PLEASE CLICK ON THE FOLLOWING LINK TO WATCH THE LECTURE ONLINE:-

https://www.youtube.com/watch?v=bc_jd7ZBw1A&list=PLuBRb5B7fa_d_ITkxtB-KQYUusx0C1s_x&index=11

POLYTRAUMA & DCO

ORTHOPEDIC SPECIALIST

DR. BASHAR ALKHALDI

Outlines

- Definition of polytrauma patient
- Pathophysiology, 1st and 2nd hits
- Approach to polytrauma patient
- Classification/risk stratification
- Treatment strategies

What is a polytrauma patient?

- “More than two significant injuries in ≥ 2 body regions.” (Border et al. *Prog Surg*. 1975;14:84–120)
- “Two or more injuries, among which at least one injury or the sum of all injuries is life-threatening.” (Tscherne 1984)
- “A syndrome of multiple injuries exceeding a defined injury severity (ISS > 17) with consecutive systemic trauma reactions which may lead to dysfunction or failure of remote—primarily not injured—organs and vital systems.” (Trentz. *AO Principles of Fracture Management*; 2000)

CONSENSUS PAPER

The definition of polytrauma revisited: An international consensus process and proposal of the new 'Berlin definition'

Hans-Christoph Pape, MD, Rolf Lefering, PhD, Nerida Butcher, MD, Andrew Peitzman, MD, Luke Leenen, MD, Ingo Marzi, MD, Philip Lichte, MD, Christoph Josten, MD, Bertil Bouillon, Uli Schmucker, PhD, Philip Stahel, MD, Peter Giannoudis, MD, *and* Zsolt Balogh, MD, *Aachen, Germany*

Two injuries that are greater or equal to 3 on the AIS **+ one** or more additional variable from five physiologic parameters

Hypotension (systolic blood pressure ≤ 90 mm Hg),
Level of consciousness (GCS score ≤ 8),
Acidosis (base excess ≤ −6.0),
Coagulopathy (international normalized ratio ≥ 1.4 or partial thromboplastin time ≥ 40 seconds)
Age (≥ 70 years)

Injury Severity Score (ISS)

Body Region
Head
Face
Neck
Thorax
Abdomen
Spine
Upper Extremity
Lower Extremity
External and other

Score	Abbreviated Injury Scale (AIS)
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Unsurviveable

All injuries are assigned from an internationally recognised dictionary that describes over 2000 injuries. Multiple injuries are scored by adding together the squares of the three highest AIS scores. The ISS can range from 1 to 75. Scores of 7 and 15 are unattainable because these figures cannot be obtained from summing squares. The maximum score is 75. By convention, a patient with an AIS of 6 in one body region is given an ISS of 75.

Pathophysiology

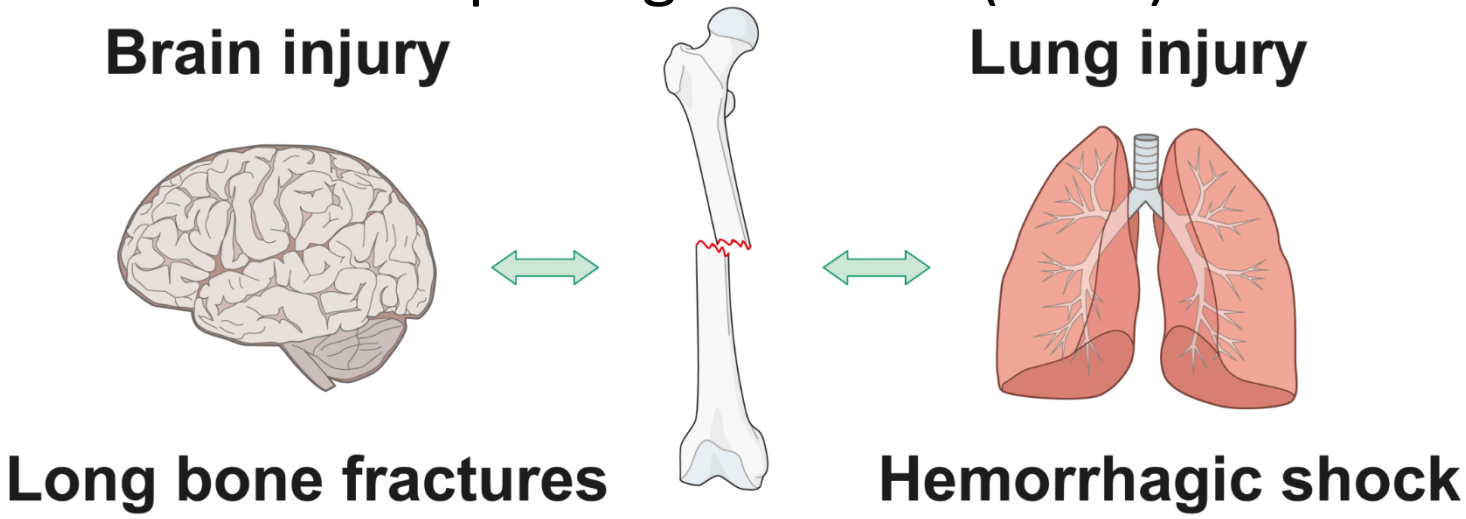
1st and 2nd hits

- The first physiologic reaction after injury involves the neuroendocrine system leading to an adrenocortical response characterized by the increased release of adrenocorticosteroids and catecholamines.
- neuroendocrine system is responsible for the increase in heart rate, respiratory rate (RR), fever, and leukocytosis observed in trauma patients after major injury

- Physiological and Immune Response to Trauma, Local and Systemic Inflammatory Response
- It is known that local tissue damage stimulates the liberation of damage-associated molecular patterns (DAMPs), chemokines, and alarmins which lead to systemic spill over and activation of the systemic immune response. The additional activation of the complement cascade initiates the chemotaxis of leukocytes and neutrophil cells.

- Blood loss and tissue damage caused by fractures and soft tissue crush injuries induce generalized hypoxemia in the entire vascular bed of the body.
- Hypoxemia is the leading cause of damage as it causes all endothelial membranes to alter their shape.
- Subsequently, the circulating immune system, namely the neutrophil and macrophage defense systems, identify these altered membranes. The damaged endothelial cell walls, by trying to seal the damaged tissue, induce activation of the coagulatory system
- This explains why these patients develop a lowered platelet count. Further cascade mechanisms, such as activation of the complement system, the prostaglandin system, the specific immune system, and others, are set in motion

- Unstabilized long bone fractures → release of mediators and cytokines → elicit local and systemic defense mechanisms → adherence of neutrophils to endothelium → damage endothelium of blood vessels → loss of barrier function in the lungs and in other organs → ARDS and multiple organ failure (MOF)



SIRS

- **Heart rate:** > 90 bpm
- **WBC:** <4000/mm^3 or >12000/mm^3 or >10% immature PMNs
- **Respiratory rate:** >20/min with P_aCO_2<32mmHg
- **Core temperature:** <36^0C or >38^0C

2 of 4 parameters = SIRS

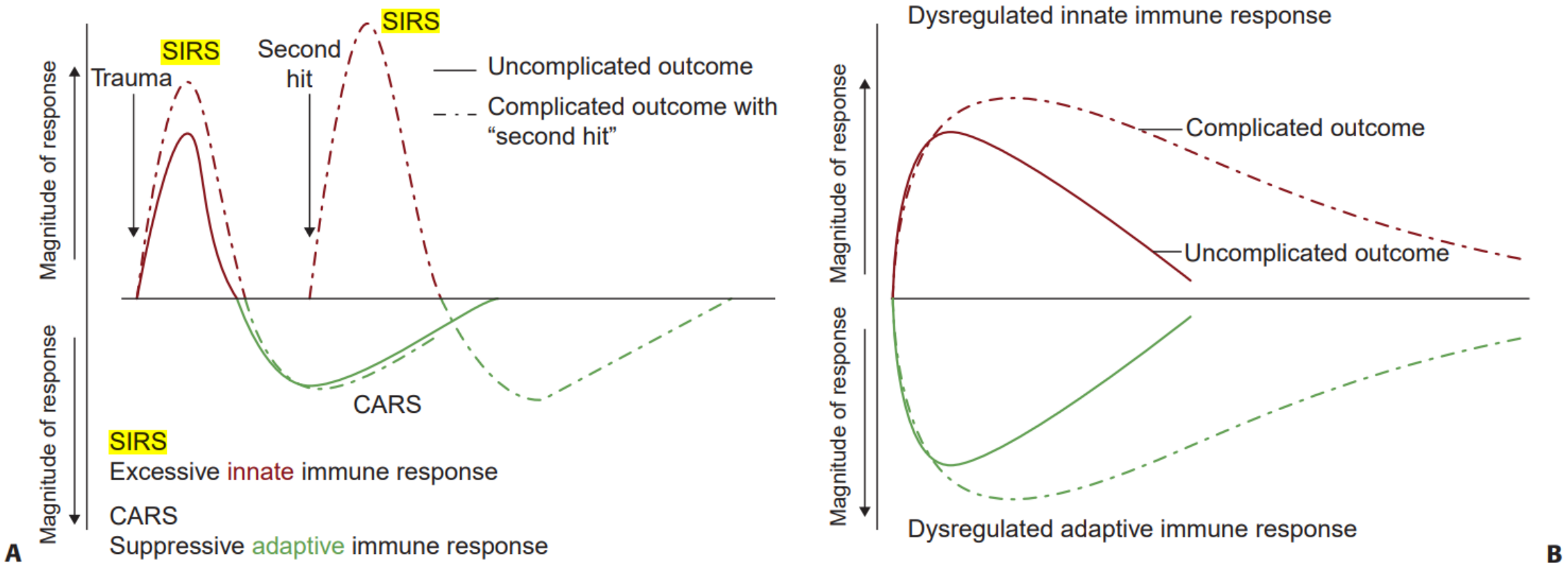
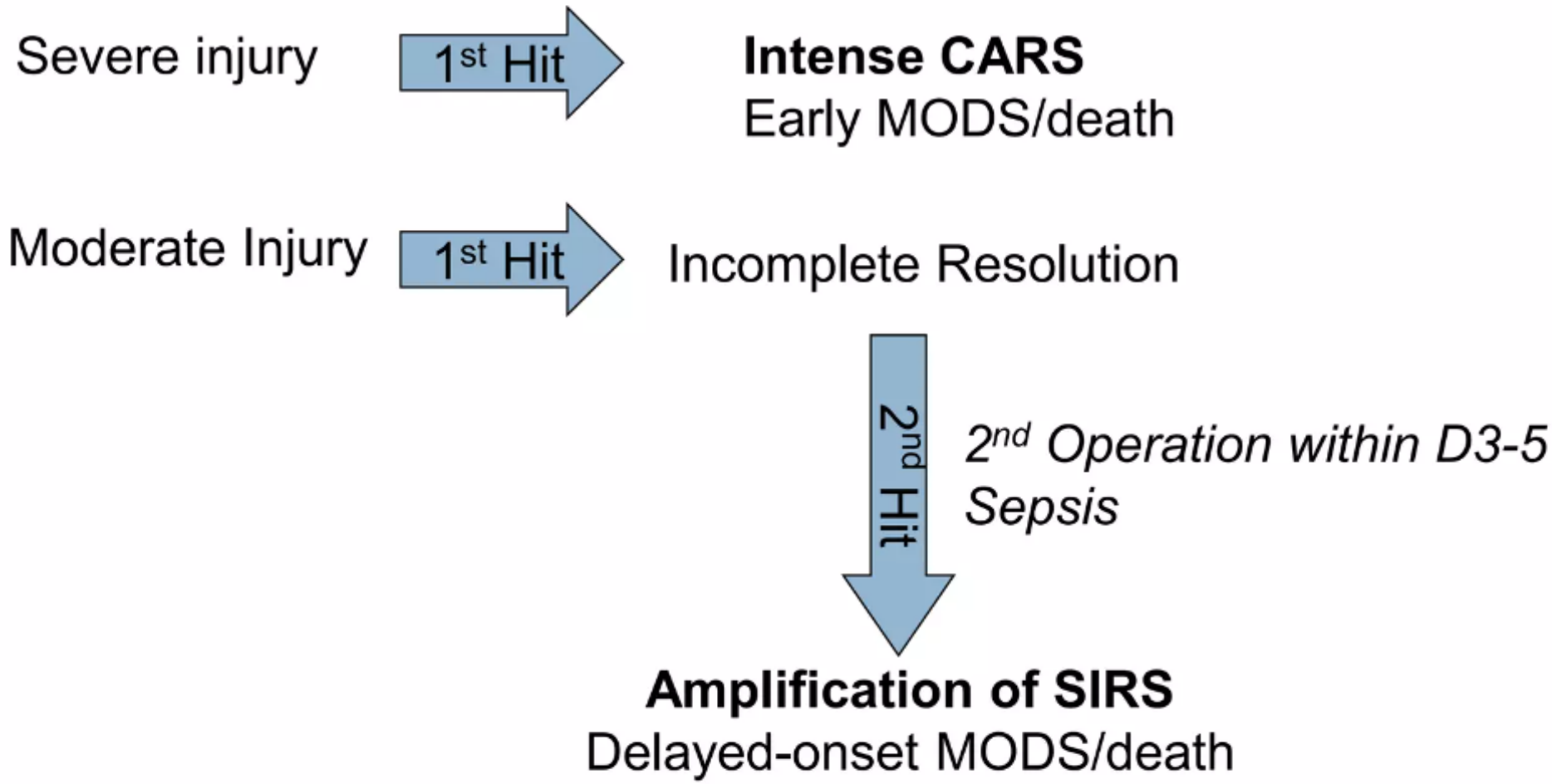


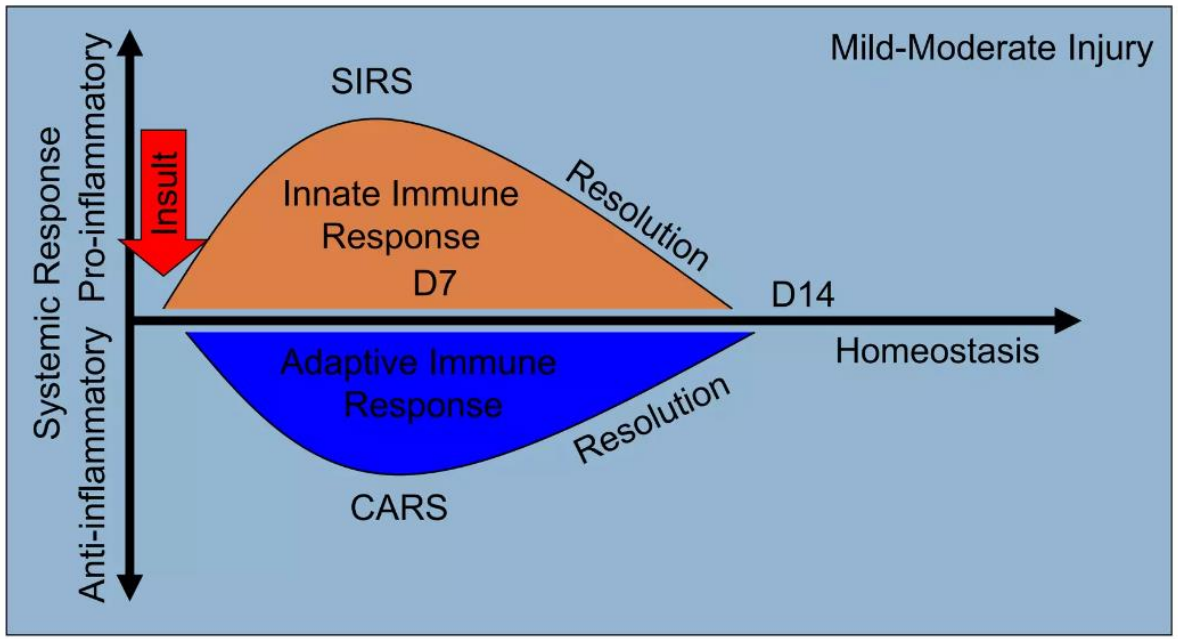
FIGURE 9-2 **A:** Current paradigm shows initial pro-inflammatory response associated with the development of systemic inflammatory response syndrome and delayed immunosuppression also known as compensatory anti-inflammatory response syndrome (CARS). **B:** New data shows a simultaneous induction of pro- and anti-inflammatory genes and suppression of adaptive immune system following trauma (Xiao W, Mindrinos MN, Seok J, et al. A genomic storm in critically injured humans. *J Exp Med.*

- Besides trauma, SIRS can be induced by other insults such as burns, infection or major surgery

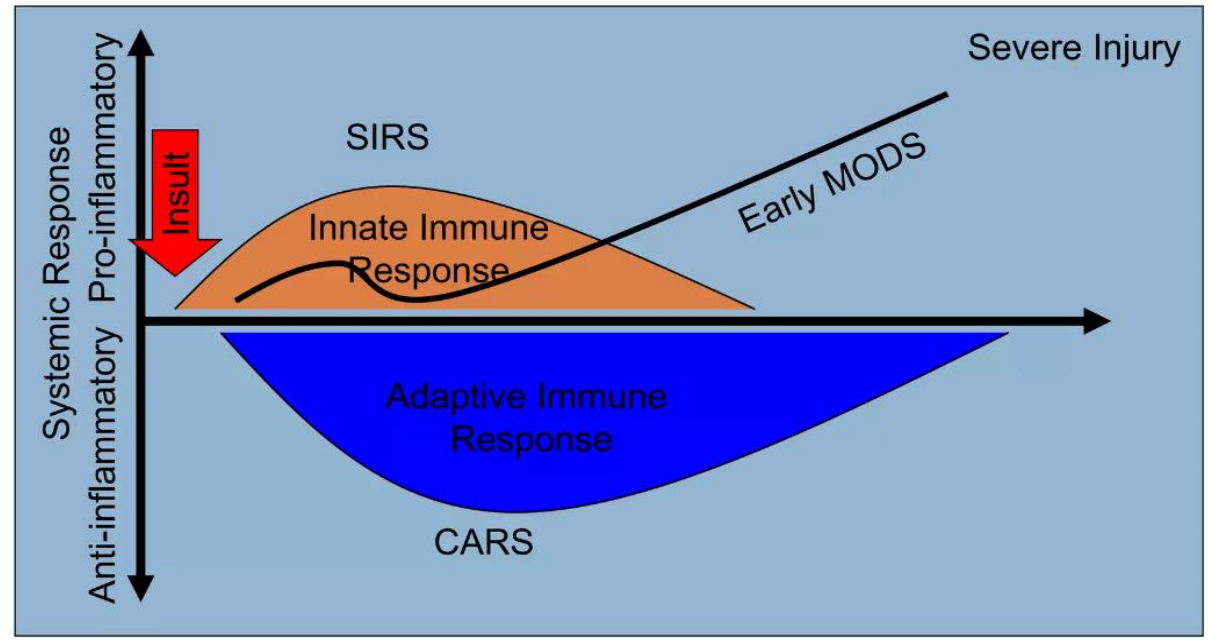
- General capillary leak: multiple organ dysfunction
- High energy consumption: Immunosuppression, sepsis

IMBALANCE BETWEEN SIRS AND CARS

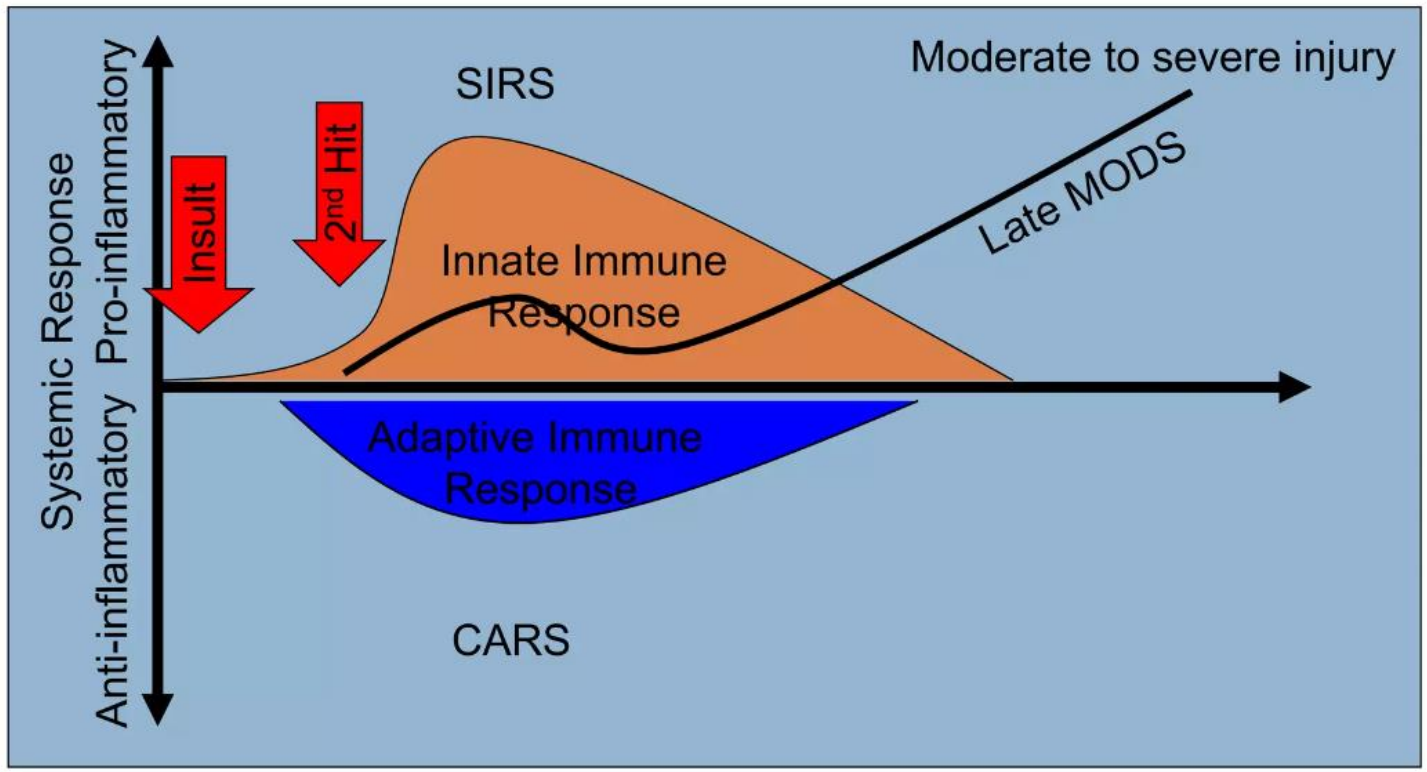




Balanced SIRS-CARS maintains homeostasis



Imbalanced CARS>SIRS leads to hypo-inflammation or early MODS



Imbalanced SIRS>CARS leads to hyper-inflammation or delayed MODS

- The release of mediators of both pro-inflammatory and antiinflammatory nature is dependent primarily on the severity of the “first hit phenomenon” (accidental trauma) and secondarily on the activation of the various molecular cascades during therapeutic or diagnostic interventions, surgical procedures, and post-traumatic/postoperative complications (“second” or “third” hits).

‘First Hit’ Impacts by Trauma

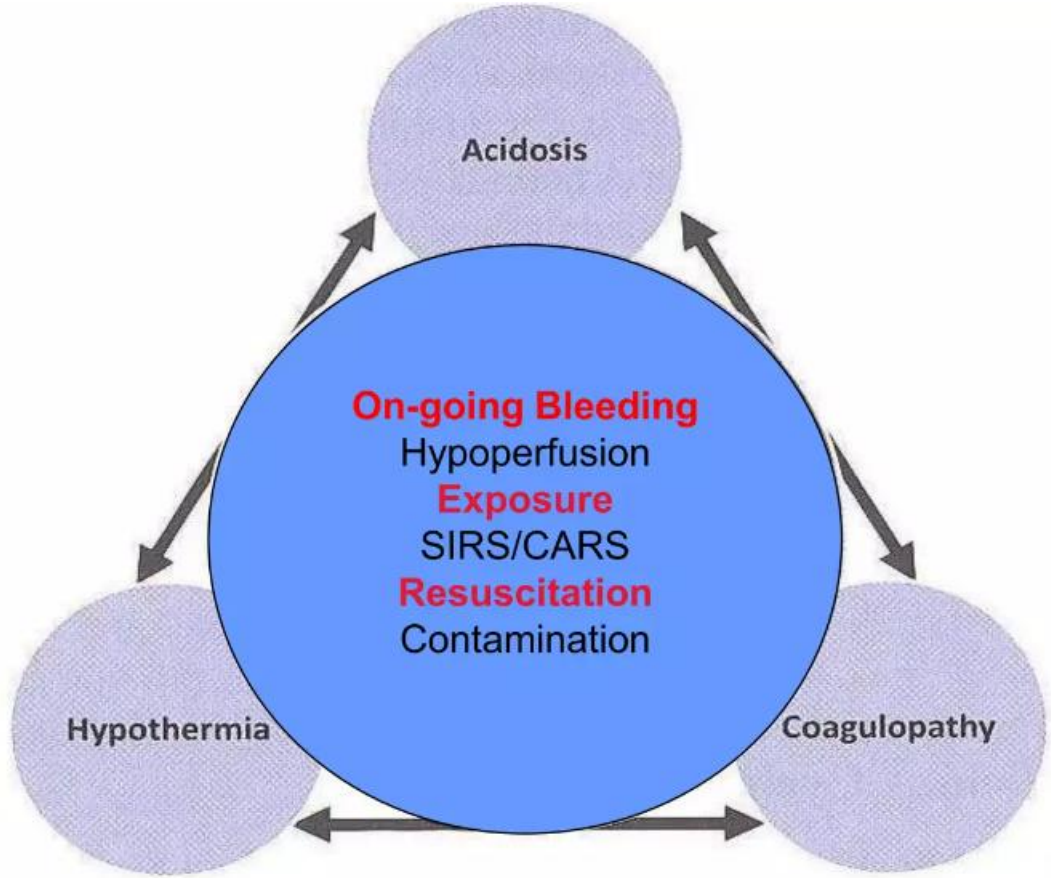
The Patient

The Limb/Organ System

‘Second Hit’ Impacts by Surgery and Resuscitation

The Patient

The Limb



Balanced Resuscitation or Permissive Hypotension	Haemostatic Resuscitation	Damage Control Surgery

Approach to Polytrauma patient

1. Simultaneous assessment and resuscitation

- Application of ATLS protocol

2. Establishing the surgical priorities

- Life saving surgeries
- Limb saving surgeries
- Function saving surgeries

Advanced Trauma Life Support (ATLS)
Primary Survey (A,B,C,D,E)

- **A**irway maintenance with cervical spine protection
- **B**reathing and ventilation
- **C**irculation and hemorrhage control
- **D**isability: neurologic status
- **E**xposure/**E**nvironmental control
- Pelvic chest lateral c spine xray

- Stop massive hemorrhage (internal or external)
  - Inside the chest
  - Intraperitoneal
  - Retroperitoneal from fracture pelvis
  - Long bones

2ry survey

- Vital functions have been stabilized

- AMPLE history
  - **A**llergies
  - **M**edications
  - **P**ast illness/**P**regnancy
  - **L**ast meal
  - **E**vents/**E**nvironment related to injury
- Head-to-toe evaluation
- More diagnostic procedures can be done

- CT scan

- Critical limb injuries (limb-saving surgery)
  - Fractures with concomitant injuries to major vessels
  - Fractures with compartment syndrome
  - Open fractures with massive soft-tissue injuries

DCO

- The term damage control was borrowed from a traditional Navy term and philosophy.
- Temporary measures are used to limit further damage and stabilize the ship to allow for a thorough assessment of the damage and development of a comprehensive strategy for definitive repair

PDF

1960s Delayed Surgery (‘too sick to operate on’)

Preliminary traction → delayed definitive fixation

1980s Early Total Care within 24 hours

(‘too sick *not* to operate on’)

ATLS concepts *plus*

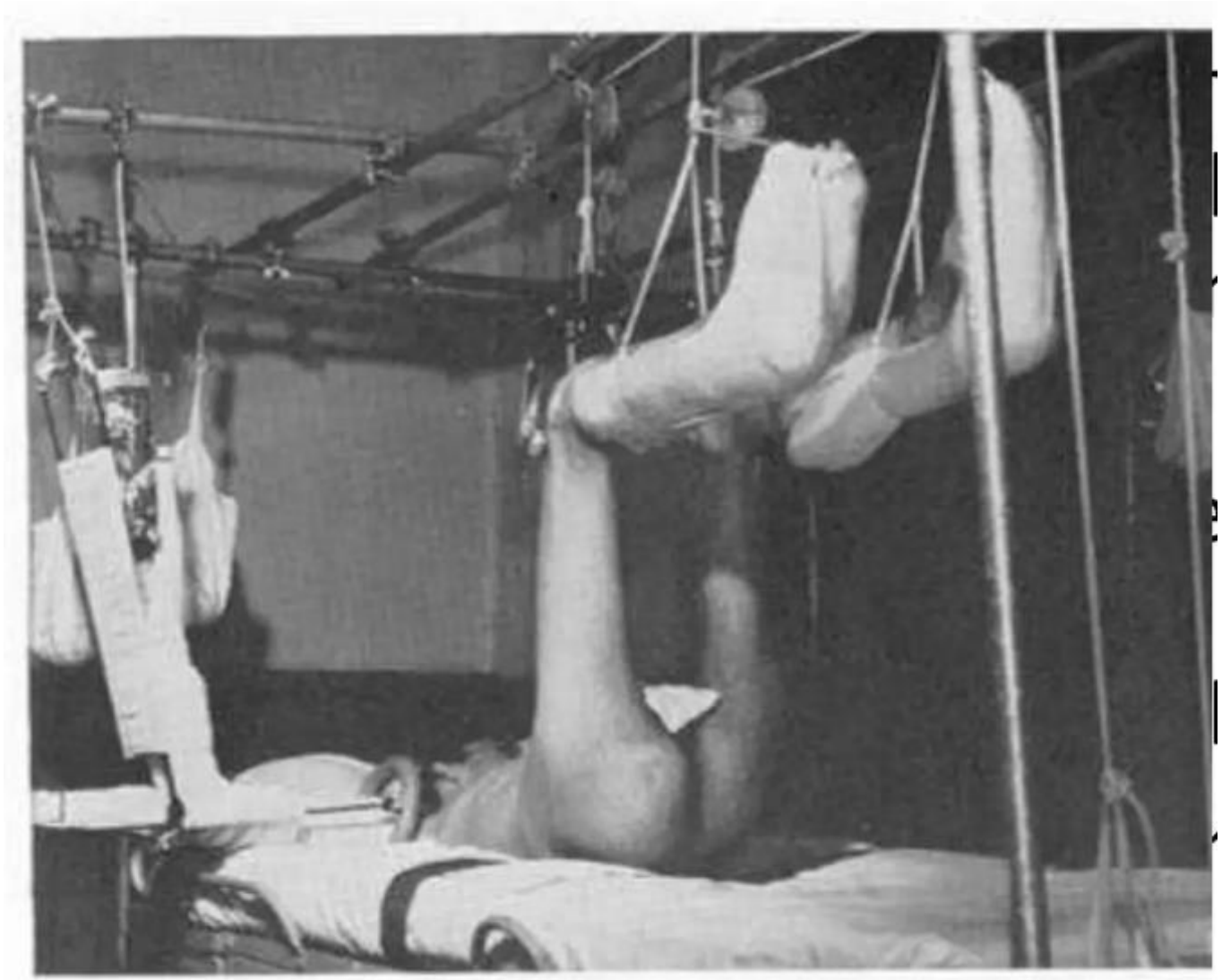
Advancement in anaesthesiology and ICU care

- early fixation prevents FES
- early mobilization facilitates nursing care and
- early mobilization prevents pneumonia, sepsis,

T

Patients with ISS>17 (borderline patients) are at high risk of complications

1990s Damage Control Orthopaedics



- The term damage control was borrowed from a traditional Navy term and philosophy.
- Temporary measures are used to limit further damage and stabilize the ship to allow for a thorough assessment of the damage and development of a comprehensive strategy for definitive repair

- DCO is a concept that consists of:
- The damage control concept consists of three separate components:
  (a) Resuscitative surgery for rapid hemorrhage control

  (b) Restoration of normal physiologic parameters

  (c) Definitive surgical management

- An approach to contain and stabilize an orthopaedic injury to improve patient's physiology
- Designed to avoid worsening pt's condition due to "second hit" phenomenon
- Delay definitive surgery until pt condition is optimized
- Focuses on hemorrhagic control, management of soft-tissue injury and provisional fracture stability

TABLE 9-8 Indications for "Damage Control" Surgery

1. Physiologic criteria
   - Blunt trauma: hypothermia, coagulopathy, shock/blood loss, soft tissue injury = Four vicious cycles
   - Penetrating trauma: hypothermia, coagulopathy, acidosis = "Lethal Triad"
2. Complex pattern of severe injuries—expecting major blood loss and a prolonged reconstructive procedure in a physiologically unstable patient

How shall polytrauma patients be treated?

Is DCO better than ETC?

Patient classification

Patient Stratification

This is done after initial resuscitation

- Stable
- Borderline
- Unstable
- In extremis

- Staging of the Patient’s Physiologic Status Once the initial assessment and intervention is complete, patients should be placed into one of the four categories in order to guide the subsequent approach to their care. This categorization is done on the basis of overall injury severity, the presence of specific injuries, and the current hemodynamic status.
- Three out of the four parameters must be met to allow a patient to be classified in a particular category

Stable Patients:

Have no immediately life-threatening injuries

They respond to initial therapy and they are hemodynamically stable without inotropic support

There is no evidence of physiologic disturbances such as coagulopathy or respiratory distress nor ongoing occult hypoperfusion which will present as abnormalities of acid–base status.

Borderline (Patients at Risk)

- Borderline patients have stabilized in response to the initial resuscitative attempts but they have clinical features or combinations of injury, which are often associated with poor outcome and put them at risk of rapid deterioration.

• ISS >40 • Hypothermia below 35ºC • Initial mean pulmonary arterial pressure >24 mm Hg or a >6 mm Hg rise in pulmonary artery pressure during intramedullary nailing or other operative intervention

• Multiple injuries (ISS >20) in association with thoracic trauma (AIS >2)
• Multiple injuries in association with severe abdominal or pelvic injury and hemorrhagic shock at presentation (systolic BP <90)

Unstable Patients

- remain hemodynamically unstable, despite initial intervention, are at a greatly increased risk of rapid deterioration, subsequent multiple organ failure, and death.
- DCO
- Stabilization and monitoring

- Stabilized fractures not only reduce pain but also minimize the release of intramedullary material into the circulation and secondary damage to the soft tissues. Furthermore, nursing is easier and early functional treatment can be initiated.

In Extremis

These patients are very close to death having suffered severe injuries and they often have ongoing uncontrolled blood loss. They remain severely unstable despite ongoing resuscitative efforts and are usually suffering the effects of a “deadly triad” of hypothermia, acidosis, and coagulopathy. A damage control approach is certainly advocated.

Lifesaving procedures only

Limited to no biological reserve

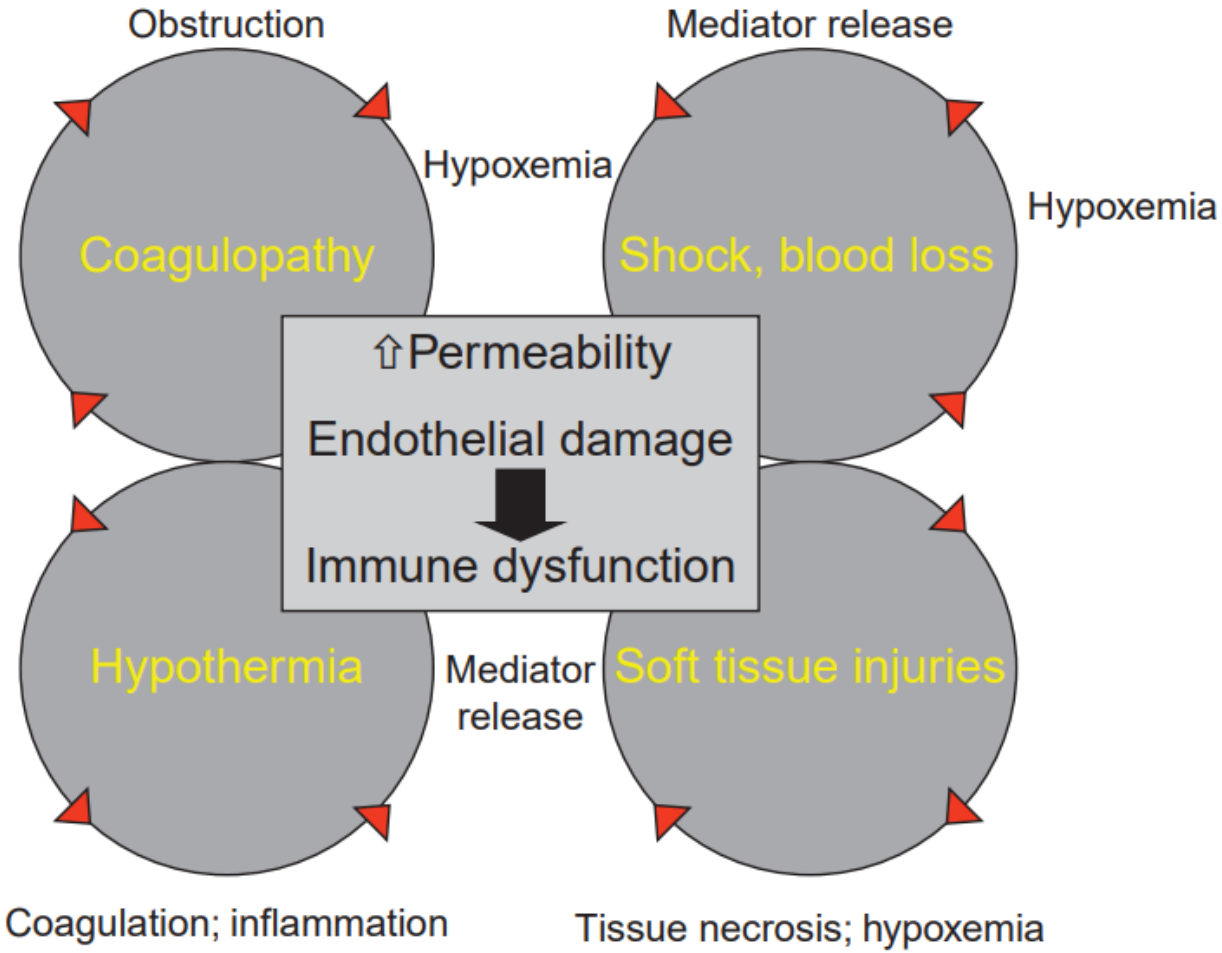


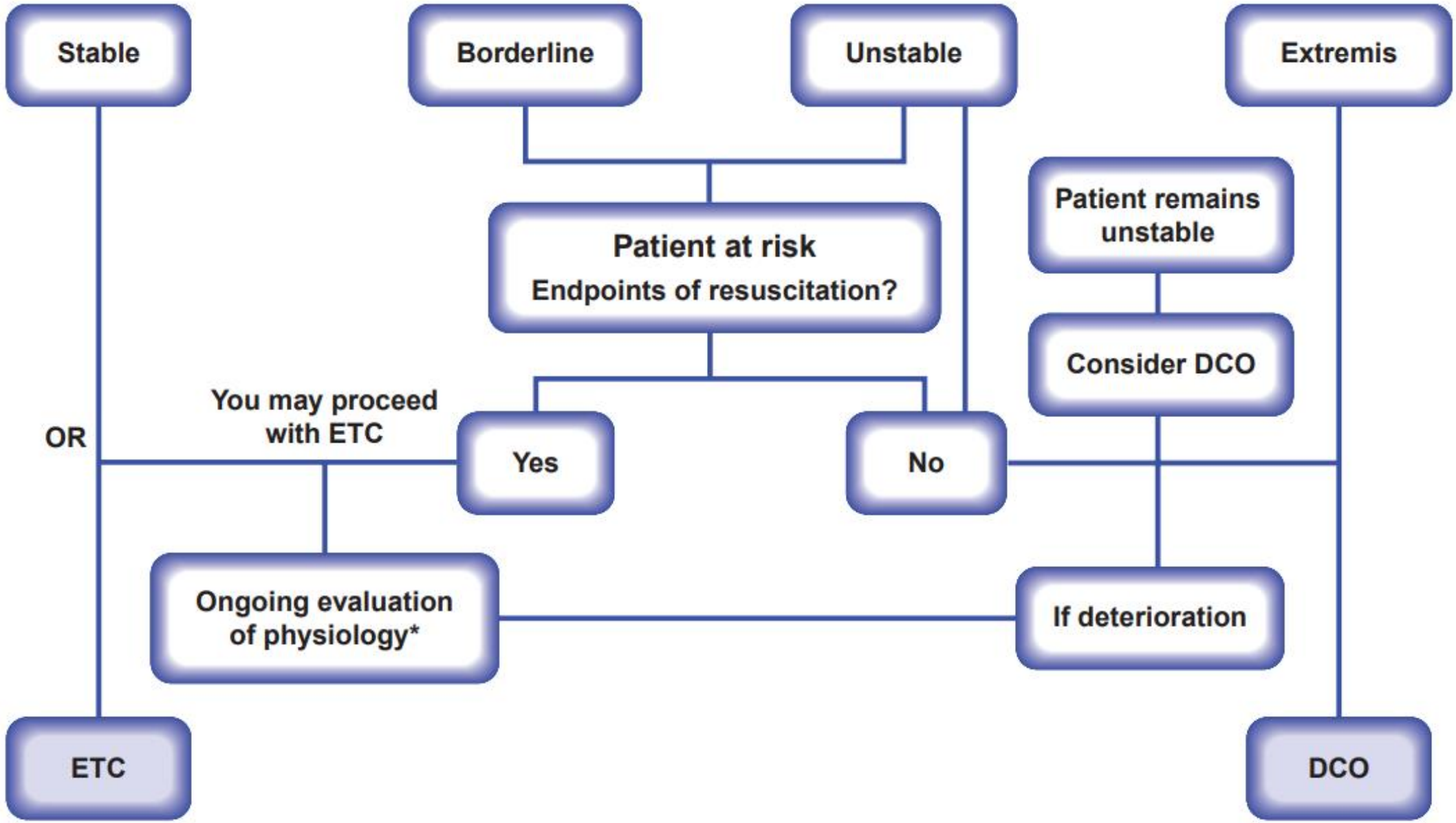
FIGURE 9-1 Four cycles demonstrate the pathophysiologic cascades associated with the development of post-traumatic immune dysfunction and endothelial damage. The exhaustion of the compensatory mechanisms results in development of complications such as ARDS/MODS.

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	2–8	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.

- Any deterioration in the patient’s clinical state or physiologic parameters should prompt rapid reassessment with adjustment of the management approach as appropriate. Achieving the endpoints of resuscitation is of paramount importance for the stratification of the patient into the appropriate category

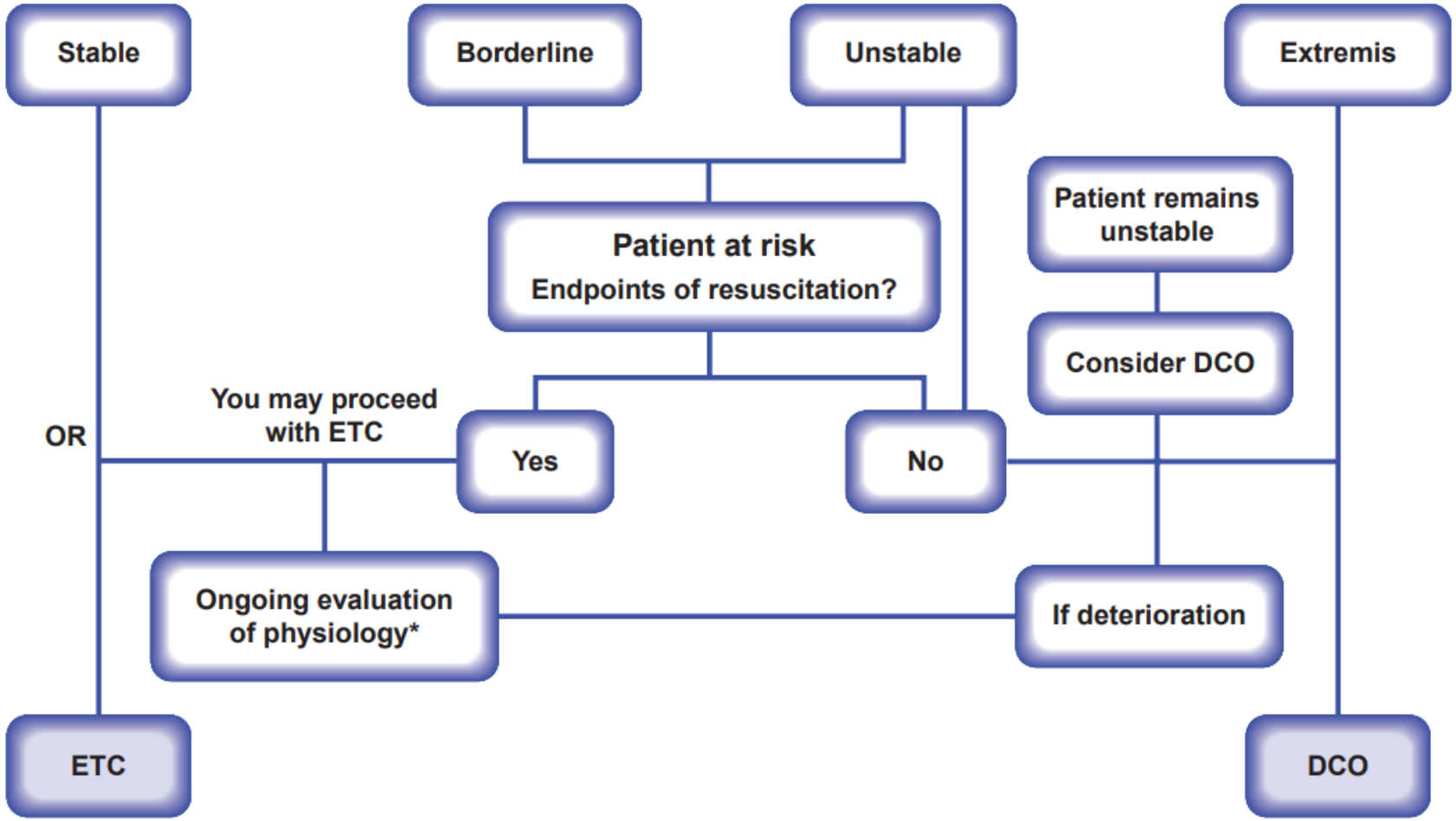
- End point of resuscitation include stable hemodynamics, stable oxygen saturation, normal lactate, urine output of 1mL/kg/hr and no requirement for inotropic support


Stable
Borderline
Unstable
Extremis
Patient at risk
Endpoints of resuscitation?
Patient remains unstable
Consider DCO
You may proceed with ETC
OR
Yes
No
Ongoing evaluation of physiology*
If deterioration
ETC
DCO

- Stable patients are safely managed by ETC

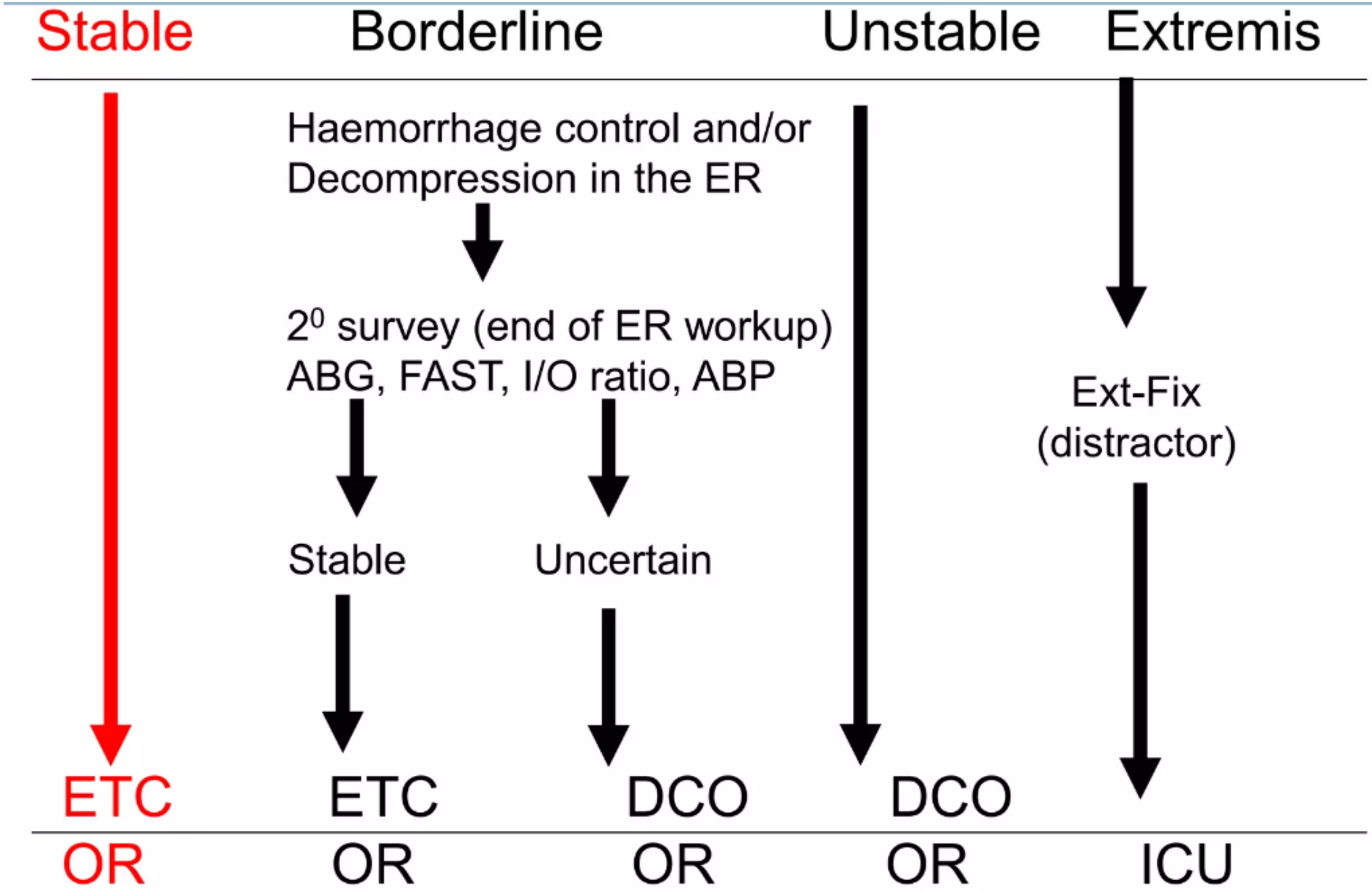
- Metaphyseal and periarticular fractures, the priorities of treatment are often dictated by the state of the soft tissues.

- A staged “damage control” concept should be strongly considered for the acute management of “borderline” patients, unstable patients, and patients “in extremis”



*Lactate, blood pressure, urine output, oxygenation, temperature, coagulation profile.

FIGURE 9-5 Treatment of severely injured patients with damage control orthopedics (DCO) algorithm. Early total care (ETC) with definitive stabilization of fractures can be used in stable patients. Unstable patients require a damage control orthopedic strategy with temporary external fixation of fractures. "Patients at risk" are patients with a high injury severity score (ISS), hypovolemia, lactate over


Stable
Borderline
Unstable
Extremis
Haemorrhage control and/or
Decompression in the ER
2⁰ survey (end of ER workup)
ABG, FAST, I/O ratio, ABP
Ext-Fix
(distractor)
Stable
Uncertain
ETC
ETC
DCO
DCO
OR
OR
OR
OR
ICU

1960s Delayed Surgery (‘too sick to operate on’)

Preliminary traction → delayed definitive fixation

1980s Early Total Care within 24 hours

(‘too sick *not* to operate on’)

ATLS concepts *plus*

Advancement in anaesthesiology and ICU care

- early fixation prevents FES
- early mobilization facilitates nursing care and
- early mobilization prevents pneumonia, sepsis,

T

Patients with ISS>17 (borderline patients) are at high risk of complications

1990s Damage Control Orthopaedics

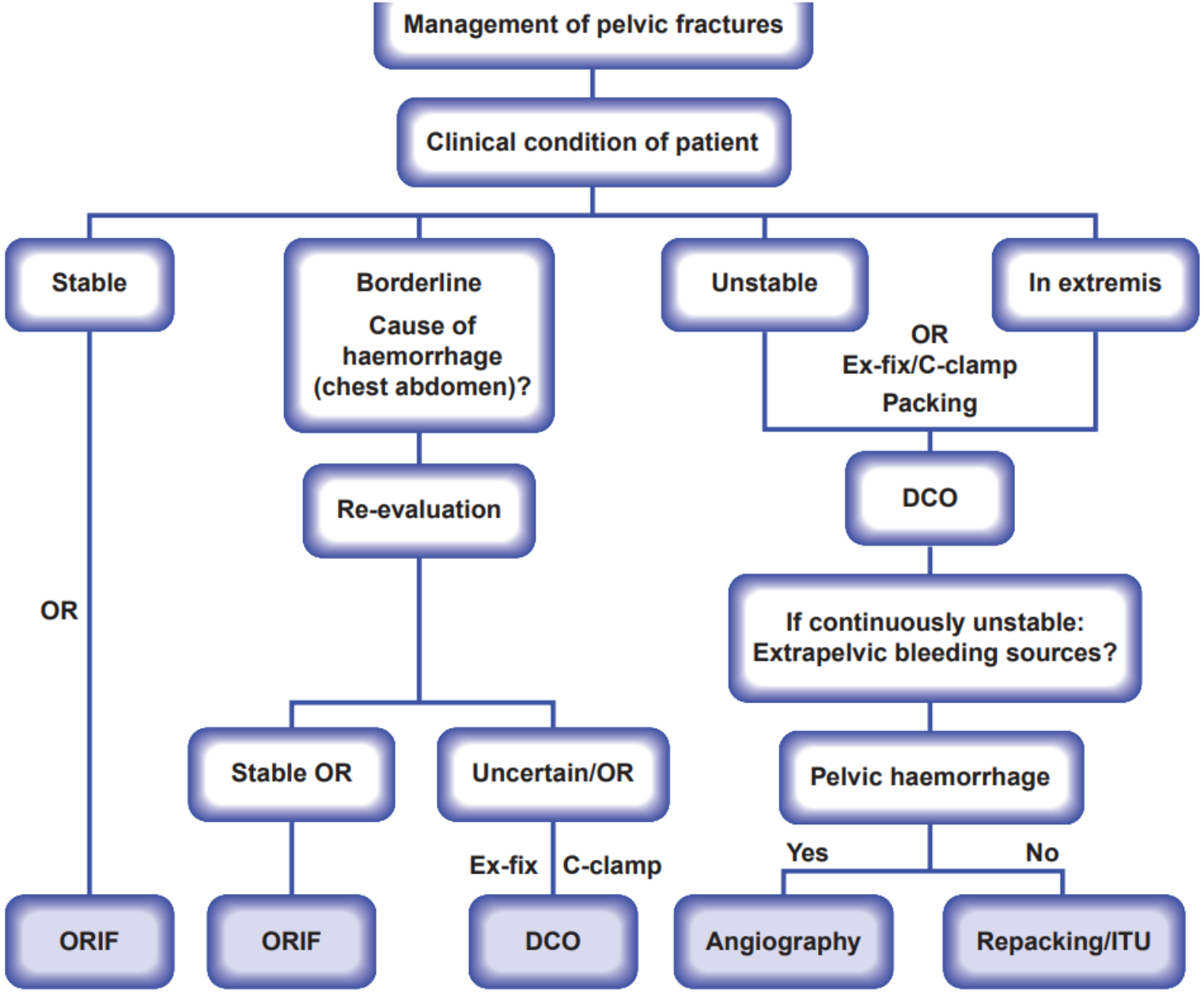
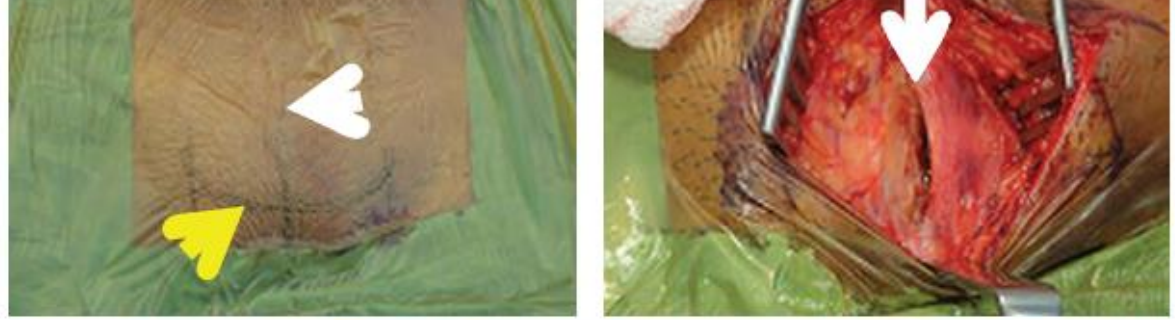


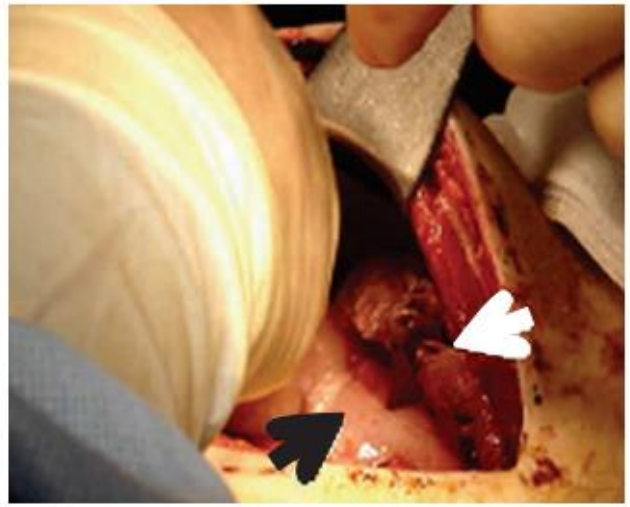
FIGURE 9-3 Treatment algorithm for patients with pelvic fractures and hemodynamic instability.

circumferential stabilization devices but have been

Figure 2. A) The T-POD (Teleflex, Wayne, PA) is a circumferential pelvic binder that uses a pulley system to bring the two ends of the device toward each other, across the abdomen. Depending on placement, there is limited groin access between the pulley cables. Reprinted with permission from Teleflex. B) The SAM Pelvic Sling is a force-controlled circumferential pelvic belt (SAM Medical, Wilsonville, OR). Notably, the buckle lies directly over the groin but allows for lower abdomen access. Reprinted with permission from SAM Medical. C) Bed sheets have long been used for temporary pelvic stabilization. This method of circumferential compression allows for abdominal access but no groin access. Photograph curtesy of Tony Pedri, MD, and Brianna Patti, MD.



B



D

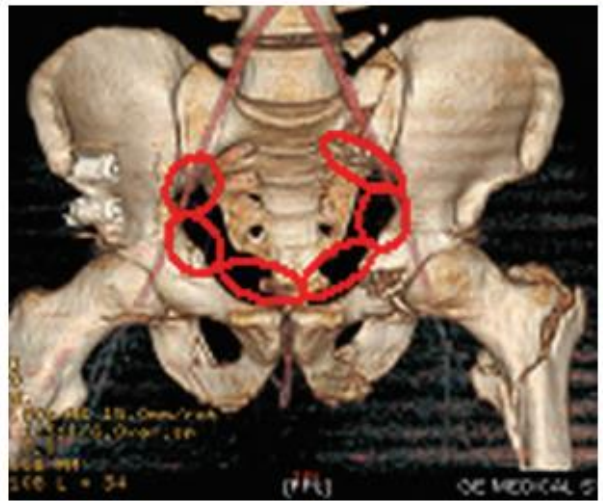
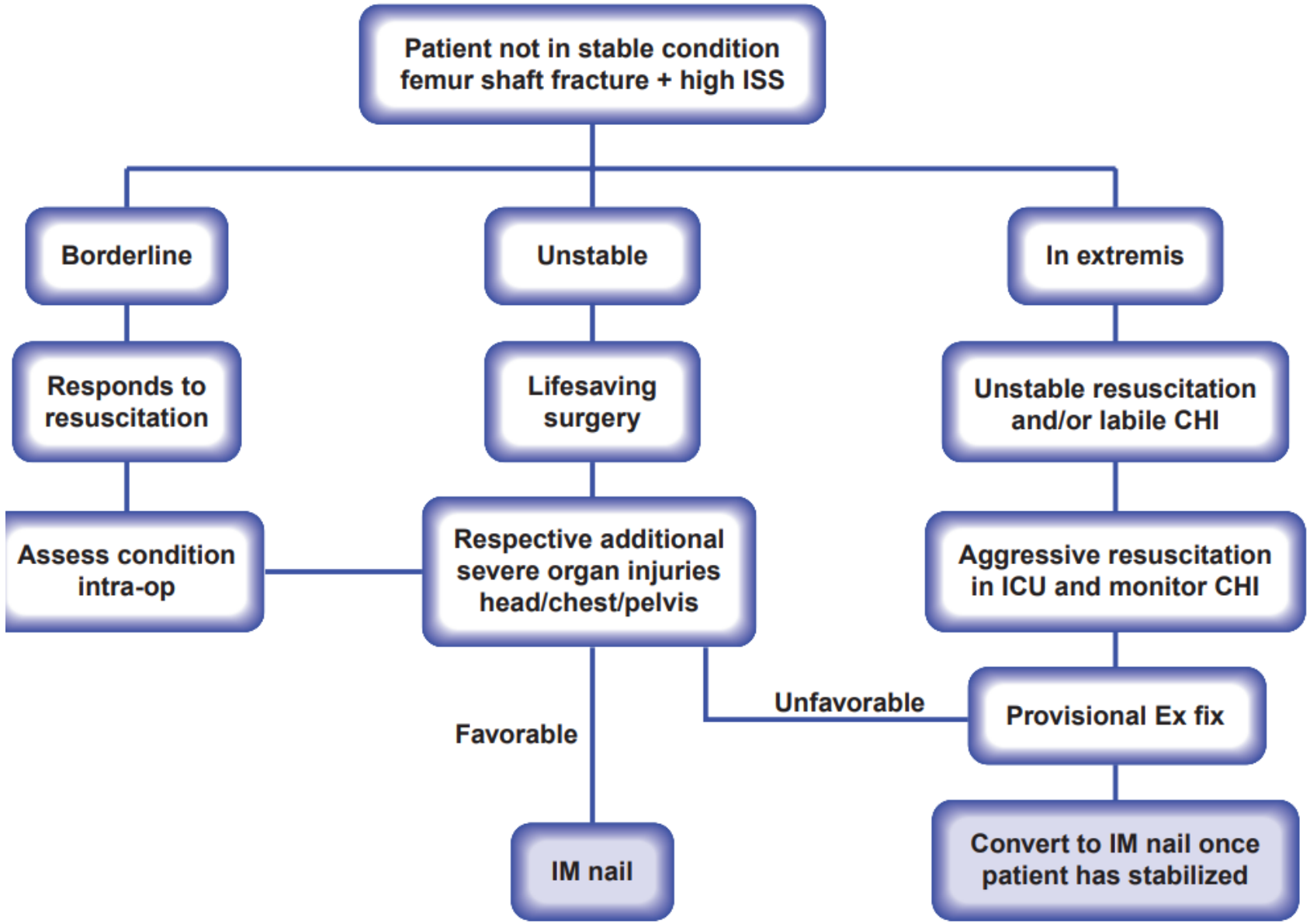


FIGURE 9-4 Retroperitoneal packing of the pelvis. **A:** Midline vertical incision (*white arrow*) is demonstrated (*yellow arrow* represents lower abdominal transverse incision). **B:** Incision of linea alba (*white arrow*). **C:** Retraction of the bladder to one side (*black arrow*) and placement of unfolded lap sponges in to the true pelvis (*white arrow*). Note that the first lap sponge is placed adjacent to the sacroiliac joint and the next should be placed anteriorly to the middle of the pelvic brim and the retropubic space. **D:** CT pelvic image revealing a lateral compression fracture pattern. **E:** Schematic representation of the position of the packs around the pelvic floor.


Patient not in stable condition
femur shaft fracture + high ISS
Borderline
Unstable
In extremis
Responds to resuscitation
Lifesaving surgery
Unstable resuscitation and/or labile CHI
Assess condition intra-op
Respective additional severe organ injuries head/chest/pelvis
Aggressive resuscitation in ICU and monitor CHI
Unfavorable
Provisional Ex fix
Favorable
IM nail
Convert to IM nail once patient has stabilized

Early Appropriate Care (EAC)

ORIGINAL ARTICLE

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

Definitive management of mechanically unstable fractures of the pelvis, acetabulum, proximal femur, femoral shaft, and spine within 36 hours of injury as long as the patient has demonstrated response to resuscitation as based on improvement of acidosis with lactate < 4.0 mmol/L, pH > 7.25, or BE less than - 5.5 mmol/L

J Orthop Trauma • Volume 27, Number 10, October 2013

When to operate?

Physiological status	Surgical intervention	Timing
Stable (responder) Unstable (nonresponder)	Early definitive care Damage control	Day 1
Hyperinflammation	“Second looks” and change of packing	Day 2–4
Time-window of opportunity	Scheduled definitive surgery	Day 5–10
Immunosuppression	No surgery!	> Day 10
Recovery	Secondary reconstructive surgery	> Week 3

Evolving concepts?

University of Zurich[UZH]

The polytrauma patient: Current concepts and evolving care

Lee, Christopher ; Rasmussen, Todd E ; Pape, Hans-Christoph ; Gary, Joshua L ; Stannard, James P ; Haller, Justin M

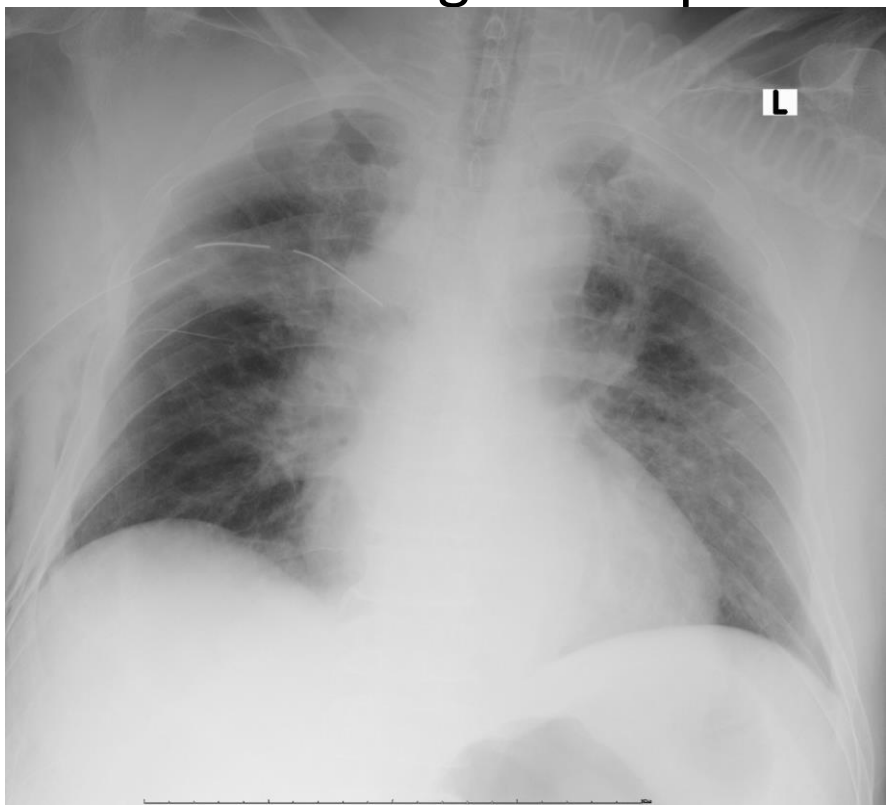
- Principles of care in the polytraumatized patients continue to evolve with advances in resuscitation, interventional hemorrhage control and negative pressure wound therapy.
- Patient assessment should be a dynamic process and treatment tailored in response to resuscitation as measured by acid base parameters
- The previously studied windows may no longer apply to borderline and unstable patient as definitive surgical treatment can be safely done in selected patients between day 1-5 if the patient showed response
- This approach, however, should be done with care and abandoned if patient shows any signs of deterioration

Questions?

50-year-old man, motorcycle accident, sent to emergency department

- Initial vital signs: blood pressure (BP) 90/60; heart rate (HR) 120; respiratory rate (RR) 30/min; body temperature (BT) 36.5°C
- Dyspnea, semi-consciousness
- Moderate pale conjunctiva
- Chest: crepitation both lungs
- Abdomen soft, not distend
- Right wrist: swelling, deformity, tenderness
- Left ring finger: swelling and deformity
- Right knee: ballottement, swelling around knee, tenderness, neurovascularly intact
- Left leg: swelling, deformity, crepitus, tenderness, neurovascularly intact

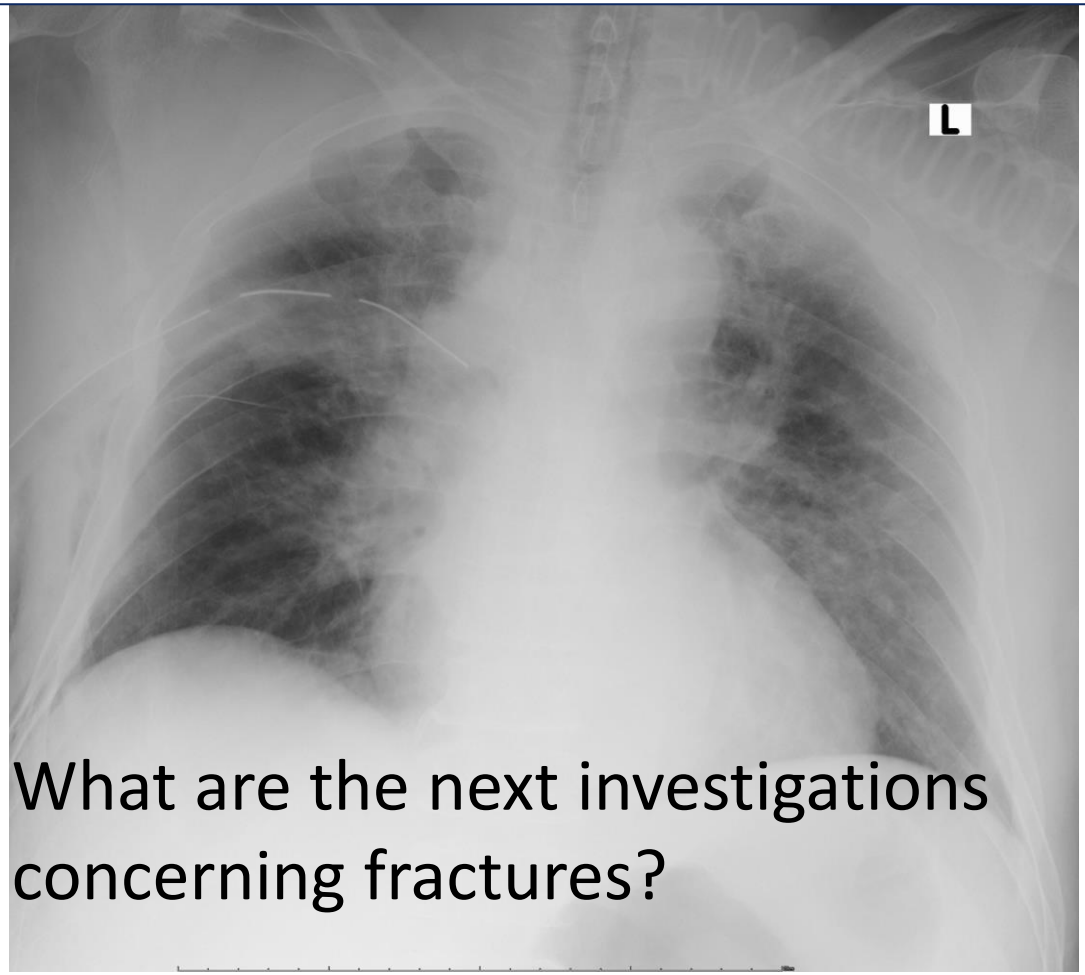
- After resuscitation, chest x-ray was done
- Diagnosis: multiple fracture ribs on both sides with hemopneumothorax of right side
- Treatment: implantable cardioverter defibrillator (ICD) was inserted
- Vital signs: BP 110/60; HR 100; BT 36.8°C
- Difficulties in spontaneous breathing: on respirator



- 50-year-old man

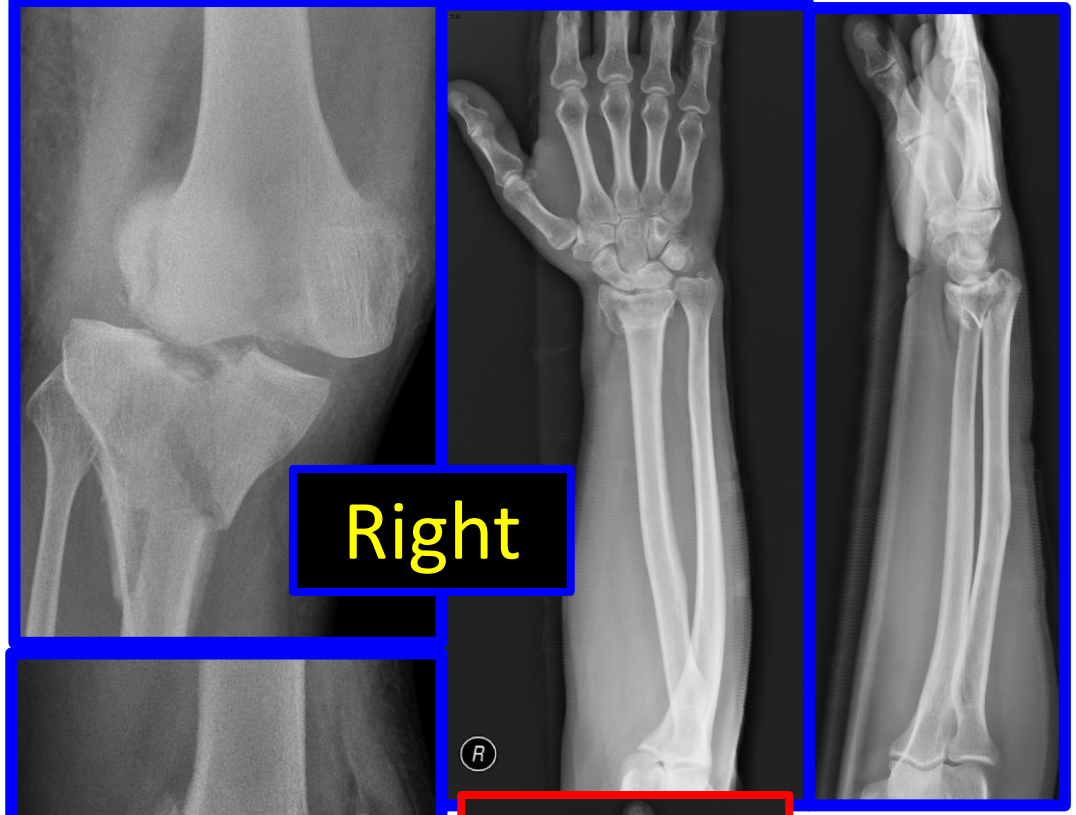
- Right wrist: swelling, deformity, tenderness
- Left ring finger: swelling and deformity
- Right knee: ballottement, swelling, tenderness around the knee
- Neurovascularly intact
- Left leg: swelling, deformity, crepitus, tenderness, neurovascularly intact

Rx: resuscitation, ICD was inserted
Vital signs: BP 110/60; HR 100; BT 36.8°C
Difficulties in spontaneous breathing: on respirator

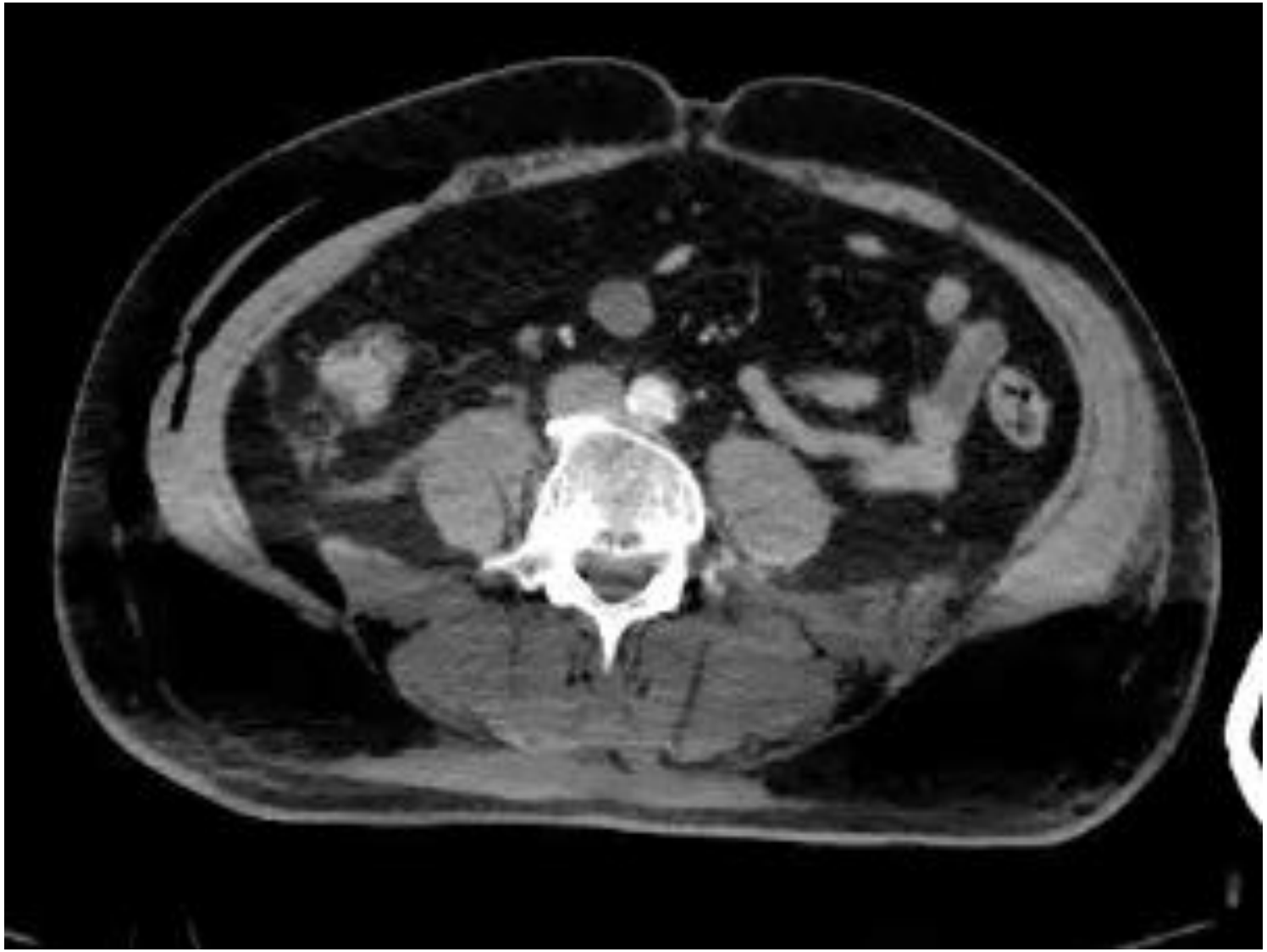


What are the next investigations concerning fractures?

Anything needed?

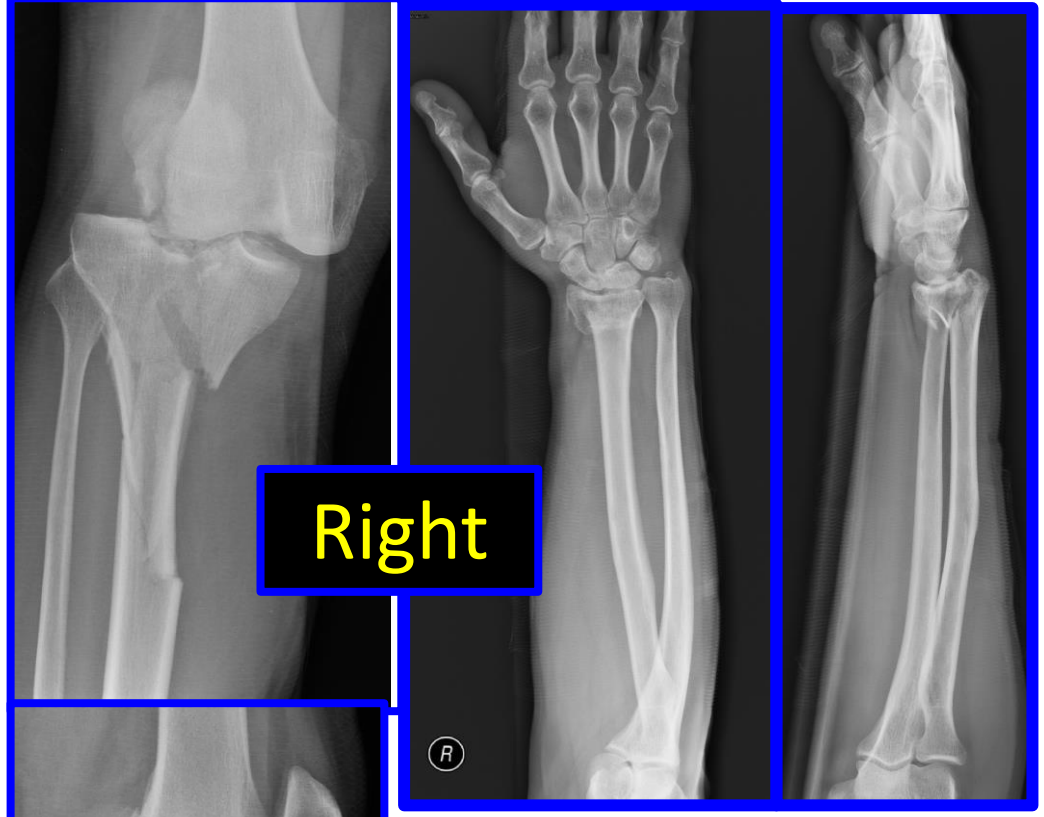


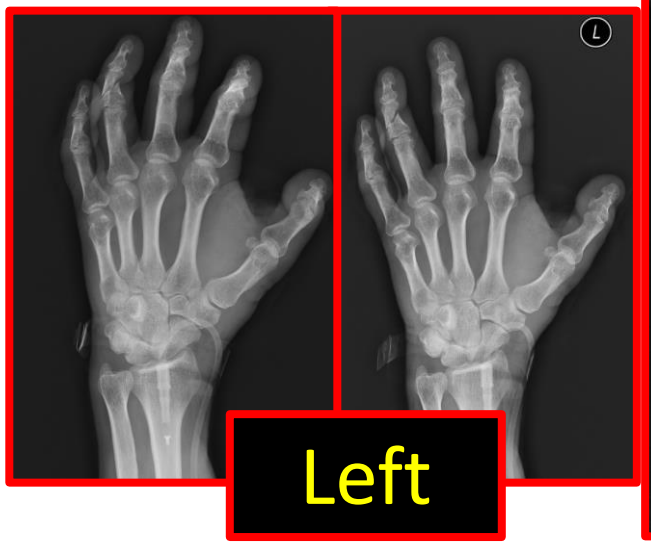
Do not forget to have x-rays including joint above and below

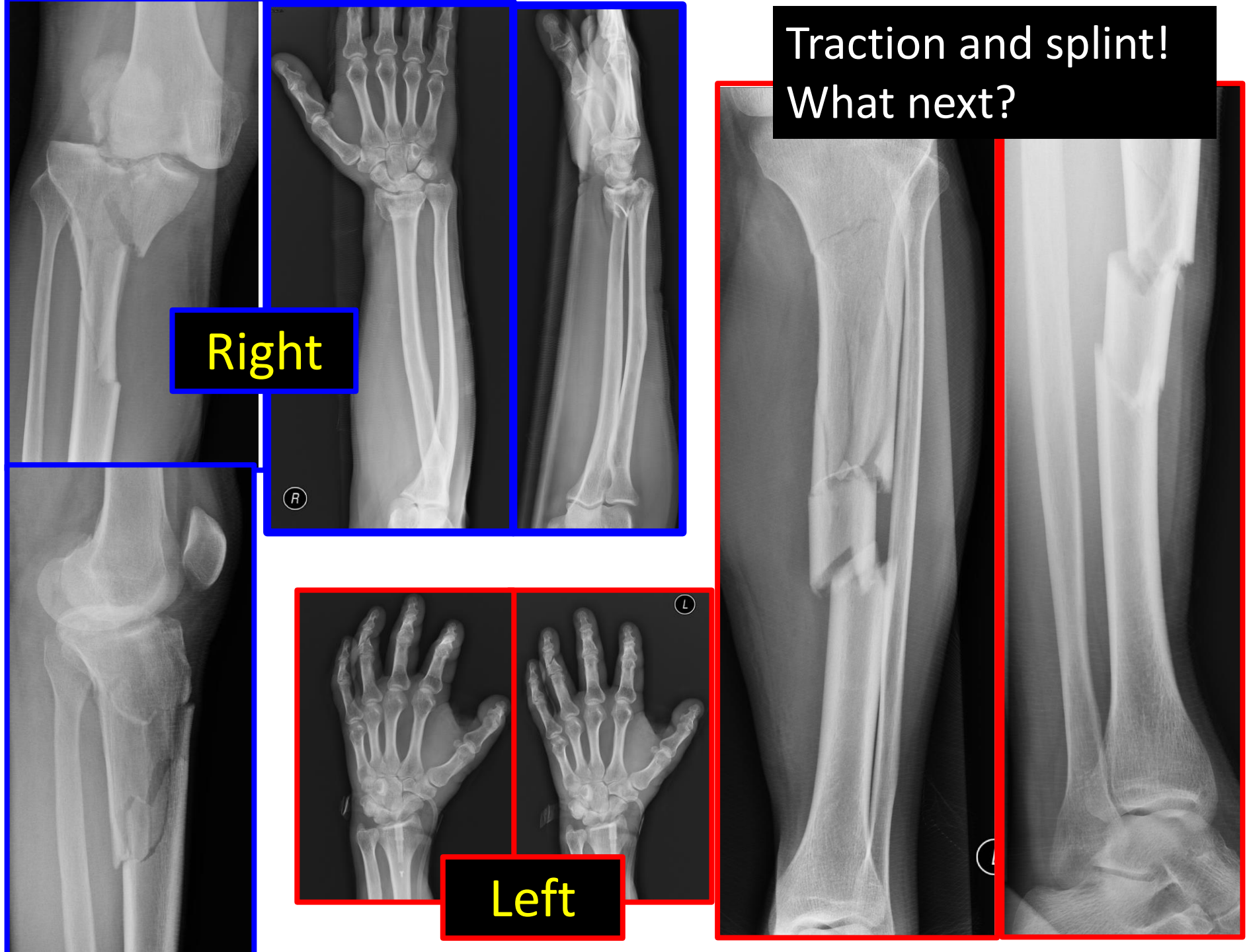


Is there any role of this total body scan in multiple-trauma patient if this facility is available?

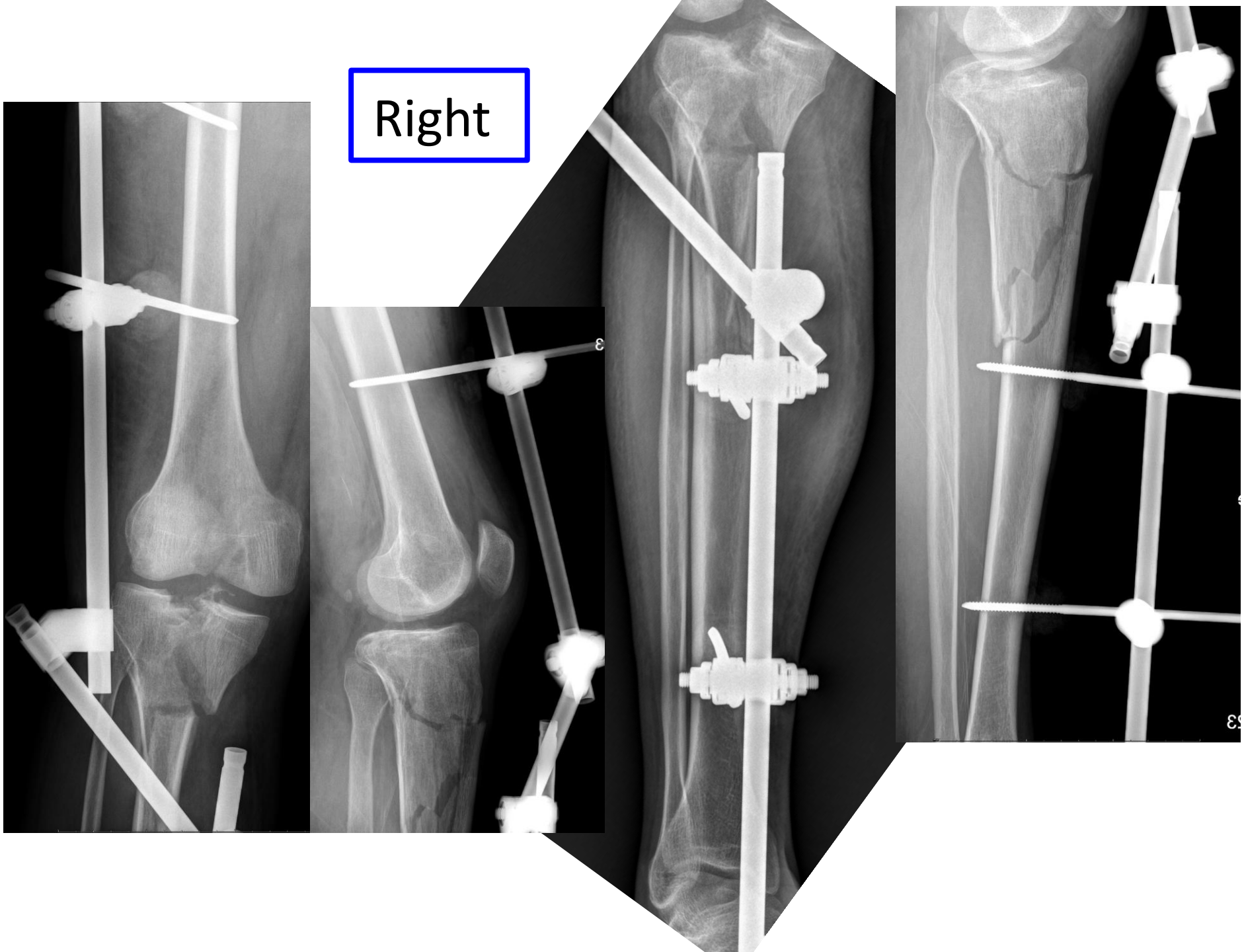
What will you do for fracture?






Traction and splint!
What next?
Right
Left

Right



Physiological status		Surgical intervention	Timing
Response to resuscitation	None	Life-saving surgery	Day 1
	Partial	Damage control	Day 1
	Normal	Early total care	Day 1
Hyperinflammation		"Second look" only!	Day 2–3
"Window of opportunity"		Definitive surgery	Day 5–10
Immunosuppression		No surgery	Day 12–21
Recovery		Secondary reconstructive surgery	Week 3 +

Take home messages

Trauma is a leading cause of death and disability, especially young patients

Multidisciplinary approach is needed to provide the best outcome

- Stable patients are safely managed by ETC
- A staged “damage control” concept should be strongly considered for the acute management of “borderline” patients, unstable patients, and patients “in extremis”

Thank you