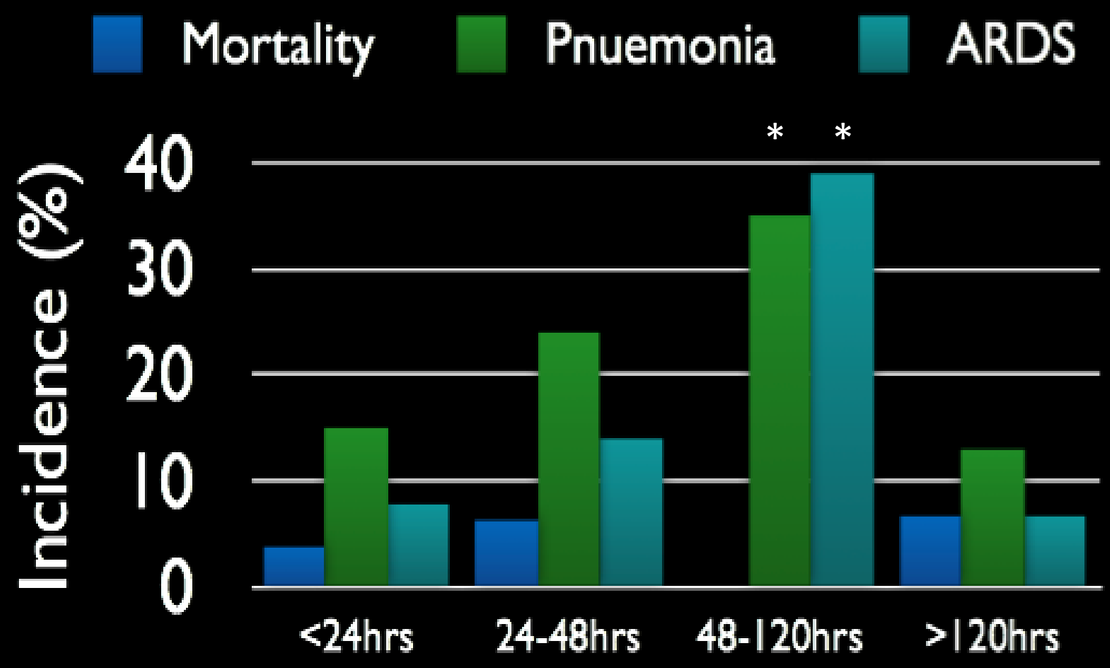
Morshed 2009

3069 femur fractures, ISS > 15



Morshed 2009

Fixation Days 2-5: Also dangerous?



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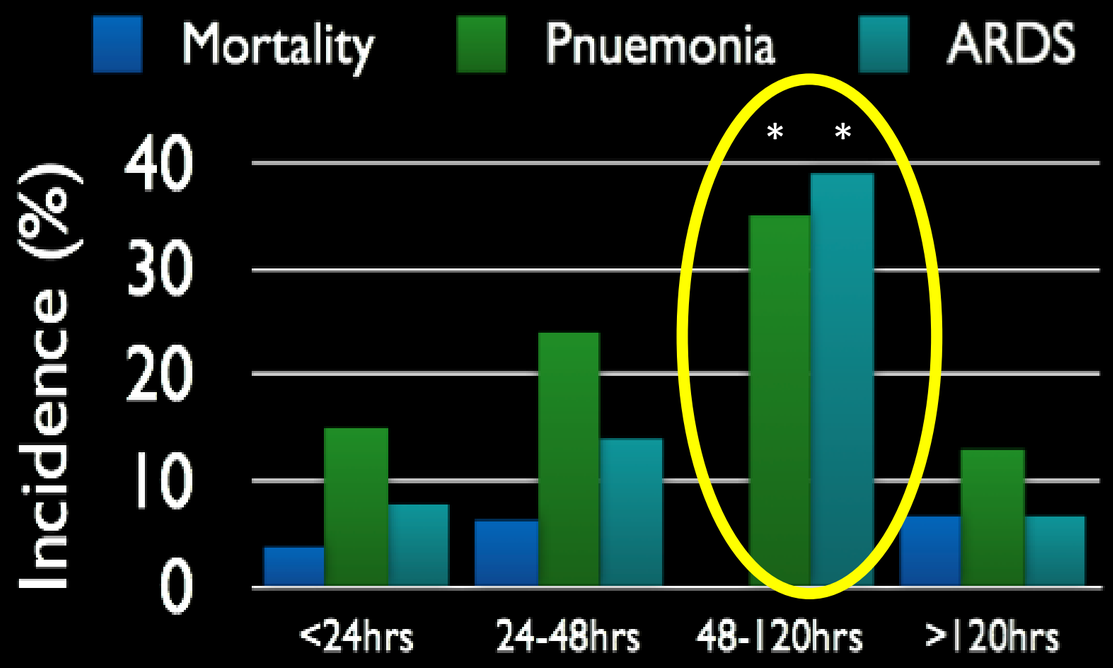
Brundage
2002

Fixation Days 2-5: Also dangerous?



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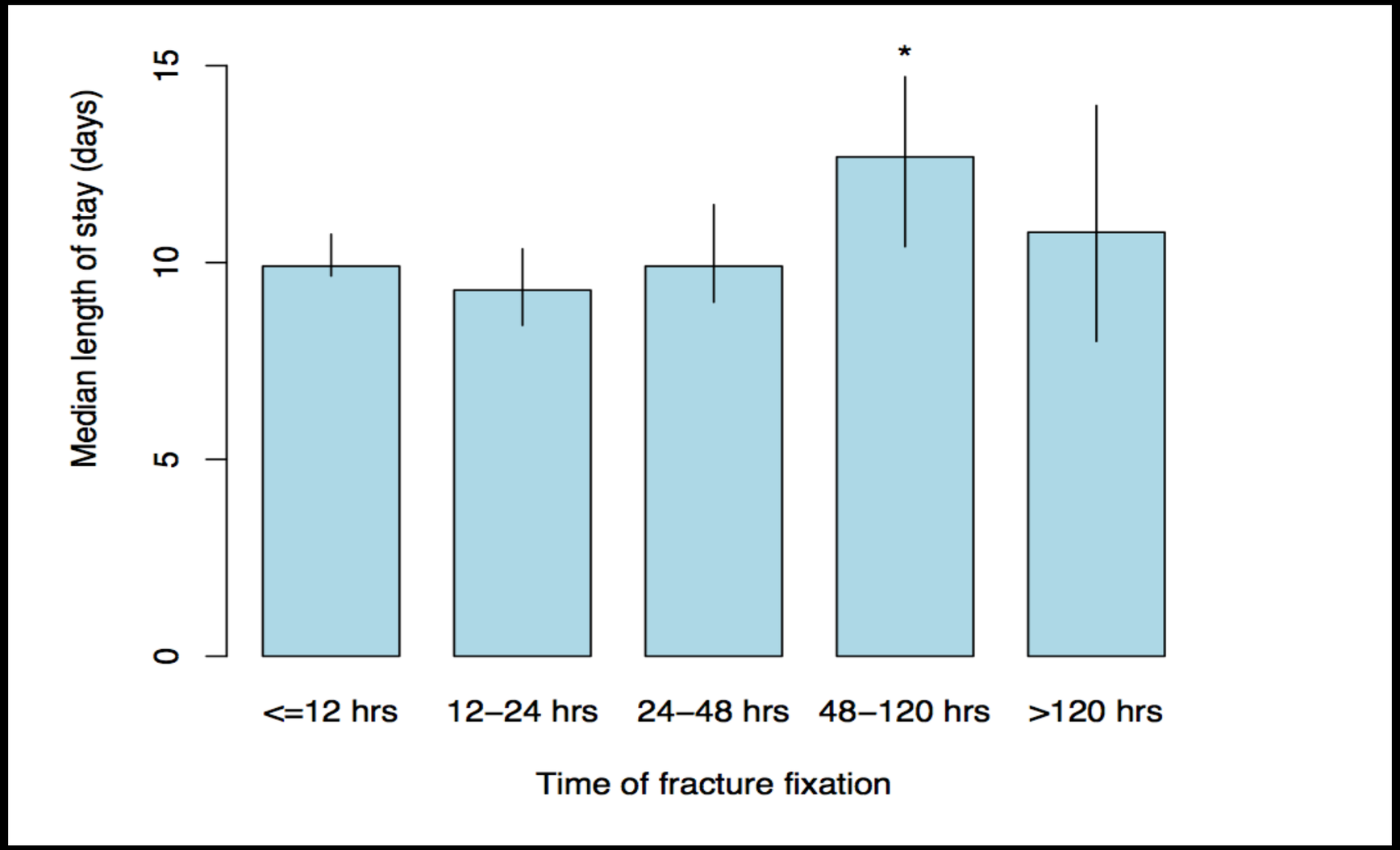
Hours from Injury

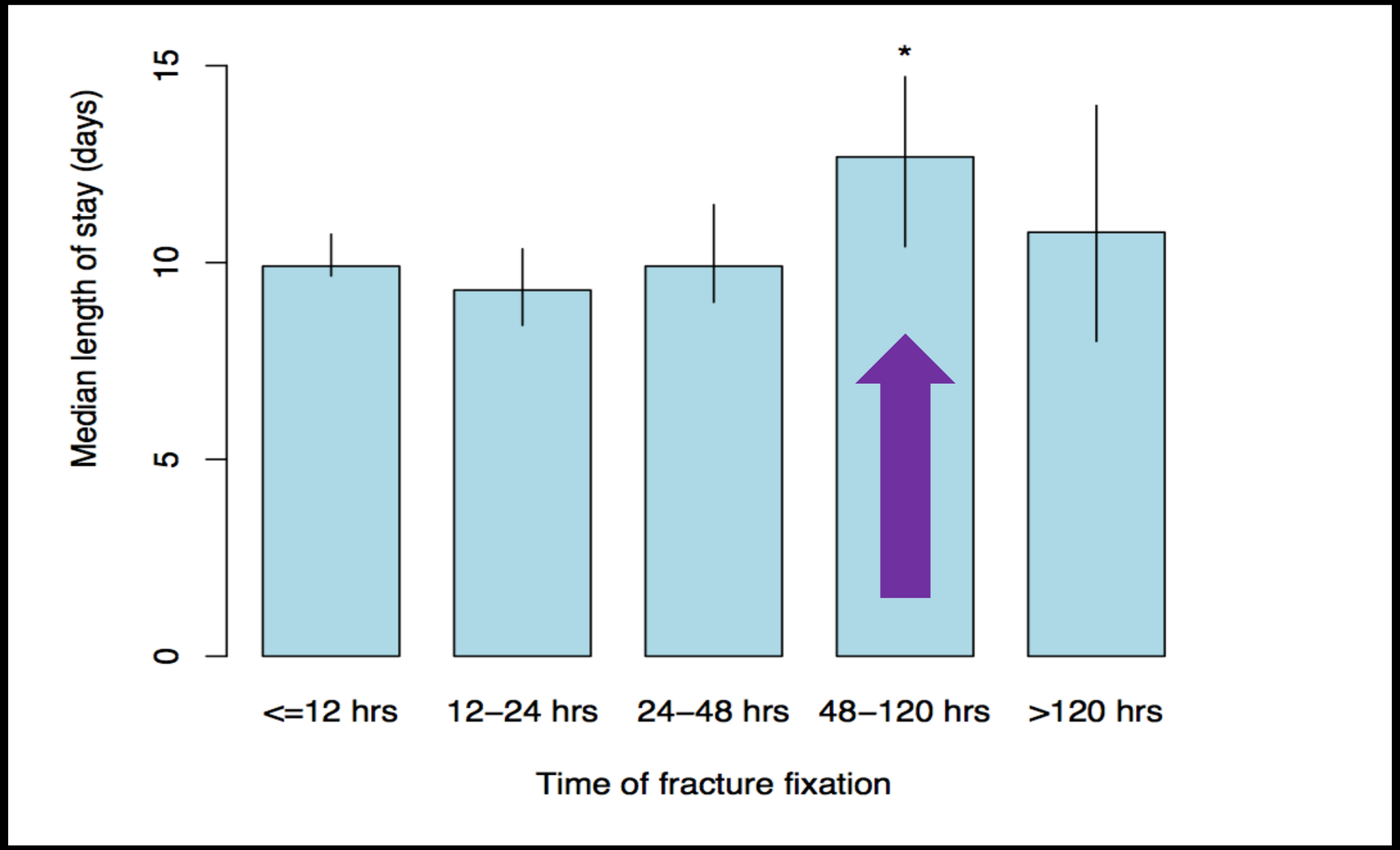
Brundage
2002

The 2-5 day risk period



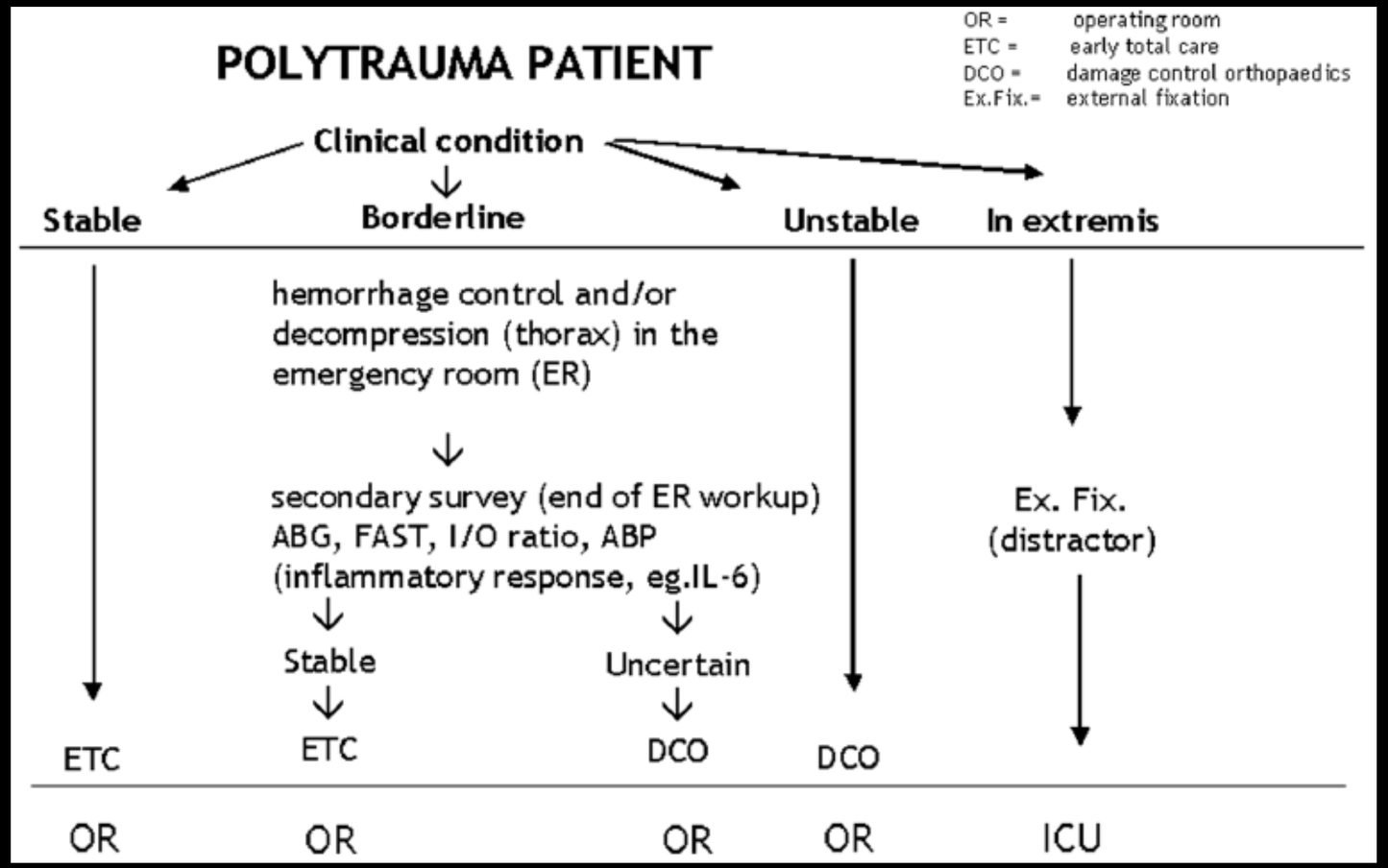
Morshed 2015

The 2-5 day risk period



Morshed 2015

Triage by Clinical Condition



Shock

Coagulation

Temperature

Soft tissues

DCO 36-47% ➤ 24% ARDS

Pape 2002

Patient Example

- HD #2: Lactate 4.1, requiring greater vent and pressor support

→ Ex-fix Femur and pelvis

- HD #5: ARDS

Era 3: Early *Appropriate* Care

Adequacy of resuscitation is what matters!

A.C. Crowl 2000

- Early treatment in the setting of occult hypo-perfusion (serum lactate $\geq$ 2.4mmol/L) associated with higher post-operative complications

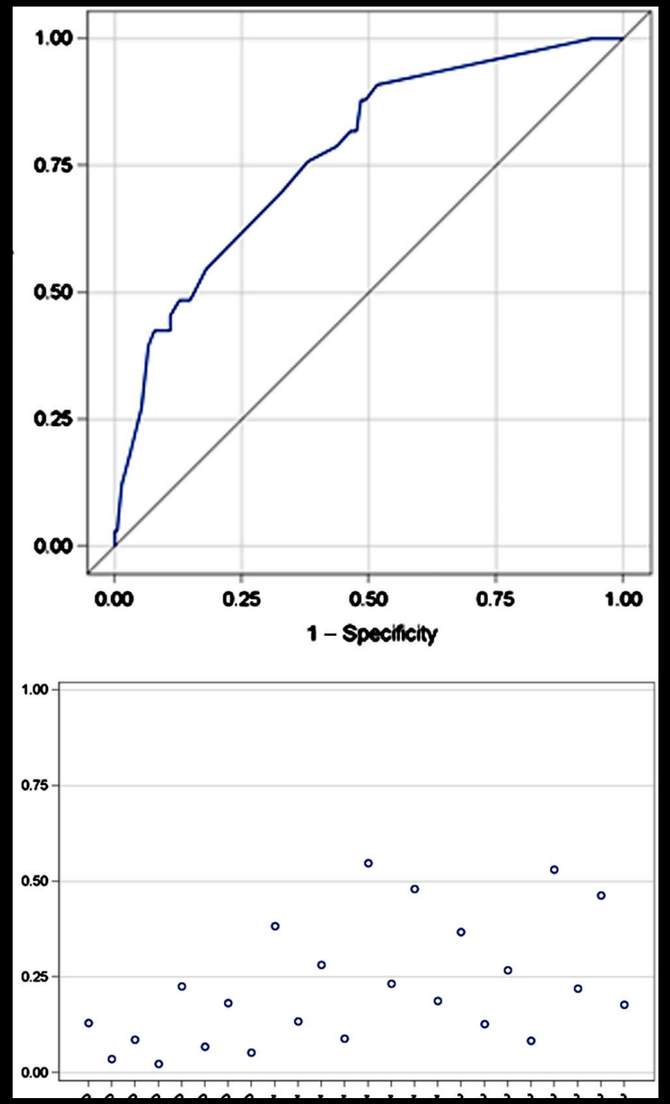
Resuscitation by Protocol and Early Operation

O'Toole 2009 – 227 patient polytrauma patients with femur fracture

- Resuscitate with goal of lactate $\leq$ 2.5
- Goal = IMN < 24hrs achieved in 88%
- ARDS – 1.5%
- ISS>17 and Lung AIS >2, 2% ARDS, 2% mortality

Early Appropriate Care (EAC) Defined

- Predictors of pulmonary complication:
  - Initial lactate (≥4mmol/L) > BE (<5.5mmol/L) > pH (<7.25) correction within 8 hours of injury
  - Presence of severe chest injury (AIS>2)
  - Fixation > 24 hours > 48 hours from injury



Vallier 2013

Testing EAC

- 335 polytrauma (mean ISS 26.9) meeting EAC
  - 380 femur fracture (n=173)
  - 128 pelvis and/or acetabulum fractures
  - 79 spine fractures
- 80% treated within 36 hours

EAC Protocol: Definitive fixation <36 hours provided:*	
Lactate	<4mmol/L
Base Deficit	≤ 5.5mmol/L
pH	≥ 7.25

*No pressor support

Vallier 2015

Testing EAC

Outcomes with early treatment:

- Complications 16.3% vs. 33.3% *
- ICU days 4.4 vs 11.6*
- Hospital days 9.5 vs 17.3*

*p<0.0001

Complications	
Infection	Organ failure
Sepsis	Pulmonary complications: - Pneumonia - ARDS - PE
DVT	

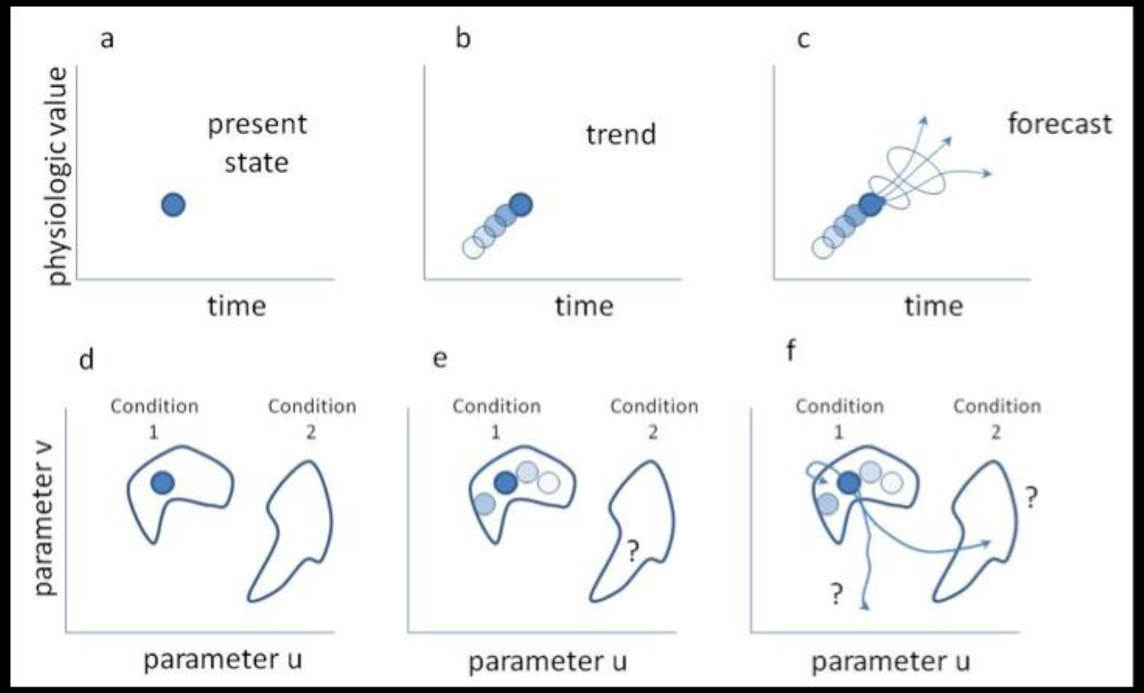
Vallier 2015

What about Damage Control Orthopaedics?

<15 % polytrauma + femur fracture patients

Era 4: Personalized Trauma Care

The real world is multivariable



T.G. Buchman 2010

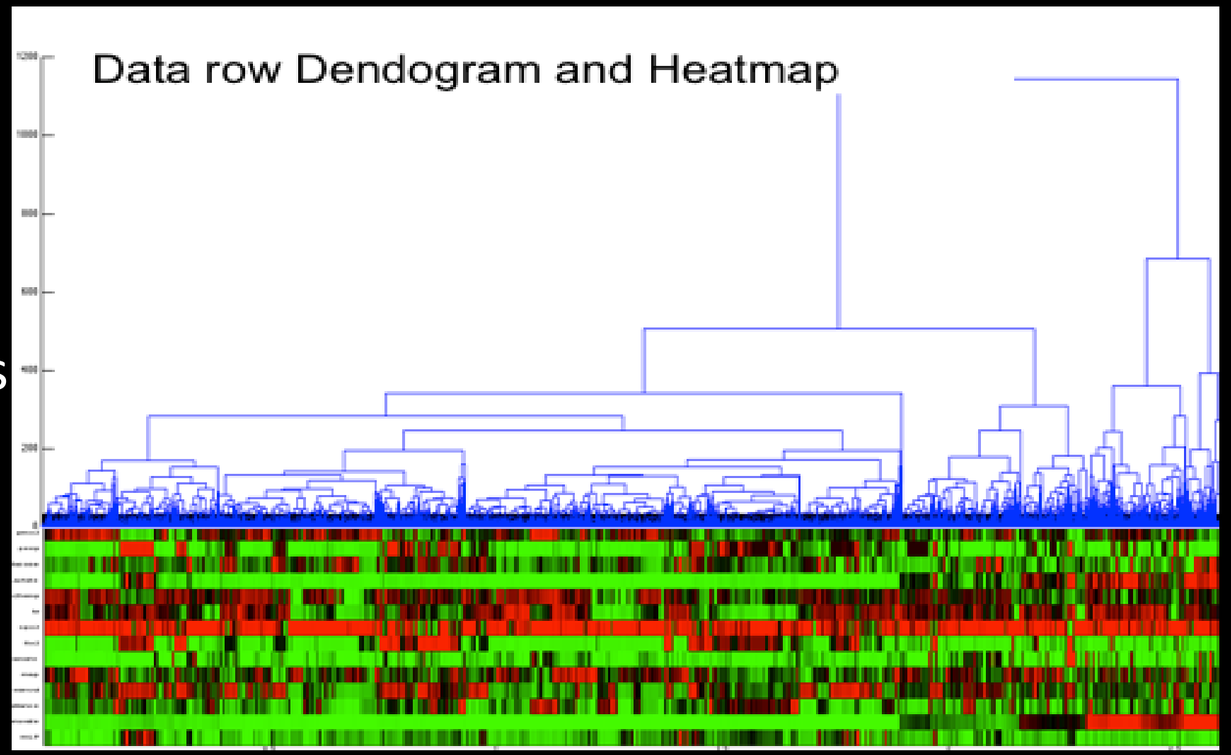
Future Point-of-Care Diagnostics:

- Dynamic Network Analysis of cytokines (interleukin-9, 17E/25, 21, 22, 23, and 33) differentiates shock-tolerance
- Neutrophil CD16 low epitopes correlate with injury severity (tissue damage)

McKinley 2020
Spijkerman 2020

Next: Early *personalized* care

Physiology
Genomics
Proteomics
Laboratory Measurements
Injury
Demographics



Probabilistic Models

Remember

- **Recognize** and monitor the hypo-perfused patient
- Early care is appropriate for the adequately **resuscitated patient**
- Computational approaches will improve assessment and **personalize timing of care**

HD#8: Definitive internal fixation pelvis and femur

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Question?

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