LEVEL I TRAUMA UNIT
IALCH

UNIVERSITY OF KWAZULU-NATAL

HEALTH
KwaZulu-Natal

Ventilation of Severe Lung Contusion – More than ARDS.net

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Disclaimer

- All images are from my own practice at either IALCH or previously Tygerberg hospital unless otherwise mentioned
- Opinions are not necessarily those of my employer, SA Department of Health

Overview

- What do I mean by Severe Lung Contusion?
- What does ARDS.net suggest?
- Don't miss the fine-print!
- What about inflammation?
- Contralateral collateral damage
- Recruitability versus further lung injury
- What is our experience?

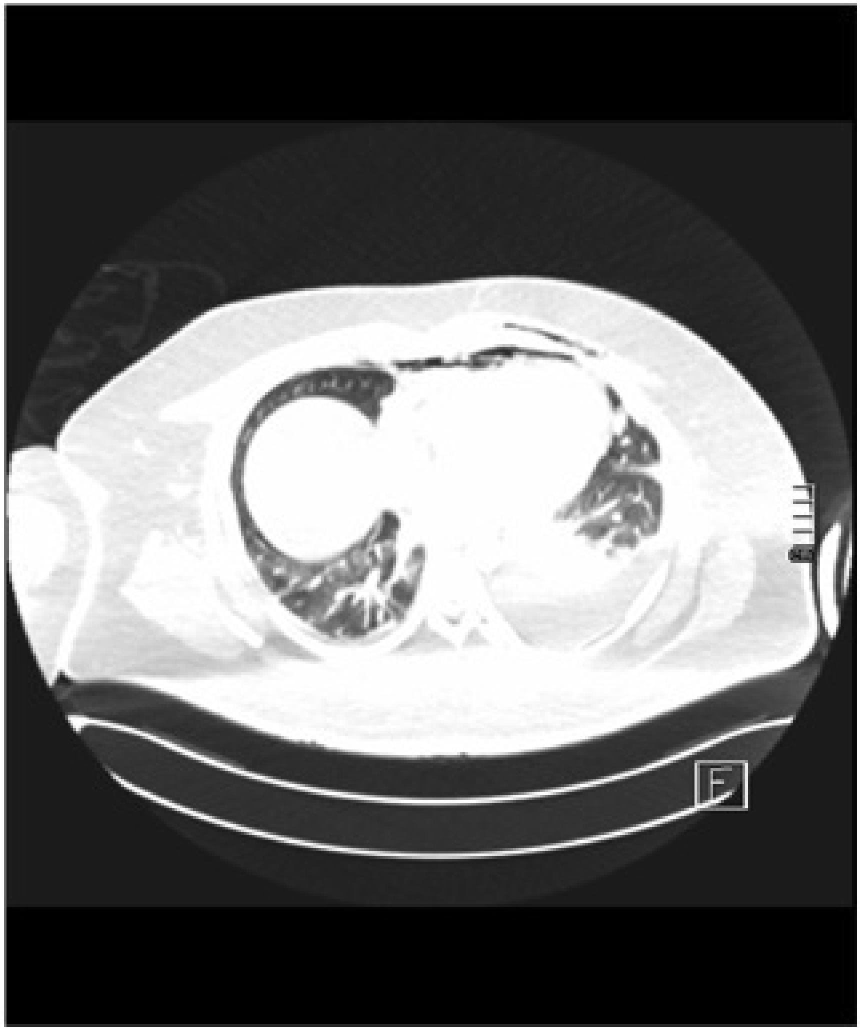
Spectrum and Burden of Disease

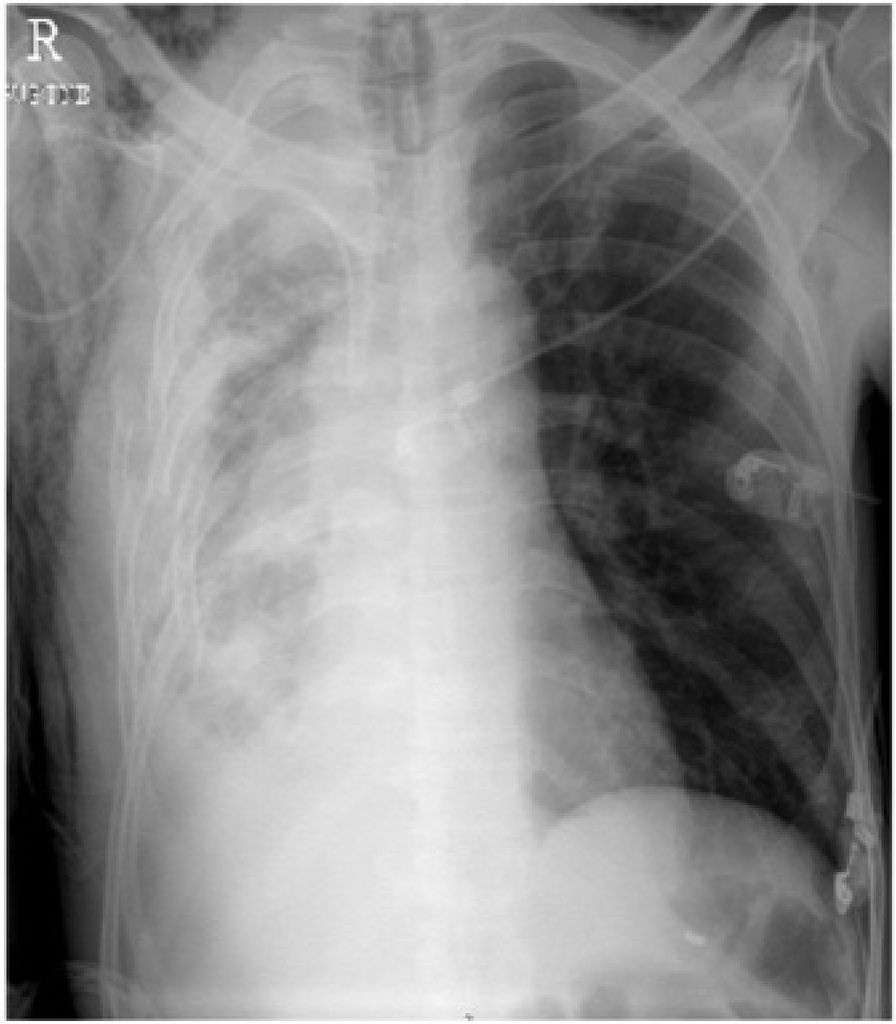
Blunt chest trauma common

- 20-30% of all major blunt trauma: Lung contusion
- Higher in adults with multiple rib # / Flail chest
- Commonest severe chest injury in children
- 25% of all trauma deaths due to chest trauma
- Up to 80% chance of pneumonia, 20% ARDS
- About 10 – 15% of this group is the severe injury subgroup
- Contributes to death from TBI due to hypoxia

Crit Care Med 2010; 38[Suppl.]:S469 –S477 / Trauma.org 2004

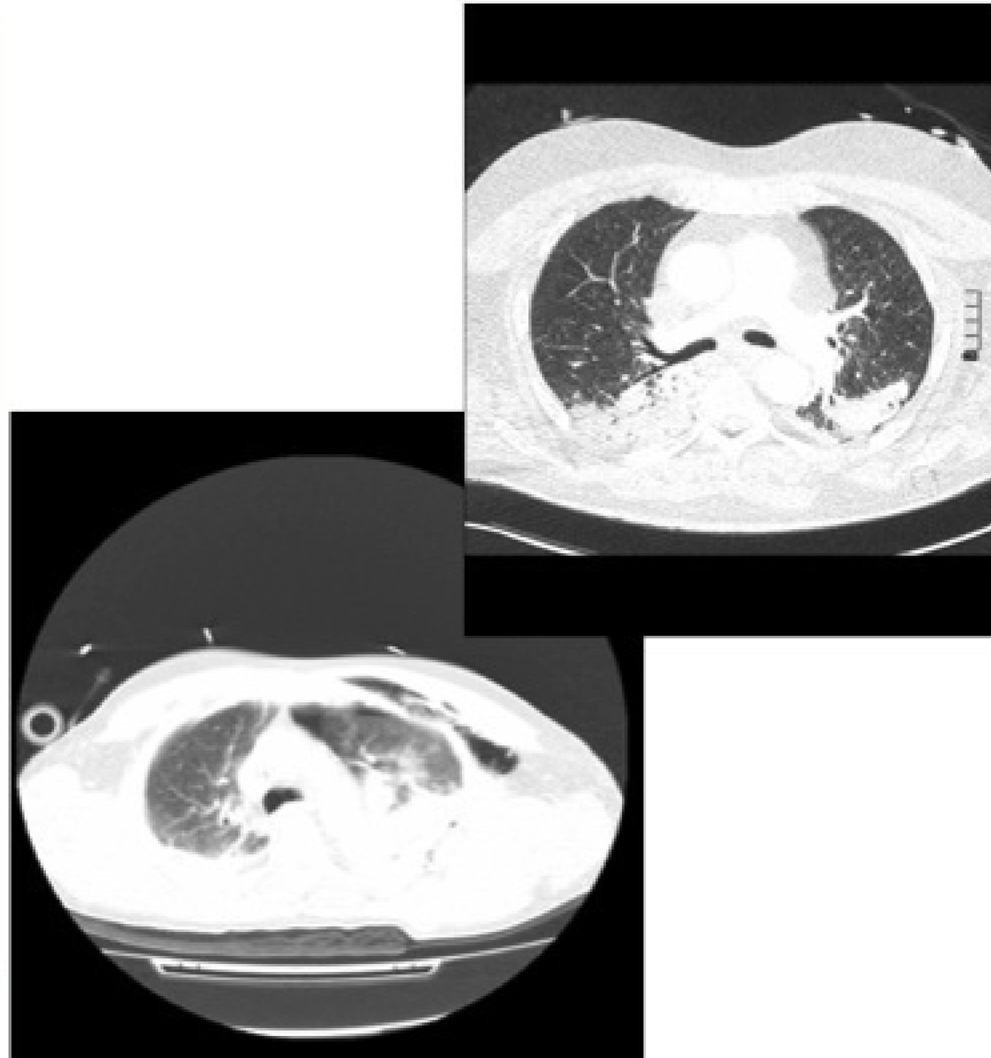
Severe chest trauma





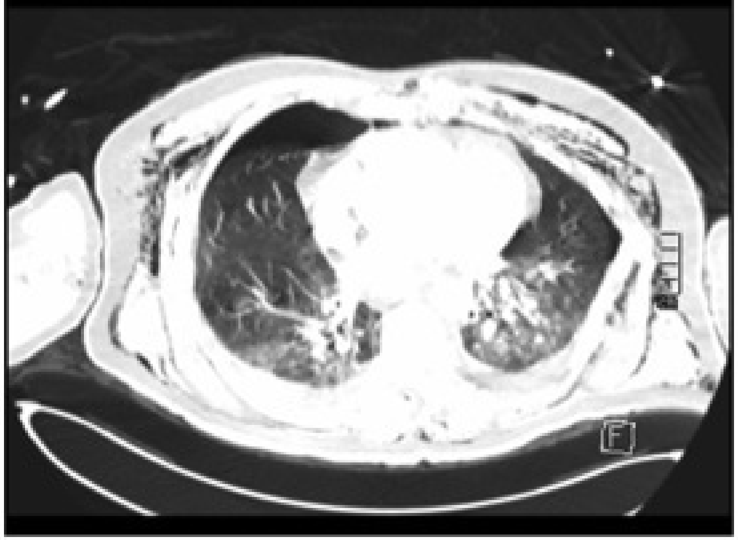
Mechanism of Injury

- Pulmonary contusion is a misnomer!
  - Actually shearing forces against the vertebral column
  - Intra-pulmonary lacerations with contained haemorrhage
  - Reason why it is postero-medial in blunt trauma!



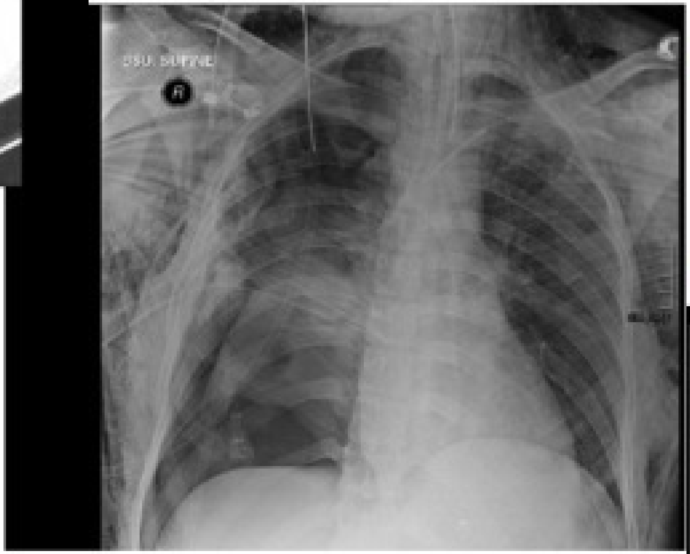
Diagnosis

- CXR under-diagnosis common
- CT Chest is current gold standard (lung window)
  – Allows arch and mediastinum to be reviewed
  – Picks up occult PTX/HTX
  – Can be used to do volumetry

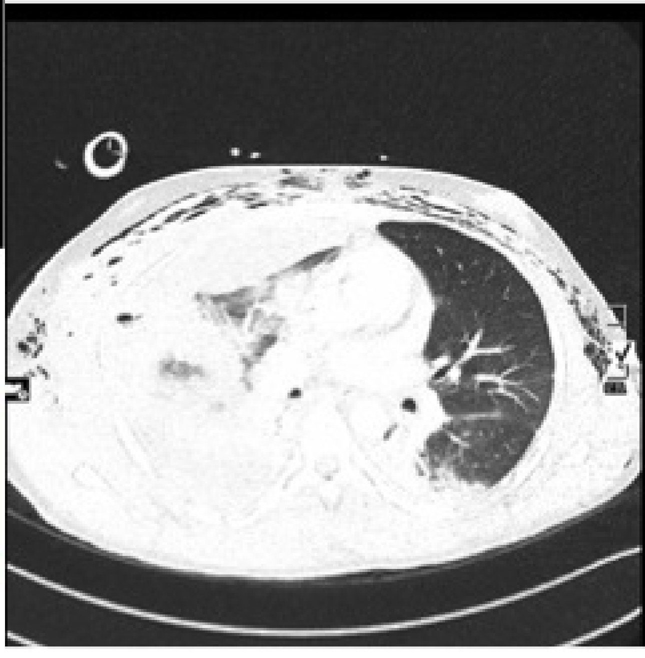


Severity

Minor <20% Volume



Moderate <30% Volume with hypoxia



Severe >30% LSA with PO2 < 8kPa / 60mmHg

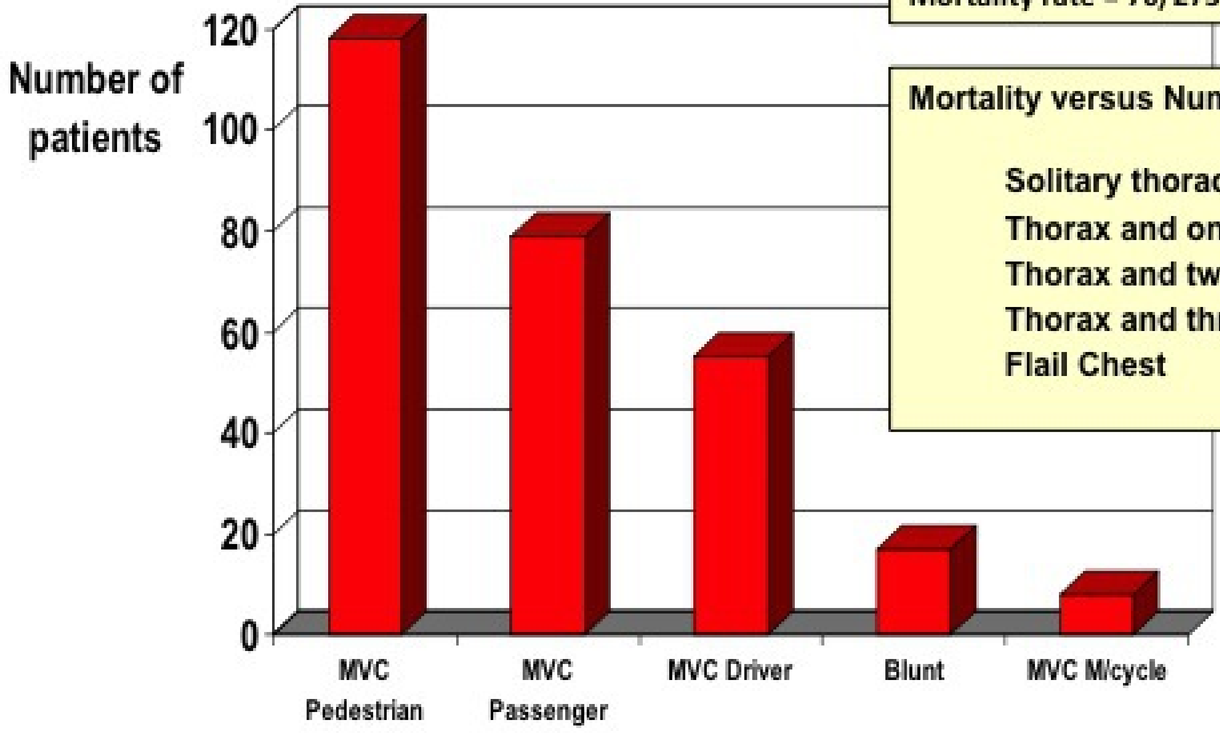
Blunt Thoracic Trauma

IALCH Trauma Unit 2007 - 2011

Chest injury in 275/756 blunt trauma admissions (36%)

Isolated chest injury in only 33/275 (12%)

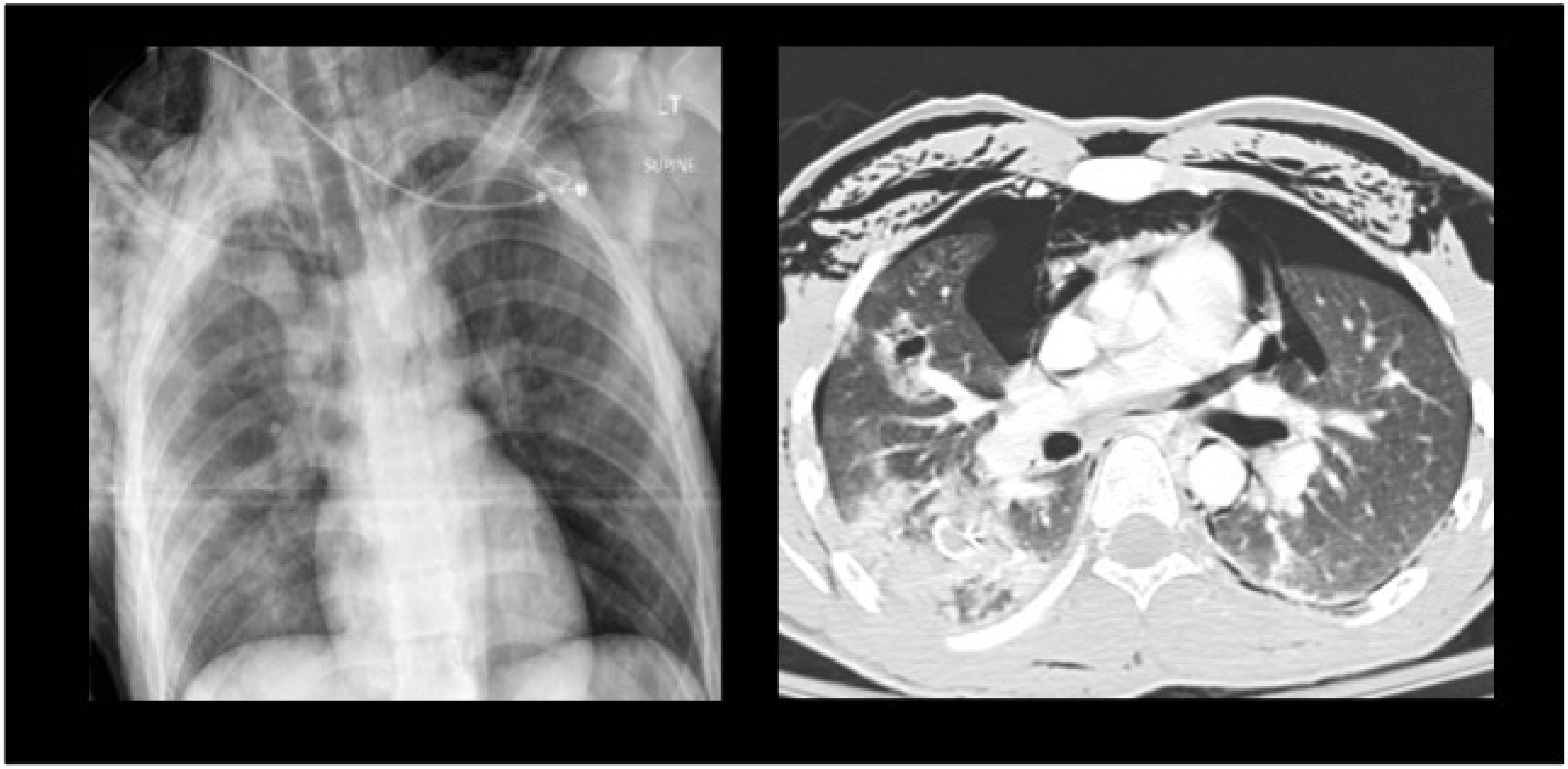
Mortality rate = 76/275 (28%)



Mortality versus Number of Injured Compartments

Solitary thoracic injury	18%
Thorax and one other	25%
Thorax and two other	29%
Thorax and three other	35%
Flail Chest	47%

Pitfalls with Severe Lung Contusion



ARDS.net Teaching

- FOR ARDS
  - PF Ratio <300!
- Limit plateau pressures to <35mmHg
  - Delta P more important???
- Tidal volumes around 6ml/kg
- Rate up to 35!

- PEEP adjust to reduce F1O2
  - Quite high values
- No mode of ventilation better than another
- I:E ratio – ideally 1:2 or greater
- Start @ 8ml/kg!!!!
- Aim for SBT

What about the fine print?

Conduct a SPONTANEOUS BREATHING TRIAL daily when:

1. $FiO_2 \leq 0.40$ and PEEP ≤ 8.
2. PEEP and $FiO_2 \leq$ values of previous day.
3. Patient has acceptable spontaneous breathing efforts. (May decrease vent rate by 50% for 5 minutes to detect effort.)
4. Systolic BP ≥ 90 mmHg without vasopressor support.
5. No neuromuscular blocking agents or blockade.

If all above criteria are met and subject has been in the study for at least 12 hours, initiate a trial of UP TO 120 minutes of spontaneous breathing with FiO2 ≤ 0.5 and PEEP ≤ 5:

1. Place on T-piece, trach collar, or CPAP ≤ 5 cm H_2O with PS ≤ 5
2. Assess for tolerance as below for up to two hours.
   a. $SpO_2 \geq 90$: and/or $PaO_2 \geq 60$ mmHg
   b. Spontaneous $V_T \geq 4$ ml/kg PBW
   c. RR $\leq$ 35/min
   d. pH $\geq$ 7.3
   e. No respiratory distress (distress= 2 or more)
      - HR > 120% of baseline
      - Marked accessory muscle use
      - Abdominal paradox
      - Diaphoresis
      - Marked dyspnea
3. If tolerated for at least 30 minutes, consider extubation.
4. If not tolerated resume pre-weaning settings.

What about NIV?

Applicable, in principle, to a patient that is:

- Conscious and cooperative
- Maintaining an airway
- Haemodynamically stable
- Not needing immediate surgery

Shows less pneumonia and shorter ICU LOS

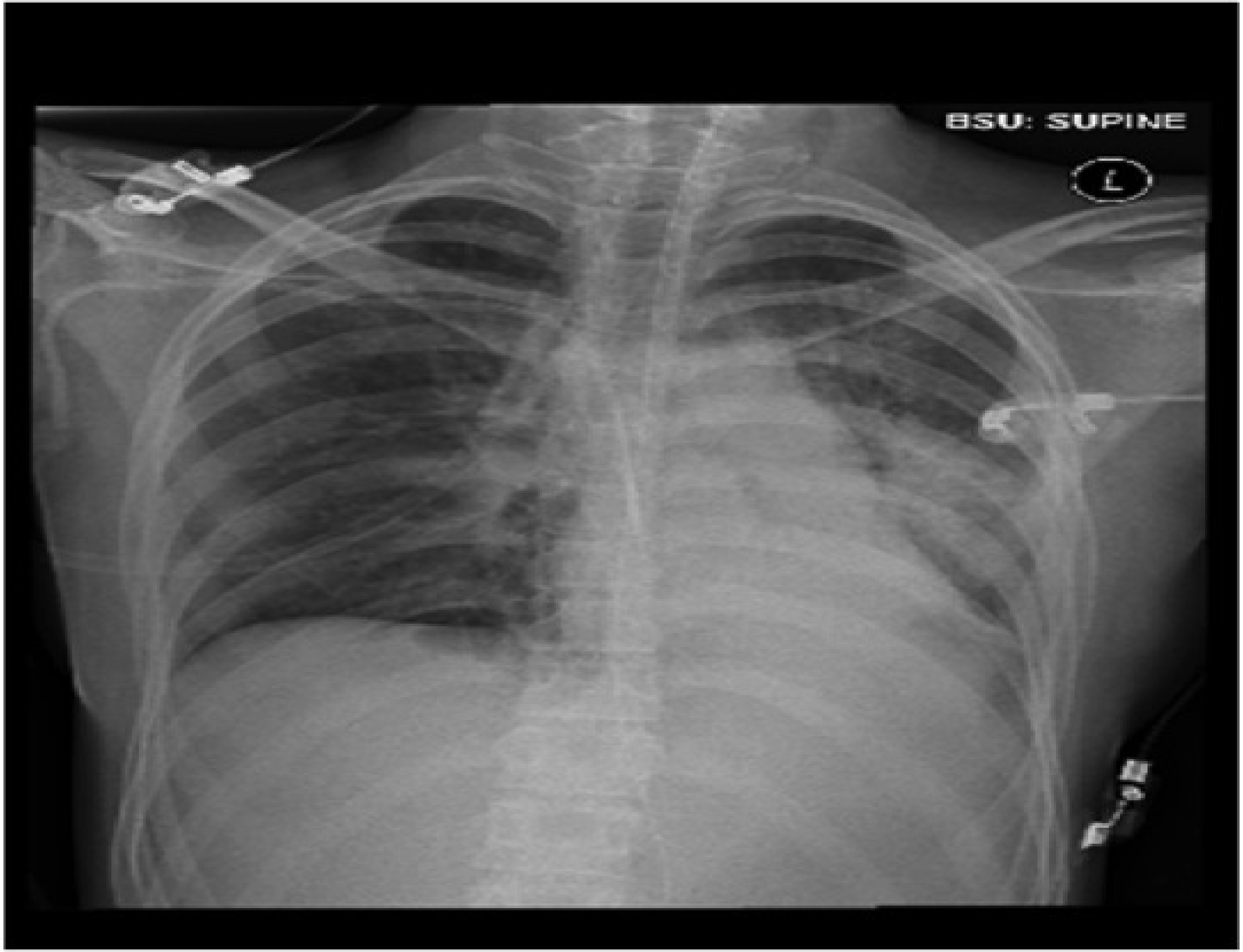
BUT…….

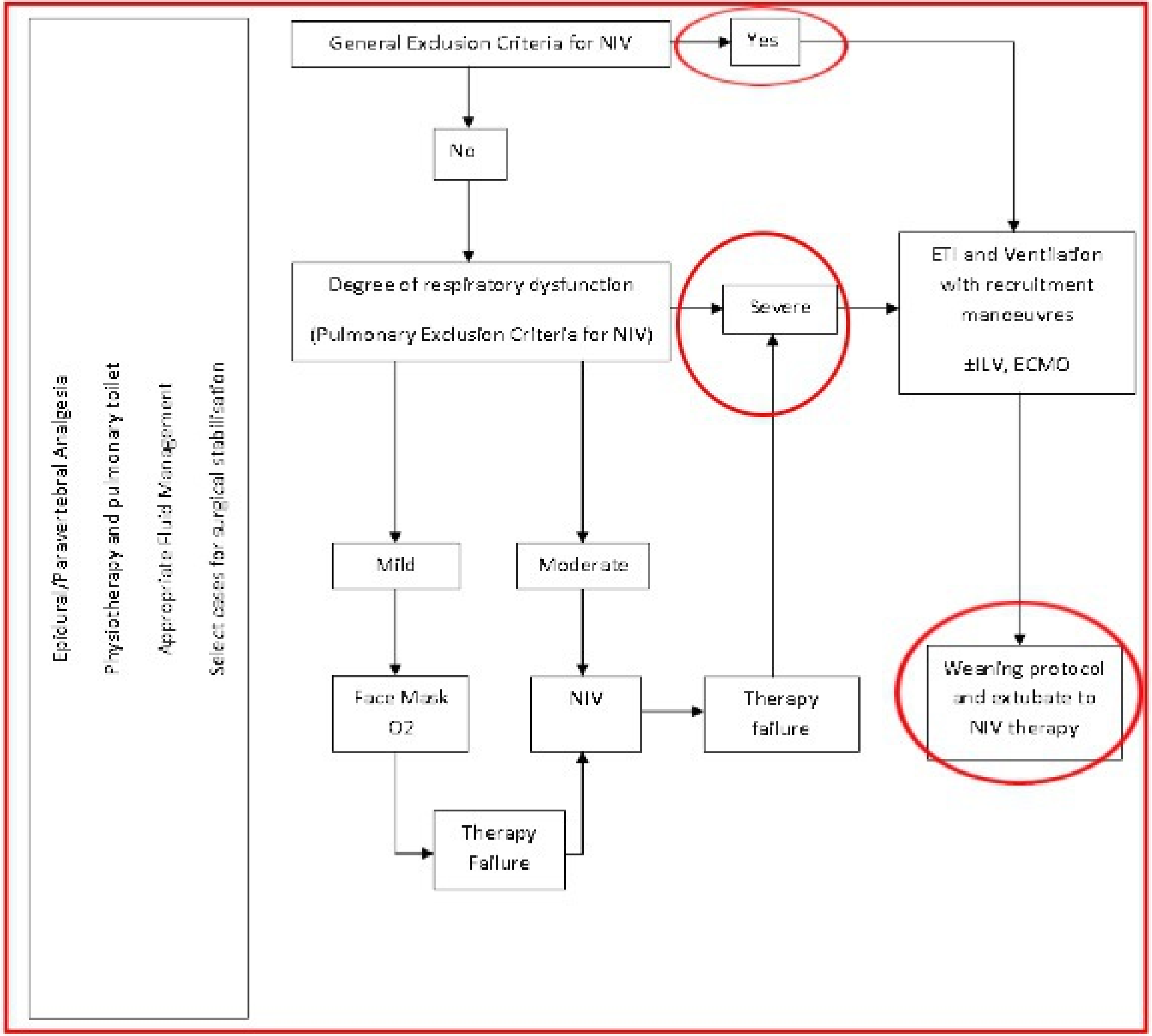
Severe lung contusion excluded in most studies*

*Bolliger and Van Eeden Chest ,1990; 97:943-948

Hernandez G, Fernandez R, Lopez-Reina P, Cuena R, Pedrosa A, Ortiz R, Hiradier P. Noninvasive Ventilation reduces intubation in chest trauma-related hypoxemia. A Randomized Clinical Trial. Chest 2010; 137(1):74–80

NIV Candidate




Epidural/Paravertebral Analgesia
Physiotherapy and pulmonary toilet
Appropriate Fluid Management
Select cases for surgical stabilisation
General Exclusion Criteria for NIV
Yes
No
Degree of respiratory dysfunction
(Pulmonary Exclusion Criteria for NIV)
Severe
ETI and Ventilation with recruitment manoeuvres
±ILV, ECMO
Mild
Moderate
Face Mask O2
NIV
Therapy failure
Weaning protocol and extubate to NIV therapy
Therapy Failure

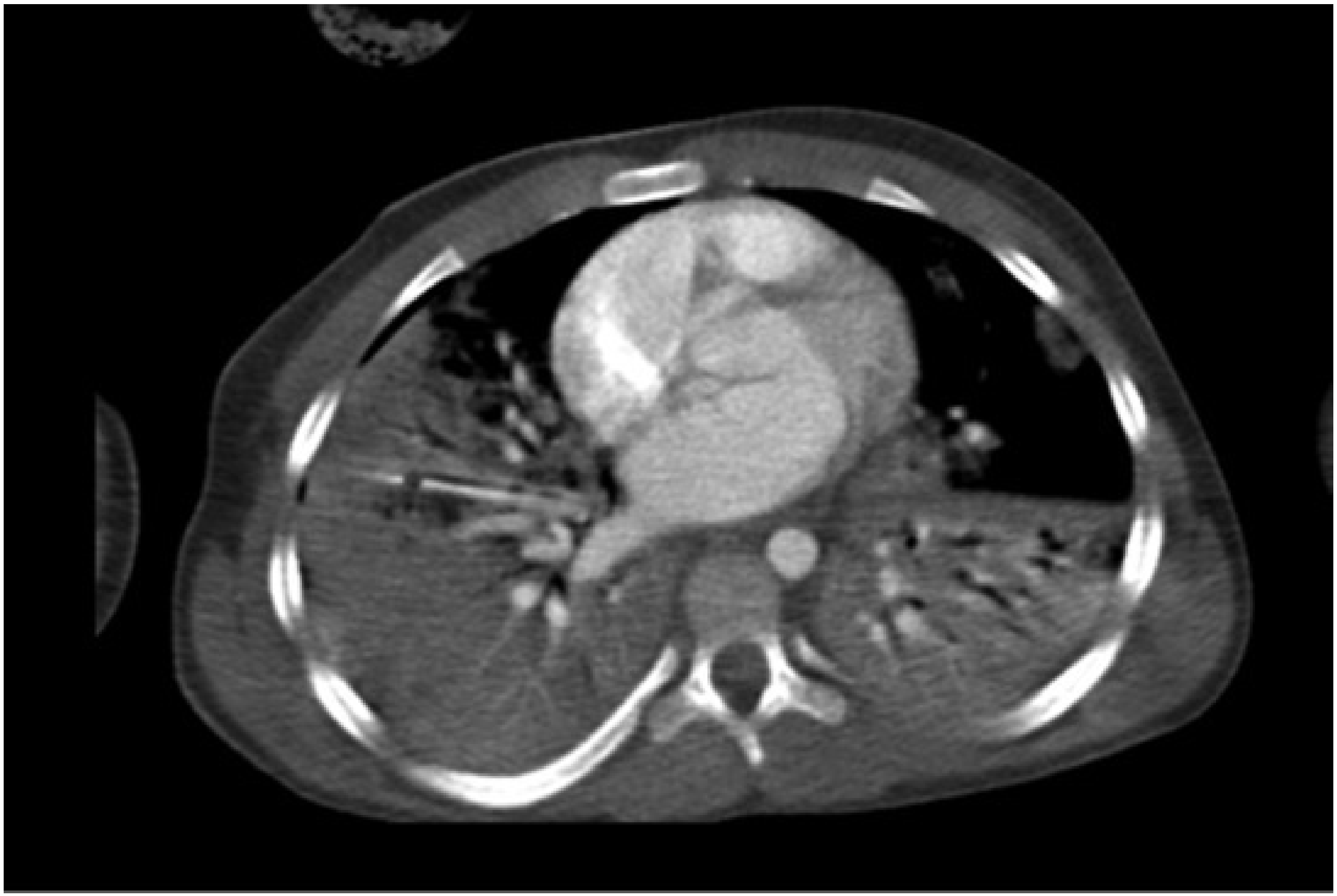
Exclusion Criteria

1) hypercapnia (Pa co 2 . 45 mm Hg)
2) orotracheal intubation indicated for another reason;
3) need for emergency intubation;
4) standard contraindications for NIMV (active gastrointestinal bleeding, low level of consciousness, multiorgan failure, airway patency problems, lack of cooperation, or hemodynamic instability);
5) severe traumatic brain injury;
6) facial trauma with pneumocephalus, skull base fracture, orbit base fracture, or any facial fracture involving a sinus;
7) cervical injury when treatment contraindicated a facial mask;
8) bronchopleural fistula;
9) gastrointestinal trauma

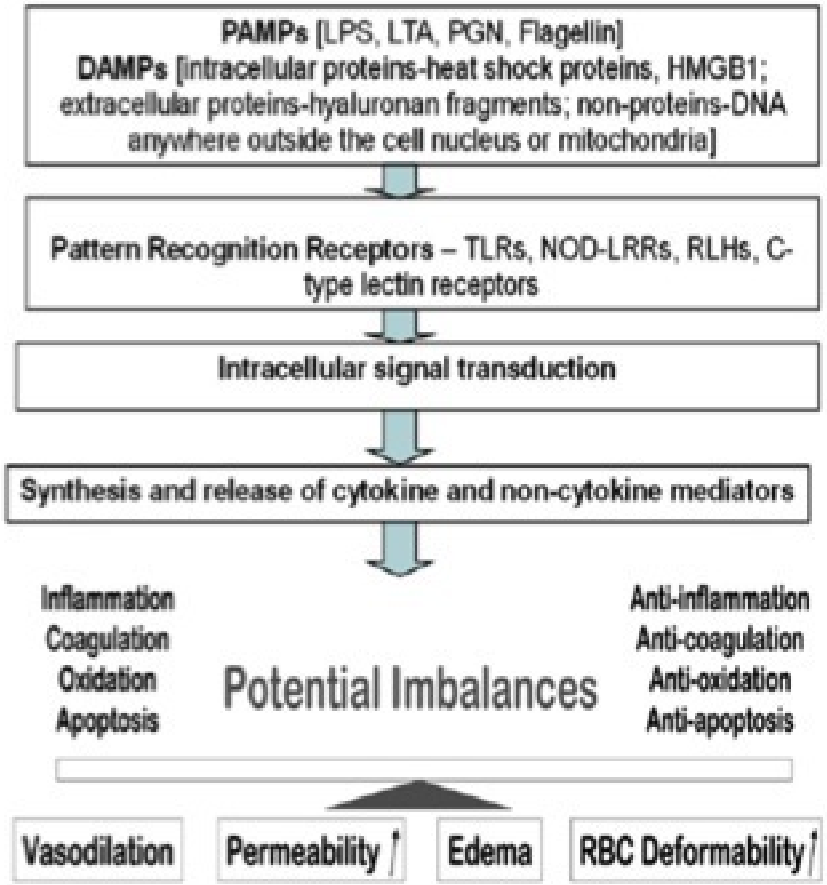
What about severe chest trauma?

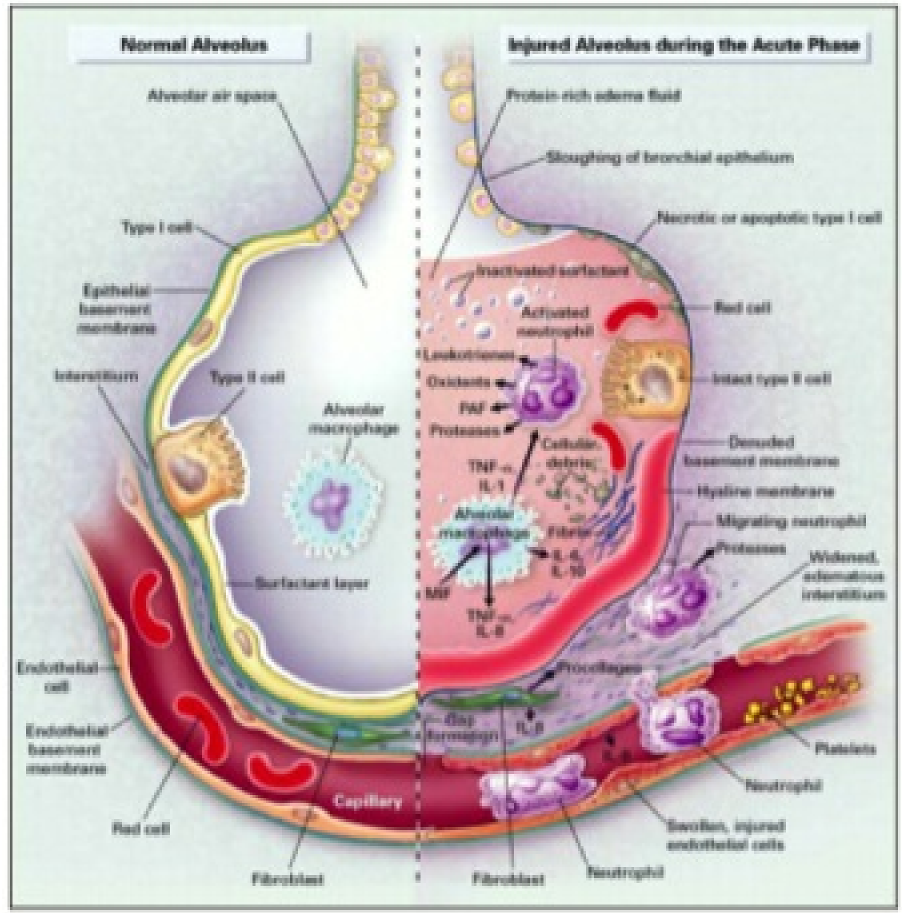
While there is a risk of ARDS – lung contusion is NOT ARDS

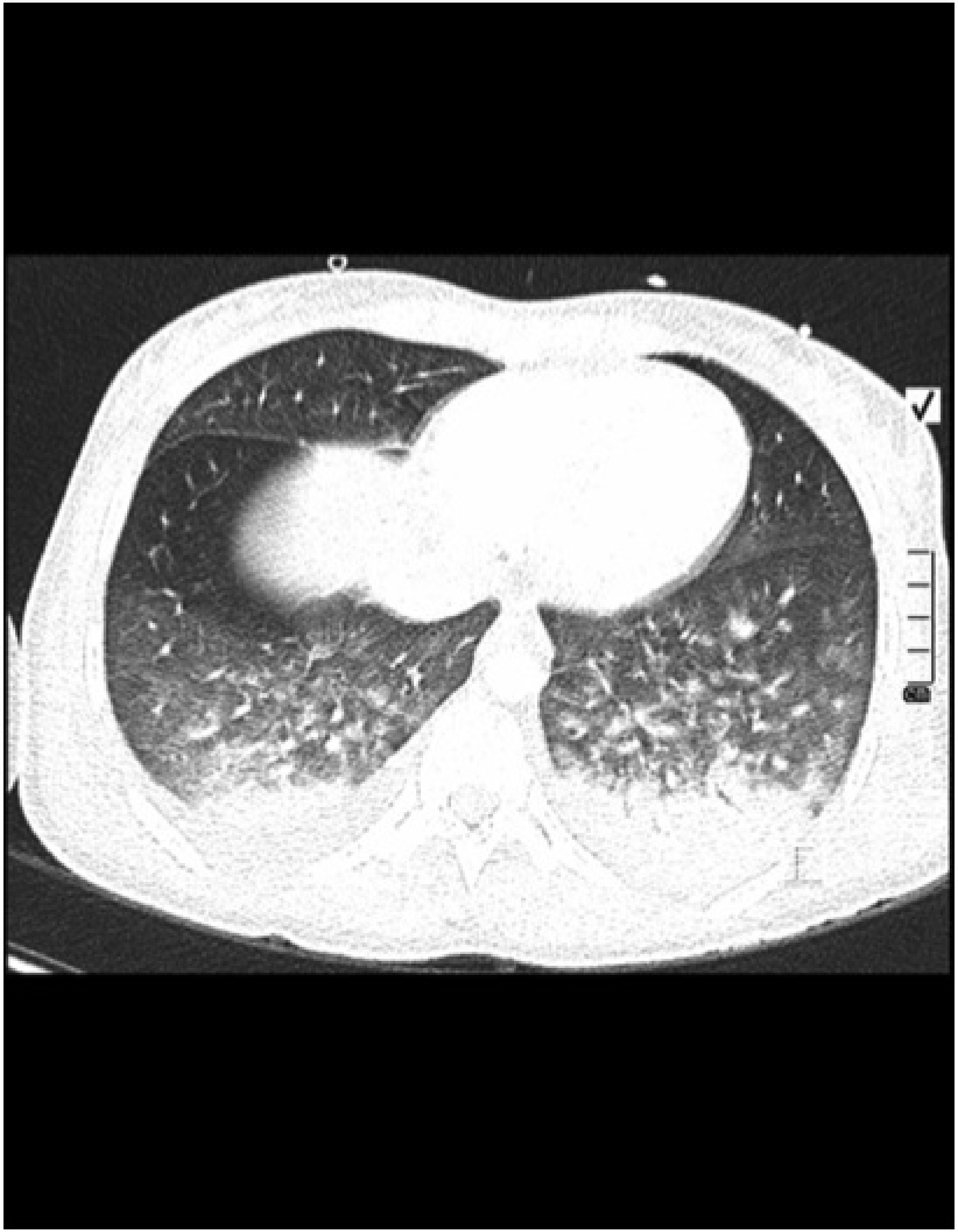
- Differences:
  - Variable areas of damage
  - Inflammatory component
  - BCI
  - Recruitable lung
  - Rib fractures add additional risk
    - Occult HTX & PTX common – may need chest tubes



DAMPS, PAMPS and other "kines"







Role of DAMPS and PAMPS

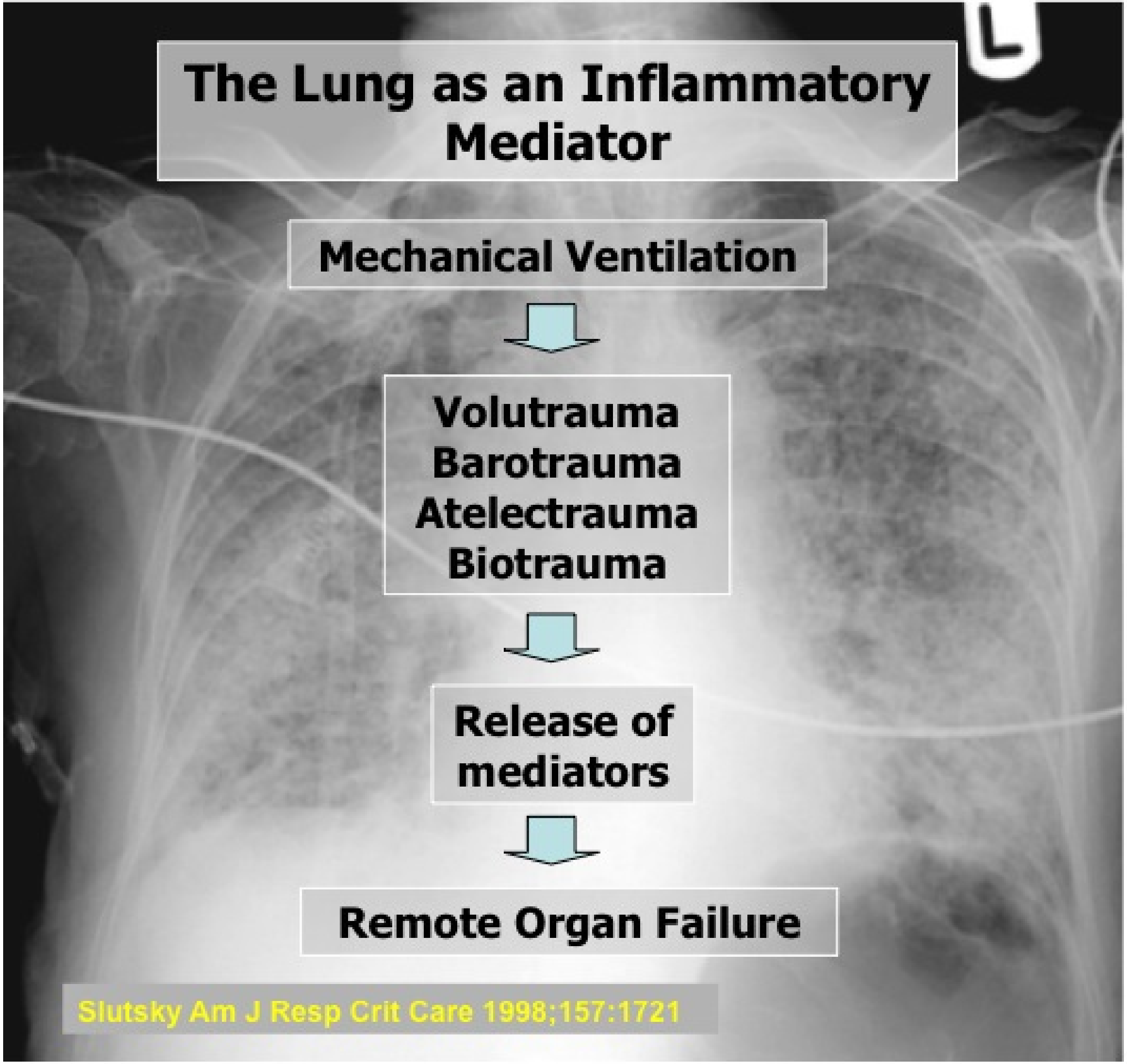
- Pathogen associated molecular patterns
- Alarmins are endogenous initiators
  - HMGB1 – trigger for inflammation

Molecule	Passive release[a]	Active nonclassical secretion	Role in inflammation/ immunity	Promoting tissue regeneration
HMGB1	•	•	•	•
S100s		•	•	1
HDGF	•	•		2
HSPs		•	•	
IL-1a		•	•	
Uric acid			•	
Cathelicidins		3	•	•
Defensins		3	•	
EDN		3	•	
Galectins		•	•	
Thymosins			•	•
Nucleolin		•	•	
Annexins		•	•	

DAMPs, PAMPs and alarmins: all we need to know about danger

Journal of Leukocyte Biology Volume 81, January 2007

Marco E. Bianchi[1]
San Raffaele University, Chromatin Dynamics Unit, Milan, Italy


L
The Lung as an Inflammatory Mediator
Mechanical Ventilation
Volutrauma
Barotrauma
Atelectrauma
Biotrauma
Release of mediators
Remote Organ Failure
Slutsky Am J Resp Crit Care 1998;157:1721

Contralateral Collateral Damage

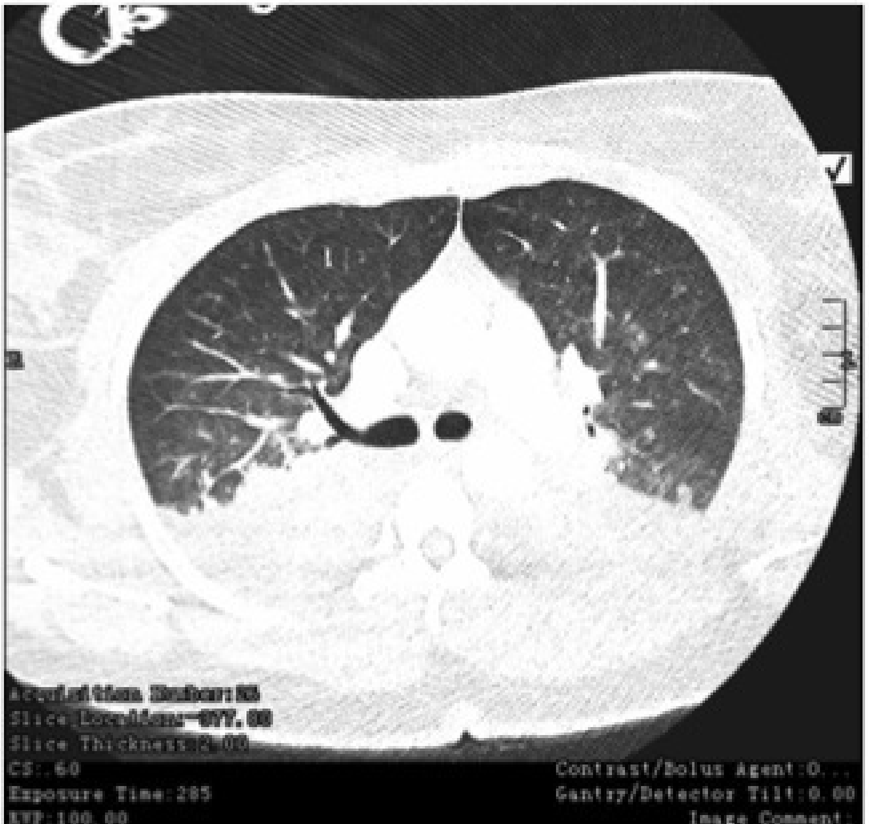
- Inflammatory reaction systemic
- Spillover during airway and pulmonary toilet
- Unappreciated pre-hospital gastric aspiration*
- Gets worse before it gets better[$]
  - Overlooked in the orthopaedic ward!

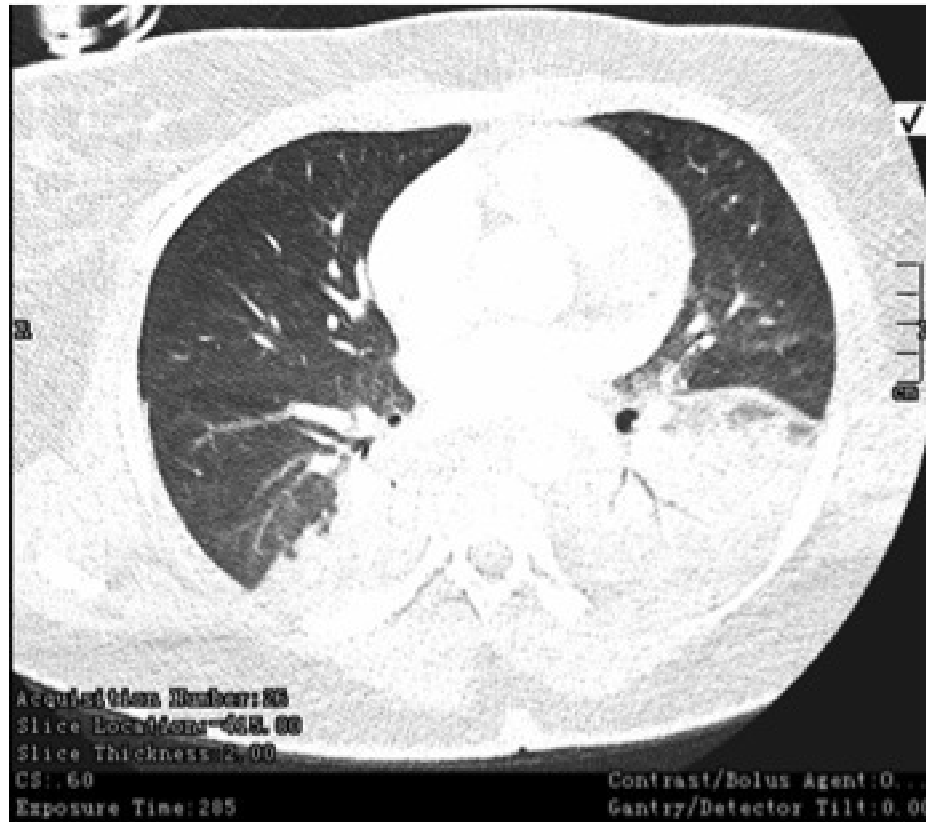
*Raghavendran, Shock. Nov 2008; 30(5): 508–517.
[$] Obertacke - Abstract in Shock, 1998

Curveballs – previous lung pathology

Aspiration or contusion?

- Lobar





What about the kids?

- 6 year period 418 patients with blunt thoracic trauma
  - 84 children of whom 55 were less than ten years old.
    - fewer males in the paediatric group.
    - Injury Severity Scores (ISS) were similar
    - Presentation lactate was significantly lower in the paediatric population ($p = 0.001$)
- 75% pedestrian MVC
- Mortality significantly lower in the paediatric group (16.7 vs. 27.8% $p = 0.037$) despite worse lung contusion
- LOS similar
- Deaths mainly due to TBI ($p = 0.024$), but not the lungs

Daan Den Hollander – IALCH Trauma Service (in review SAMJ)

ITACCS approach

ITACCS
GUIDELINES FOR MANAGEMENT OF MECHANICAL VENTILATION IN CRITICALLY INJURED PATIENTS

M McCunn, MD, MIPP, (USA)
A Sutcliffe, MBChB, FRCA, (United Kindgdom)
W Mauritz, MD, PhD (Austria)
and the ITACCS Critical Care Committee*

- Early use of PEEP
- Gradual recruitment
- Use PSV modes and pressure limiting
- Permissive hyperpnoea unless TBI
- NIV is an option

- Tidal volumes 6 – 8 ml/kg
- PEEP higher than the lower inflection point
- Limit peak/plateau pressure to < 35 cm H2O
- Adjust I:E ratio and respiratory rate as needed to achieve above
- Wean FiO2 to obtain paO2 80 – 100 mm Hg (or an oxygenation saturation of 93 – 97%)
- Early conversion to pressure-limited modes of ventilation

Recruitment methods

- Traditional: So-called 40/40 maneuver
  - Cardiovascular side effects
  - Most patients did not tolerate
  - Short-lived effect
  - Requires chemical paralysis (GA)
- Modern approach: gradual PEEP and PSV increase to improve the Delta P
  - PEEP 10-12 and PSV 25-30: Plateau still <35mmHg

Recruitability and Ventilation (How I do it)

- We recruit with early use of slightly higher Vt
  - 8 to even 10ml/kg! Open lung concept.
- Early PEEP 1:5 ration with Fi02
- Pressure support / Pressure control
  - Aim to balance Vt with venous return
  - Reduce Fi02 as soon as able to maintain Sats > 92% or pO2 >8kPa
- Wean rapidly to PSV, use early tracheostomy

- Liberal use of chest tubes
- Early nutrition
- Aggressive physio
  - Vibration and suctioning
- IVI Morphine or Ketamine infusion if intubated
- Para-vertebral or epidural block with bupivicain if NIV

- Spontaneous breathing with PSV and PEEP may be prolonged: takes 5-7 days to reverse and a week or two more for the ribs to settle!