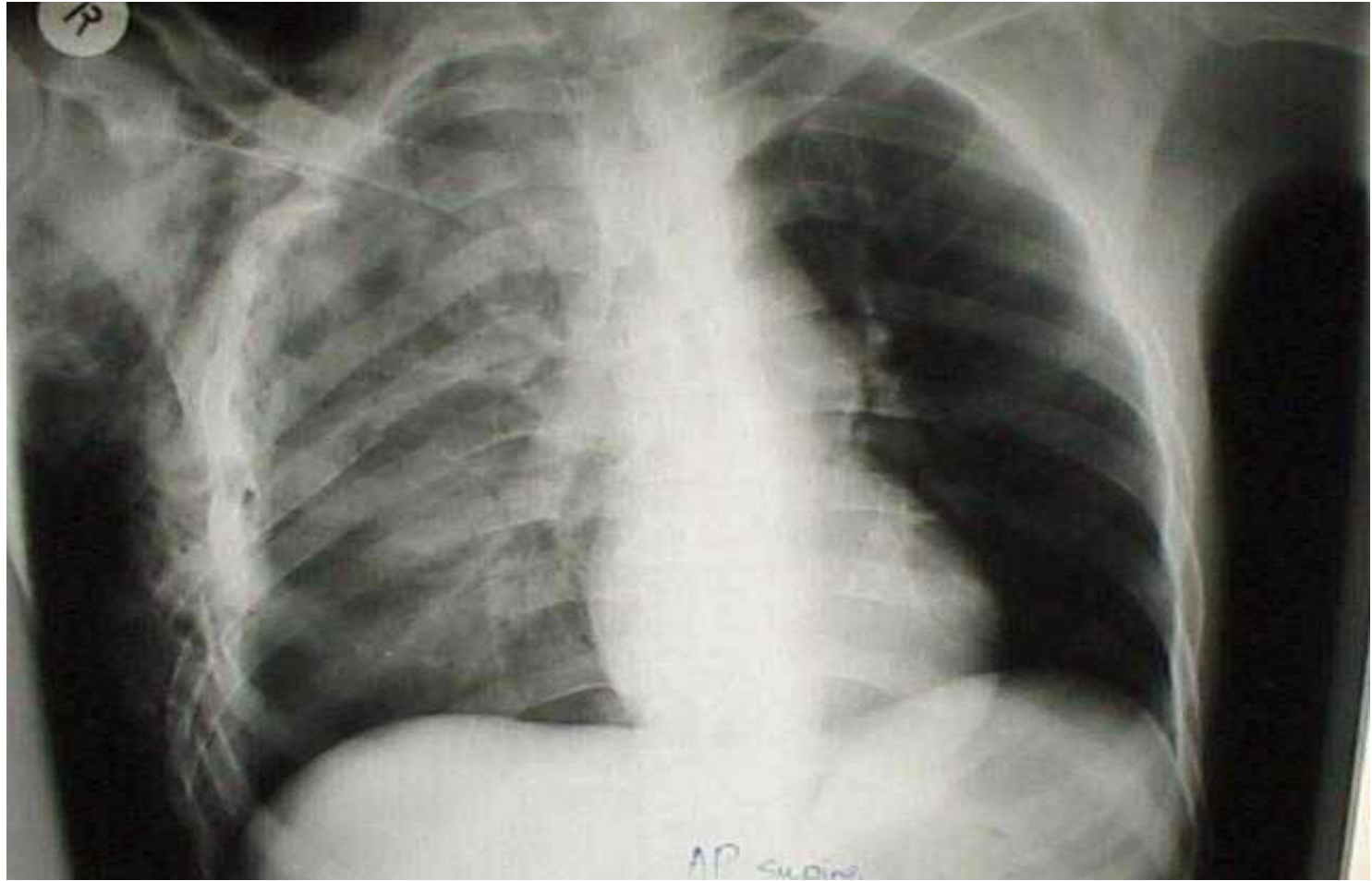




Management of the unventilatable Trauma Patient

Riaan Pretorius







Pathophysiology:

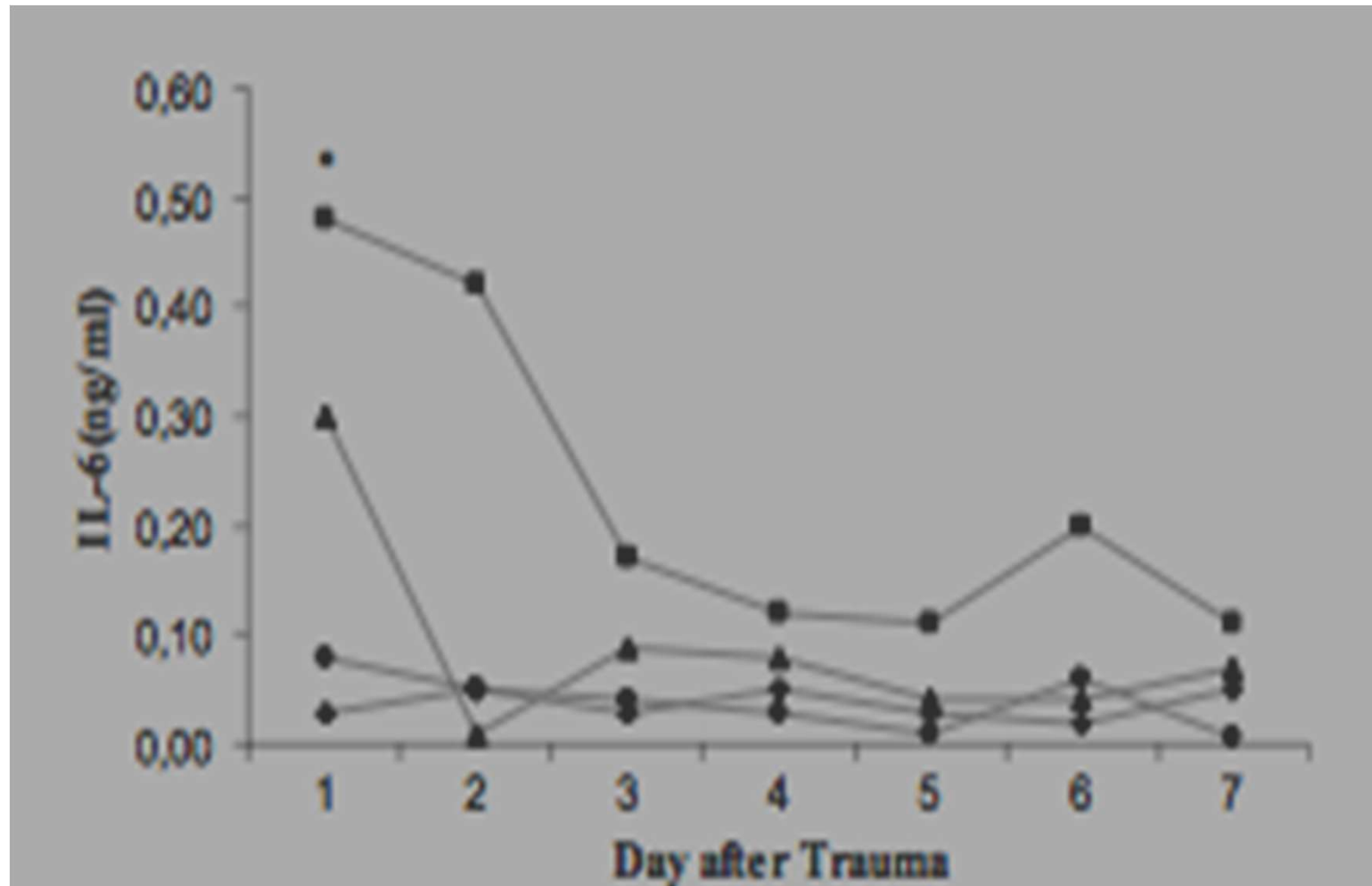
- Interstitial edema
- Hemorrhage
- Decreased lung compliance
- Airway inflammation
- Atelectasis
- ARDS

Pulmonary contusion:

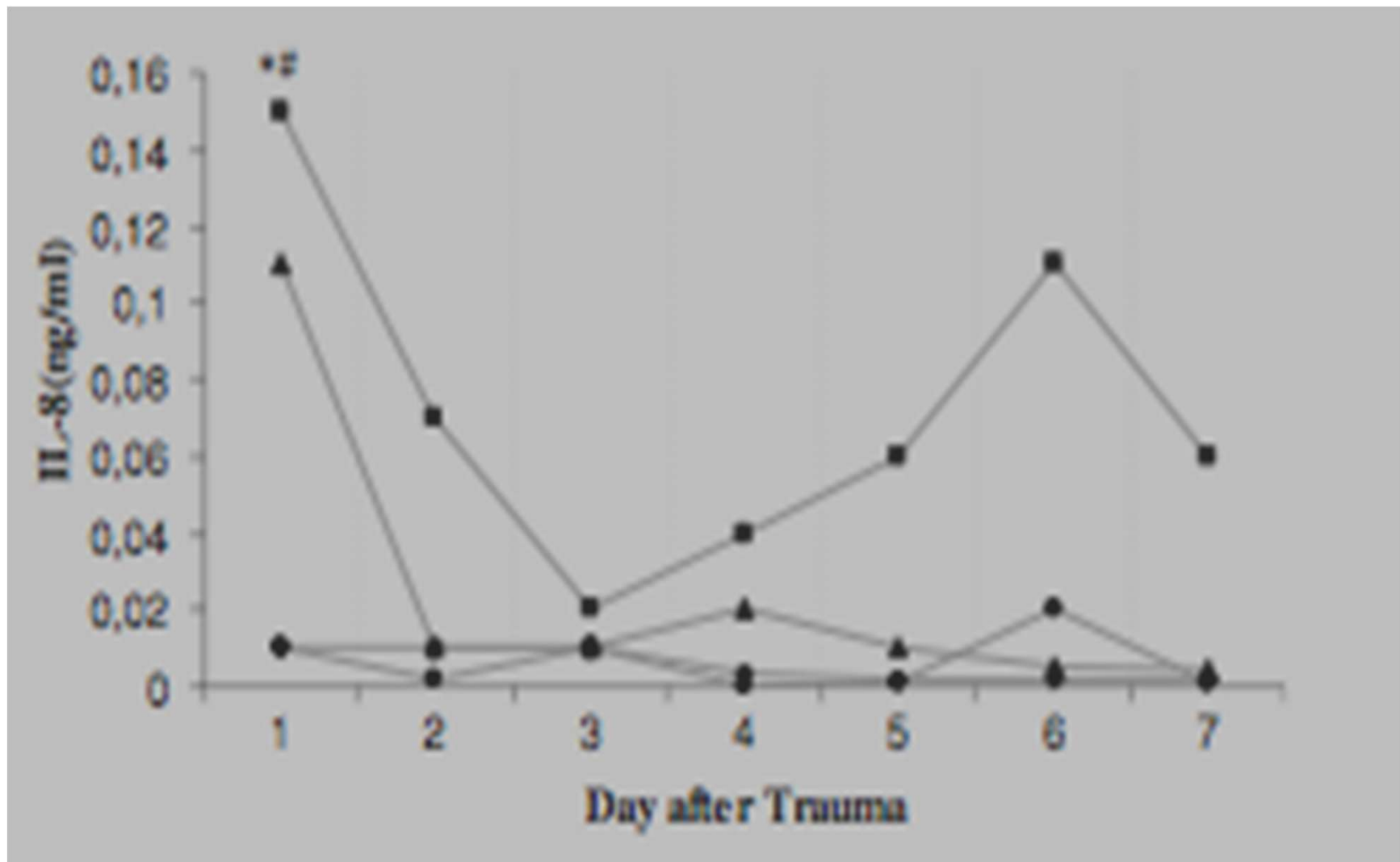
- High incidence of MOF
- 45 pst ISS score <25 and >25, minor and major pulmonary contusion (CT scan)
- Monitored IL-6, IL-8, CRP, PMN elastase, TNF, MLS and MOF score

Maier M, et al. Role of lung contusion and MOF in severely traumatized patients. Eur J Trauma Emerg Surg 2009. No 5: 463- 469

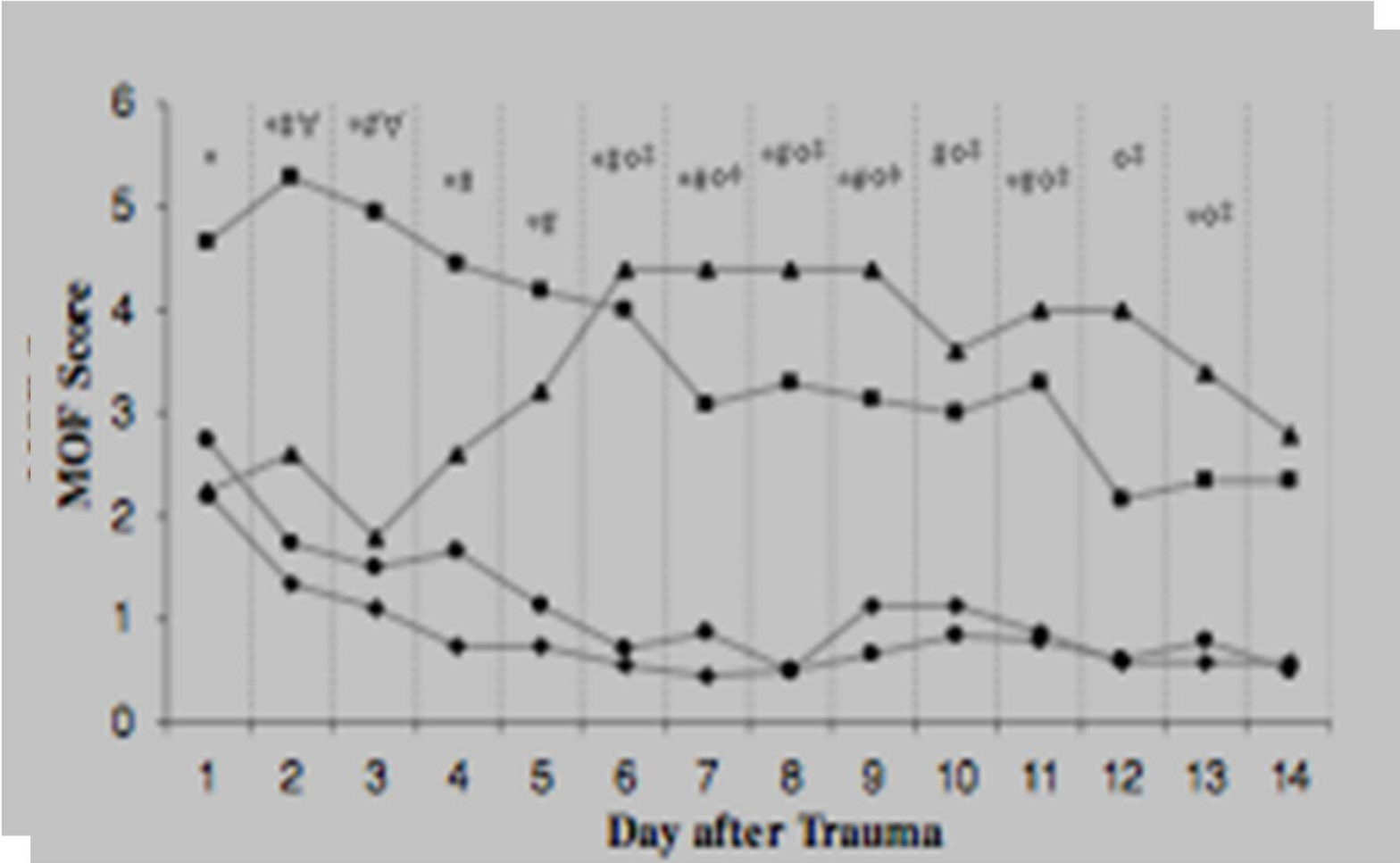
IL-6



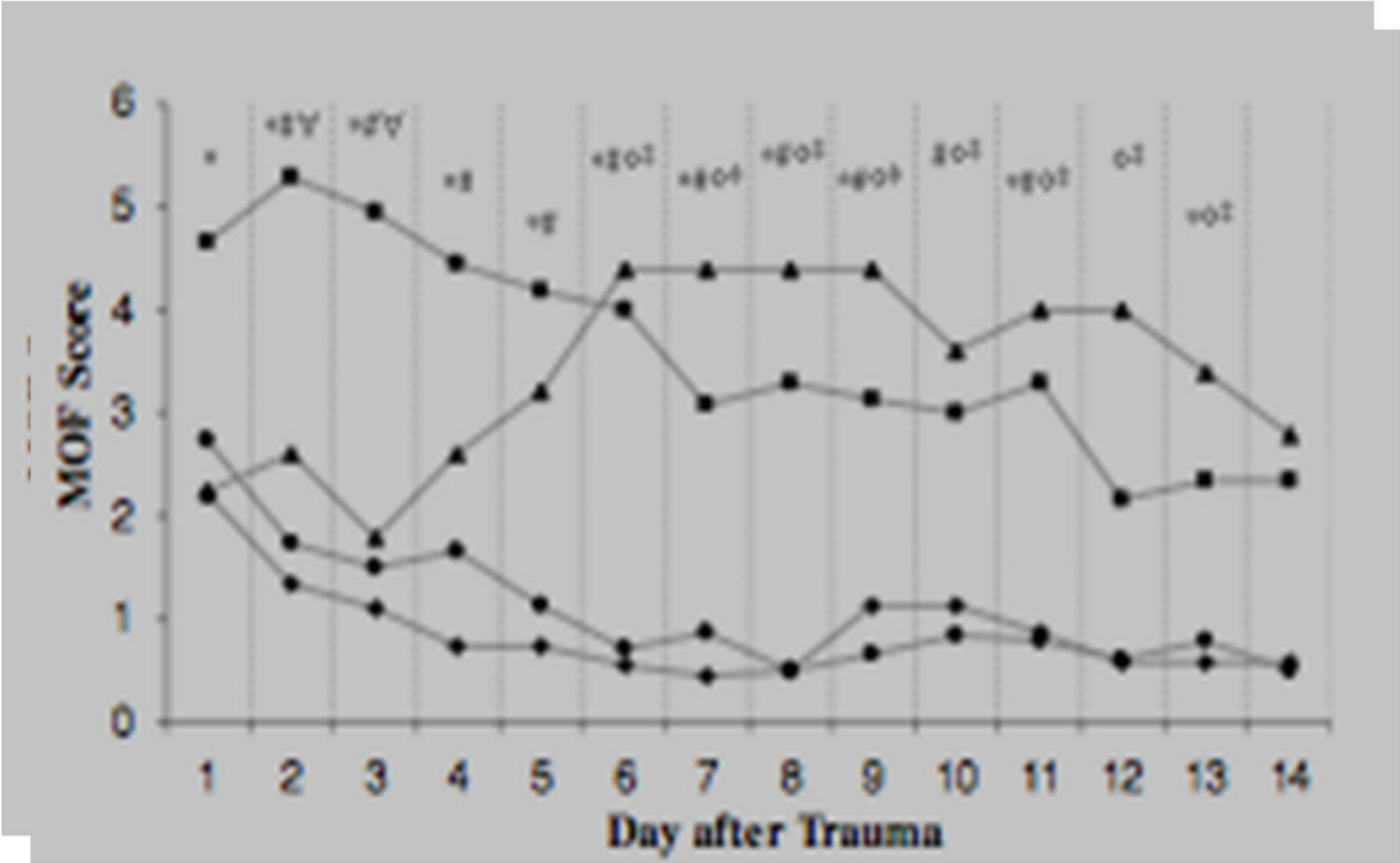
IL-8



MOF



MOF



Pathophysiology

- Low ISS – moderate inflammatory response irrespective of pulmonary contusion
- High ISS + severe pulmonary contusion
 - Higher MLS and MOF scores
- High ISS + mild pulmonary contusion
 - Similar MOFS and MLS only after day 5

Maier M, et al. Role of lung contusion and MOF in severely traumatized patients. Eur J Trauma Emerg Surg 2009. No 5: 463- 469



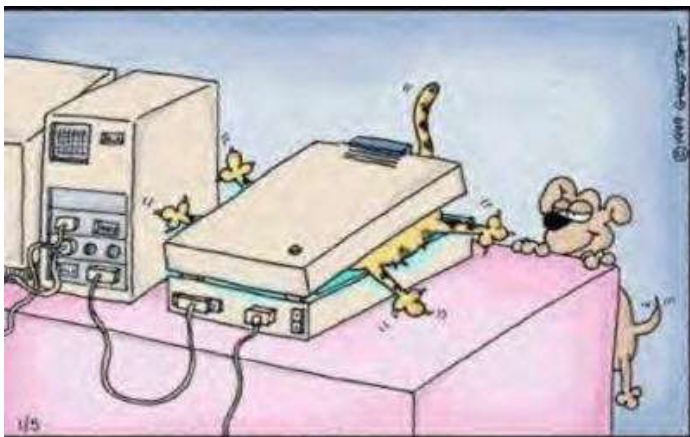
Pulmonary contusion:

- 25% of blunt trauma mortality
- 30 – 75% in blunt thoracic trauma
- Ventilatory support
- Very little change in morbidity and mortality



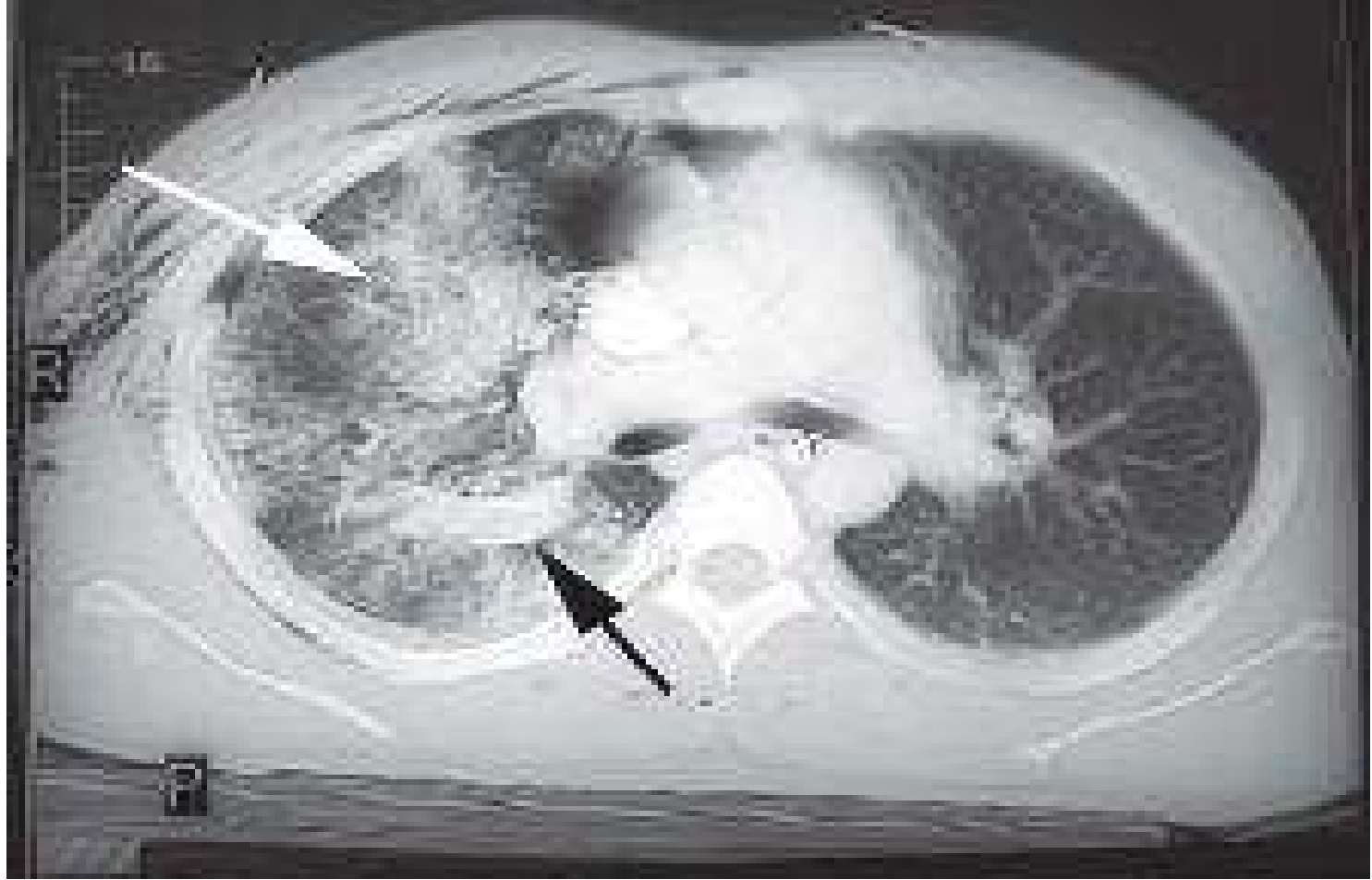
Longterm outcome

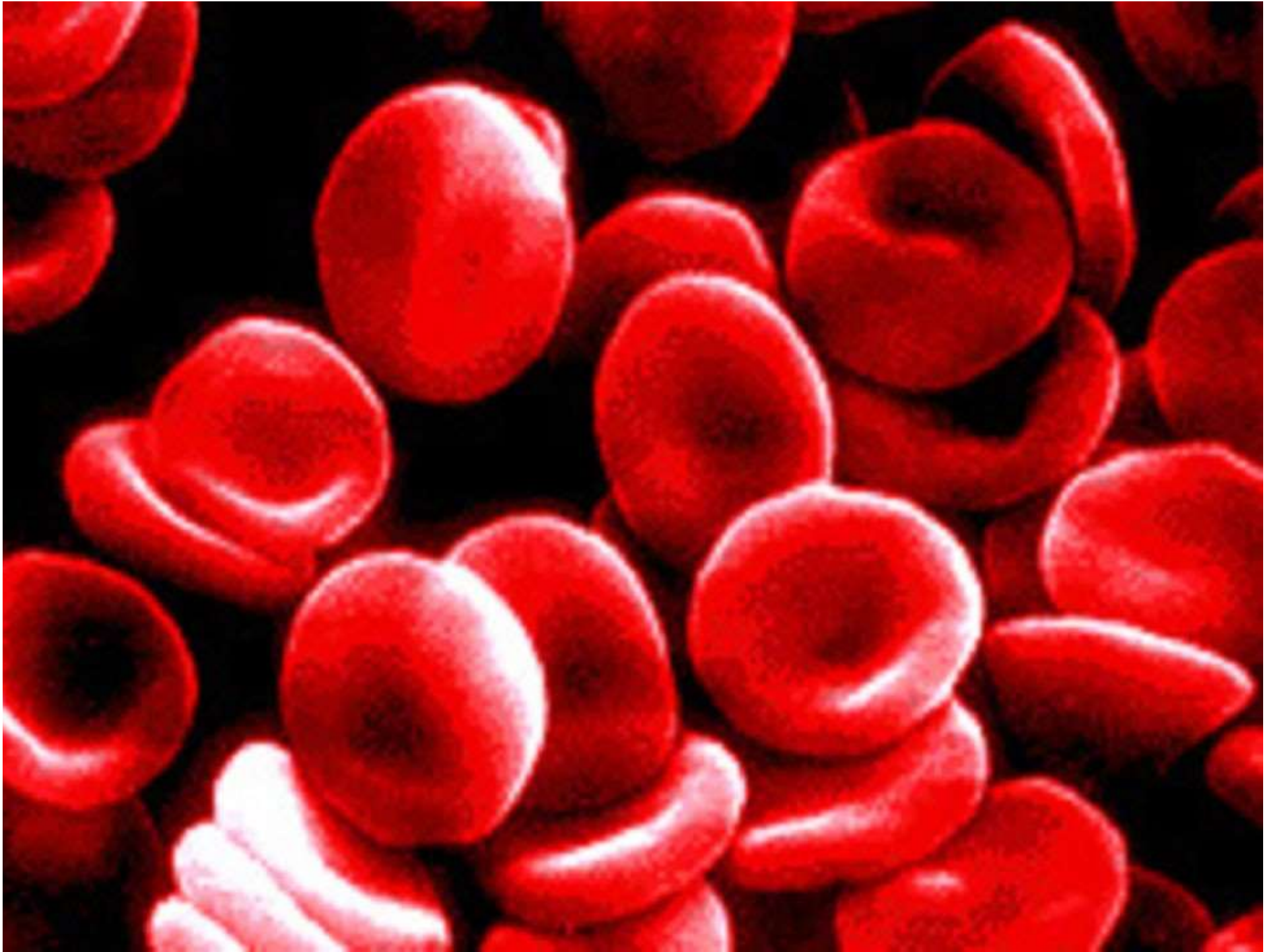
- Kishikawa – 6/12 follow up
 - No contusion = pulmonary function recovered in 6 months
 - Contusion = 1 -6 year CT f/u show fibrosis = dyspnea, decreased FRC, decreased pO_2



"Cat Scan"

*East guideline for pulmonary contusion-flail chest.
2006*



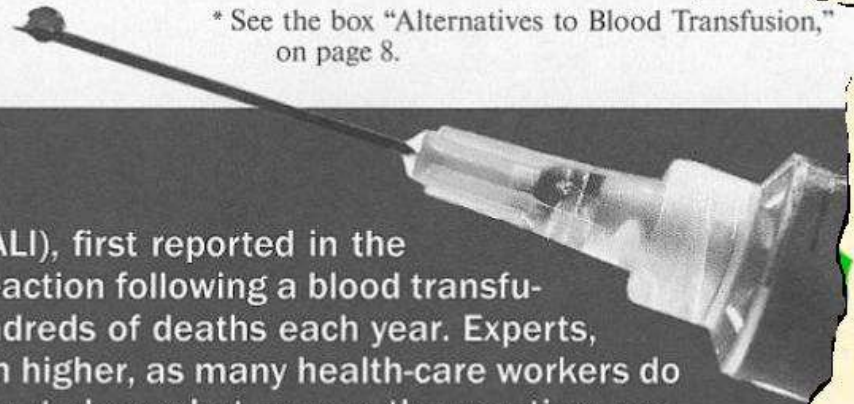


... that are currently used as alternatives to transfusions. According to an article

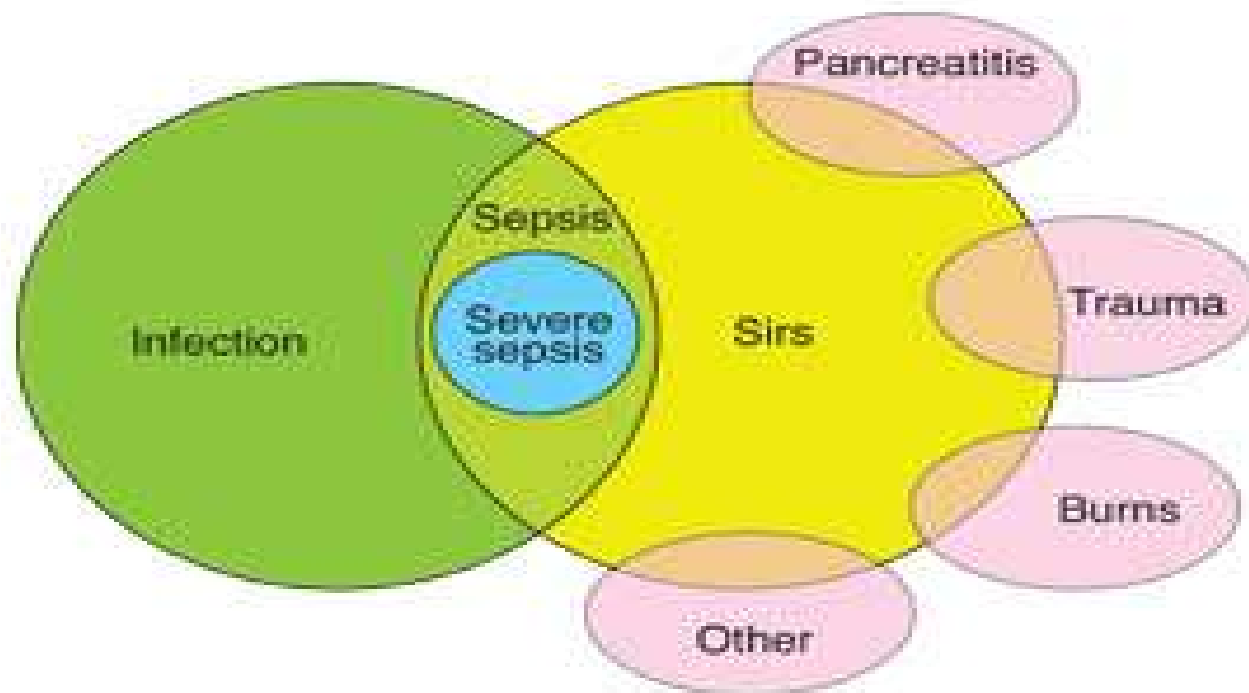
* See the box "Alternatives to Blood Transfusion," on page 8.

Death by TRALI

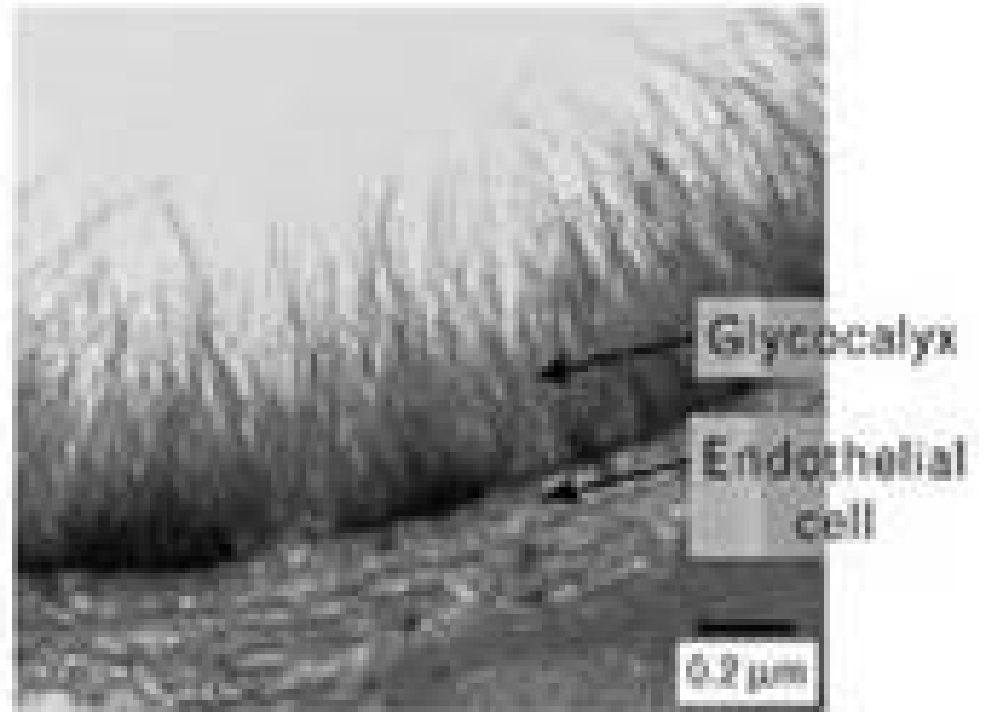
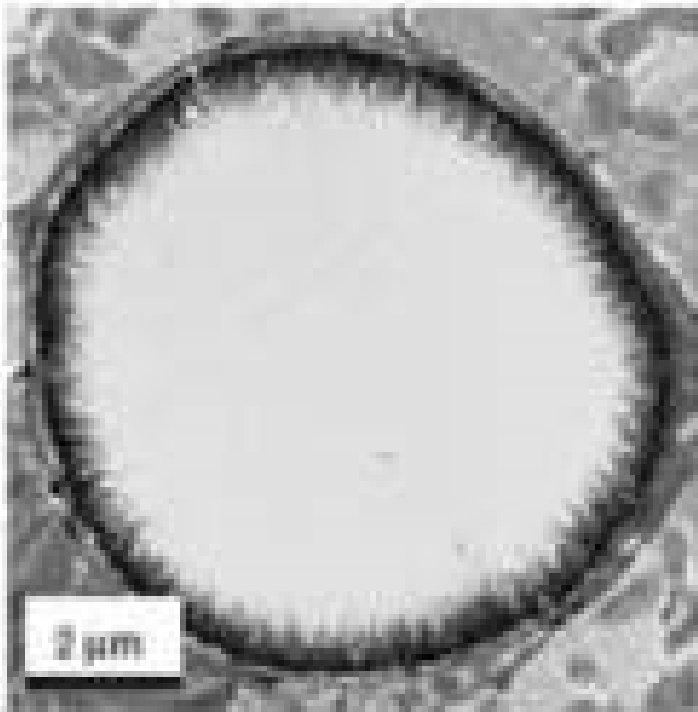
Transfusion-related acute lung injury (TRALI), first reported in the early 1990's, is a life-threatening immune reaction following a blood transfusion. It is now known that TRALI causes hundreds of deaths each year. Experts, however, suspect that the numbers are much higher, as many health-care workers do not recognize the symptoms. Although it is not clear what causes the reaction, according to the magazine *New Scientist*, the blood that causes it "appears to come primarily from people who have been exposed to a variety of blood groups in the past, such as . . . people who have had multiple transfusions." One report states that TRALI is now near the top of the list for causes of transfusion-related deaths in the United States and Britain, making it "a bigger problem for blood banks than high-profile diseases like HIV."



Trauma



Glycocalyx

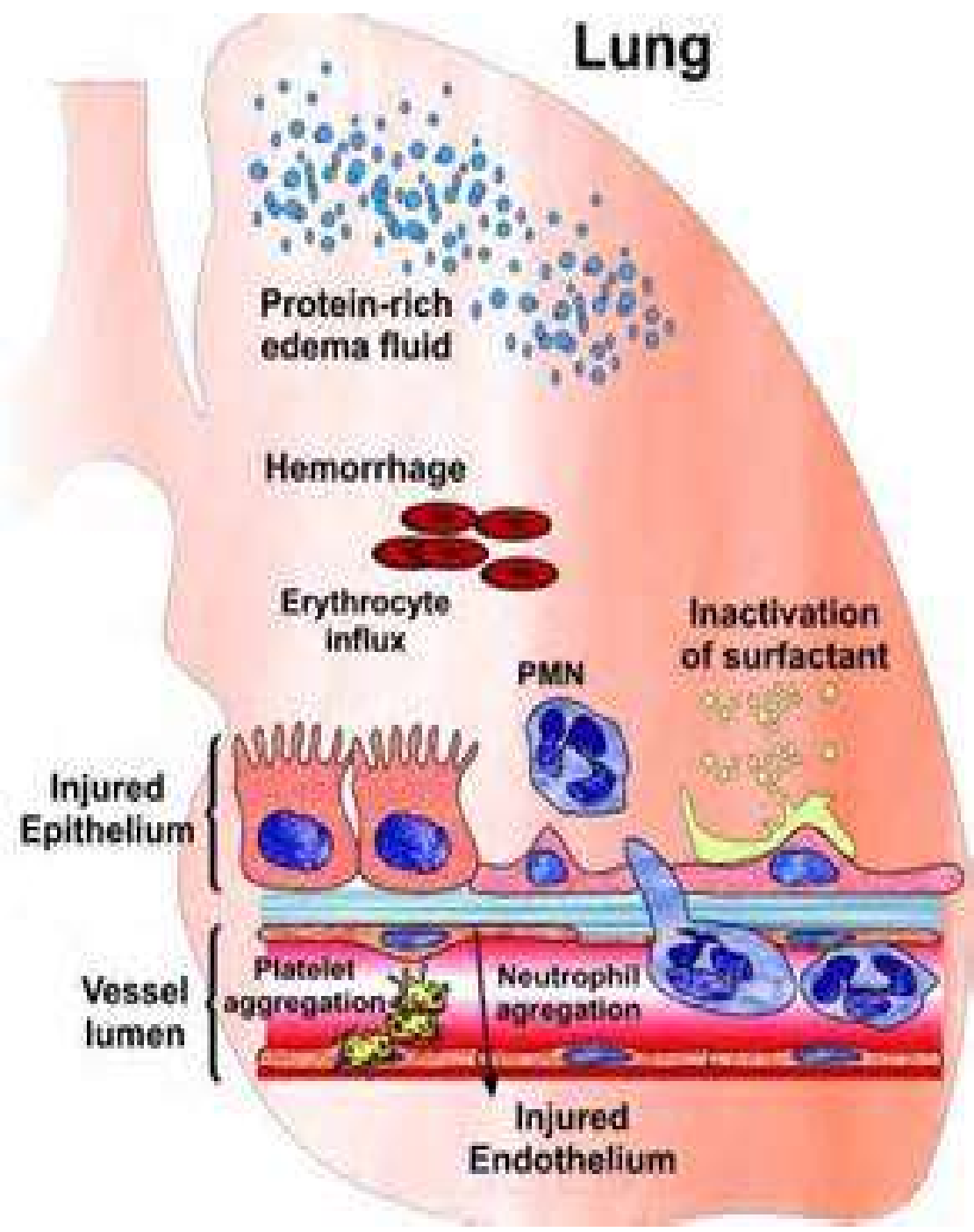


Trauma

- Decrease in endothelial glycocalyx
- 121 microvessels
- Decrease of function despite resuscitation

Torres, Luciana et all. Evaluation of resuscitation fluids on endothelial glycocalyx, venular bloodflow, and coagulation after hemorrhagic shock in rats. J Trauma:75;5: 759-766. Nov 2013

Lung



Ventilation

- Adequate analgesia and physiotherapy
- Early intubation and mechanical ventilation for poor gas exchange
- CPAP/NIV



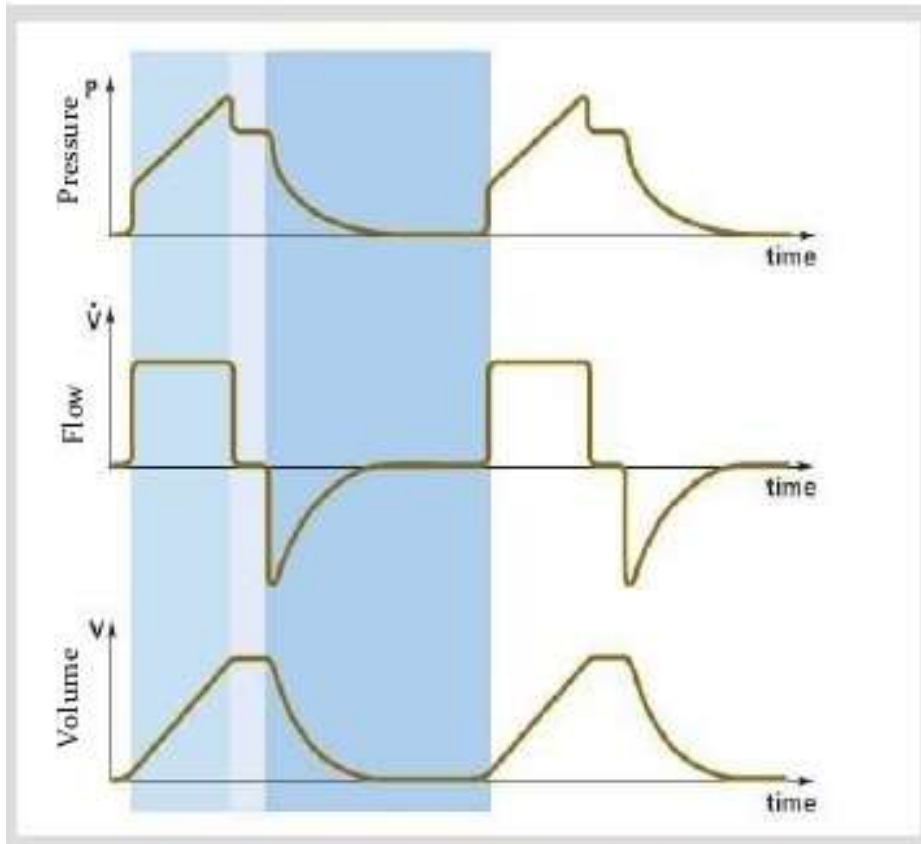
Mechanical ventilation:

- High mean airway pressures to counteract poor compliance
 - PEEP
 - I:E ratio reversal
 - Pressure control mode

Ferdinand R. Rico, Julius D. Cheng. Mechanical ventilation strategies in massive chest trauma. Crit Care Clin 23 (2007) 299 -315.

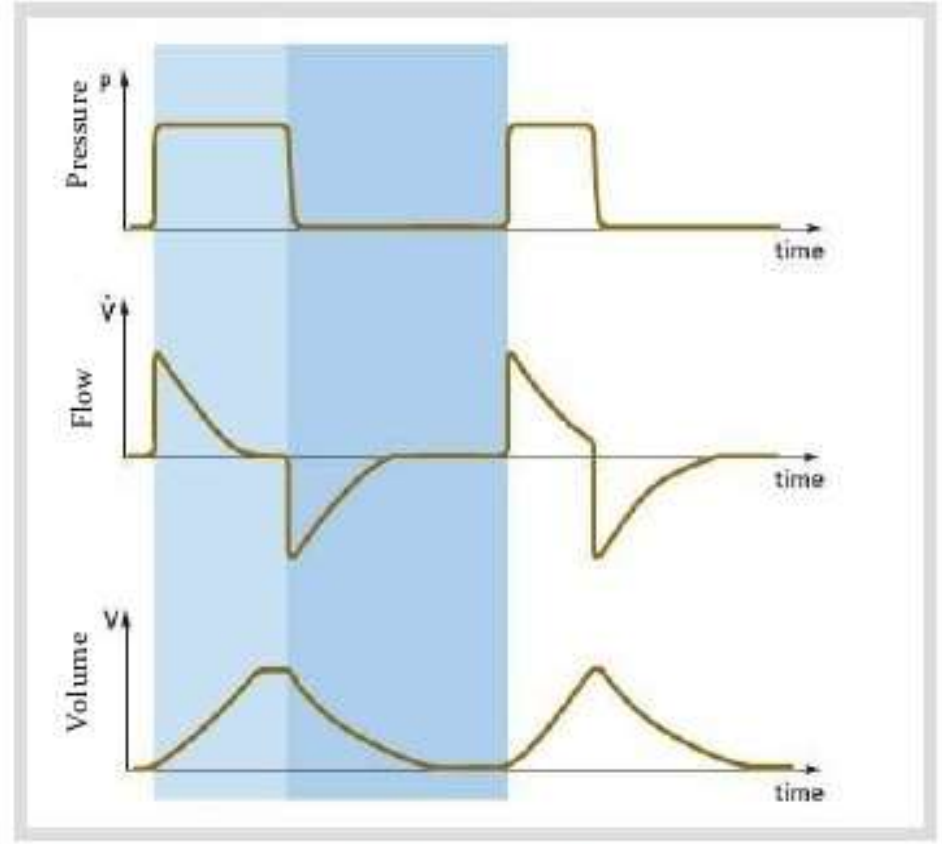
Types of Waveforms

Volume Modes



Volume Control/ SIMV (Vol. Control)

Pressure Modes



Pressure Control/ PRVC
SIMV (PRVC)
SIMV (Press. Control)

Pressure Support/
Volume Support

Prone ventilation

- **Prone positioning:**

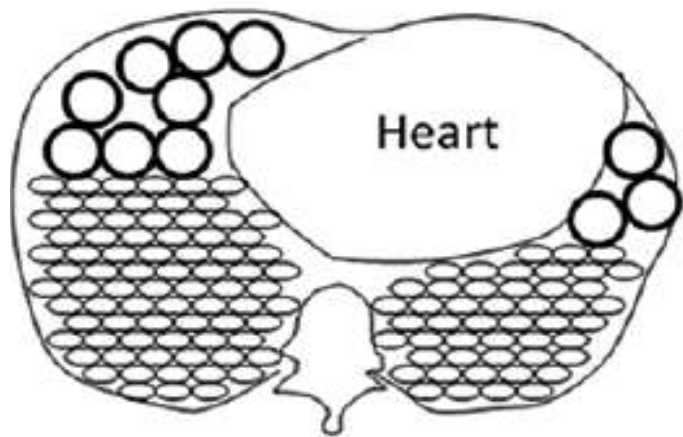
Same indications as ARDS

Problematic in polytrauma patients

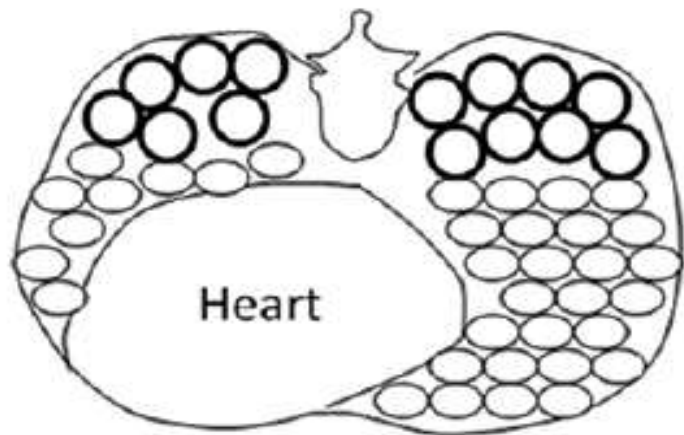
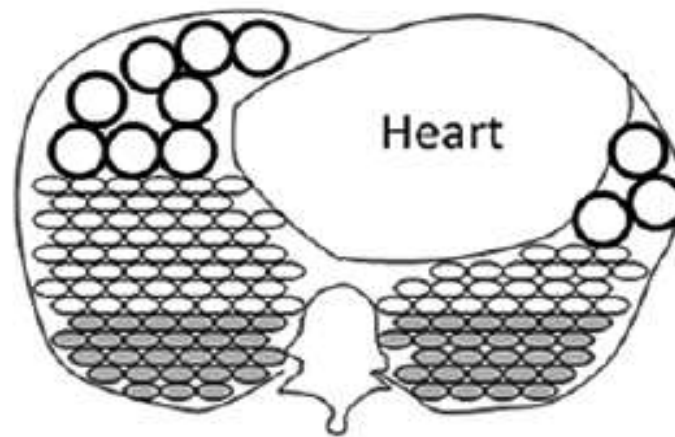


Ferdinand R. Rico, Julius D. Cheng. Mechanical ventilation strategies in massive chest trauma. Crit Care Clin 23 (2007) 299 -315.

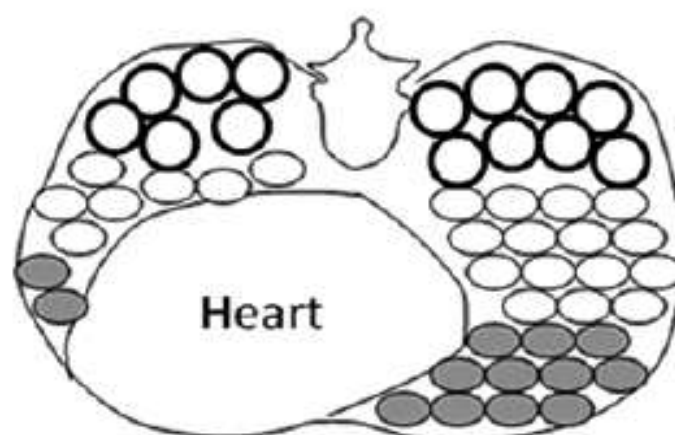
**A. Supine Position
Normal Lung**



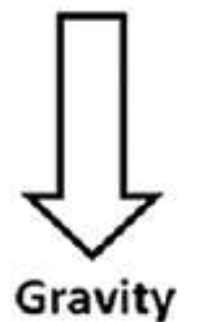
**B. Supine Position
ARDS Lung**

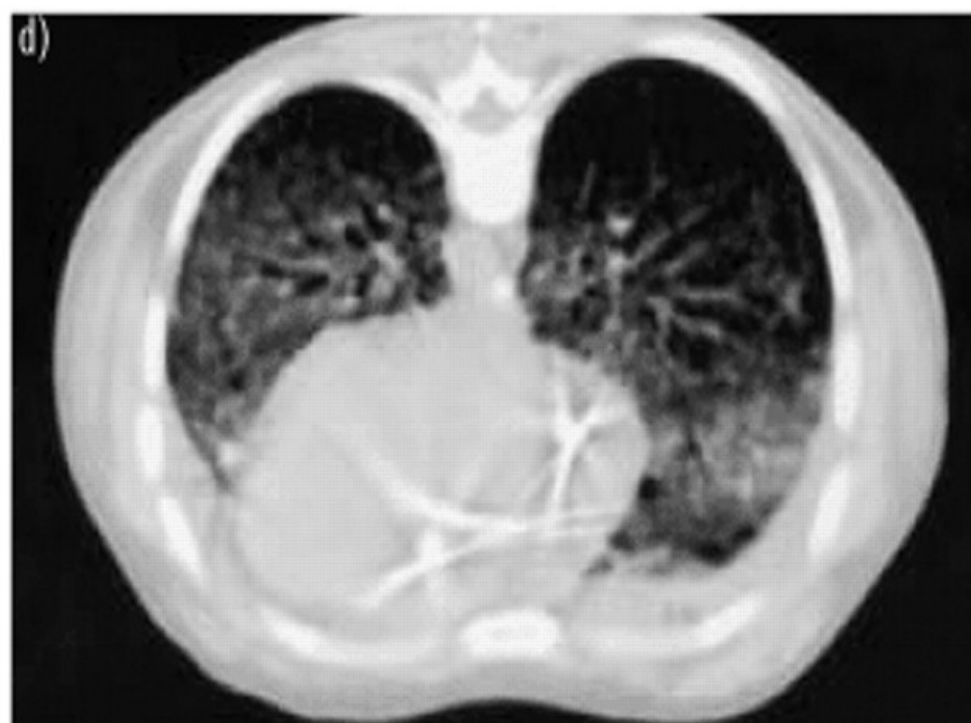
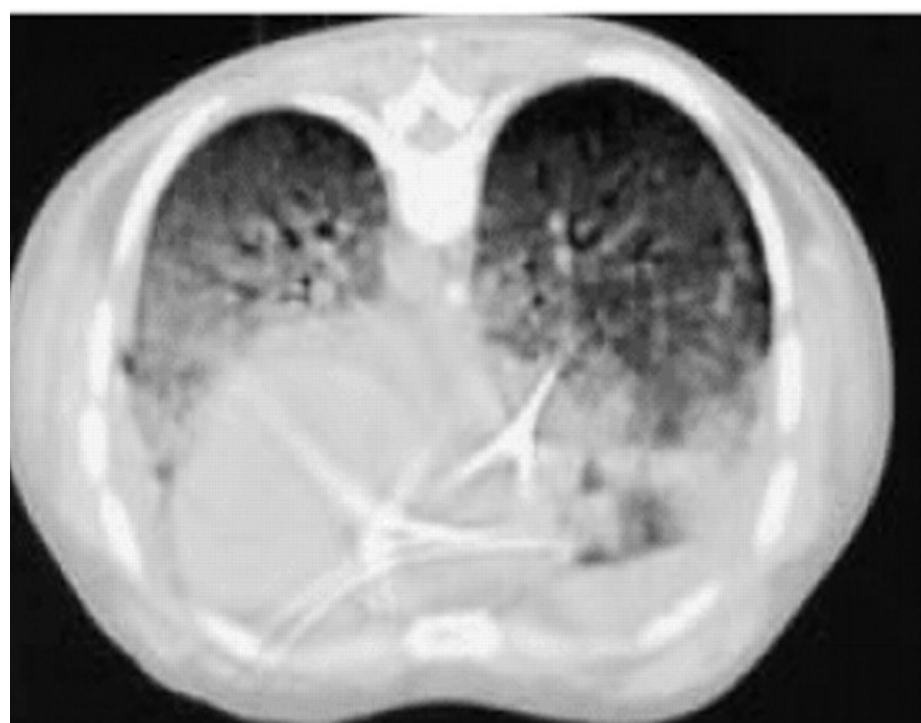
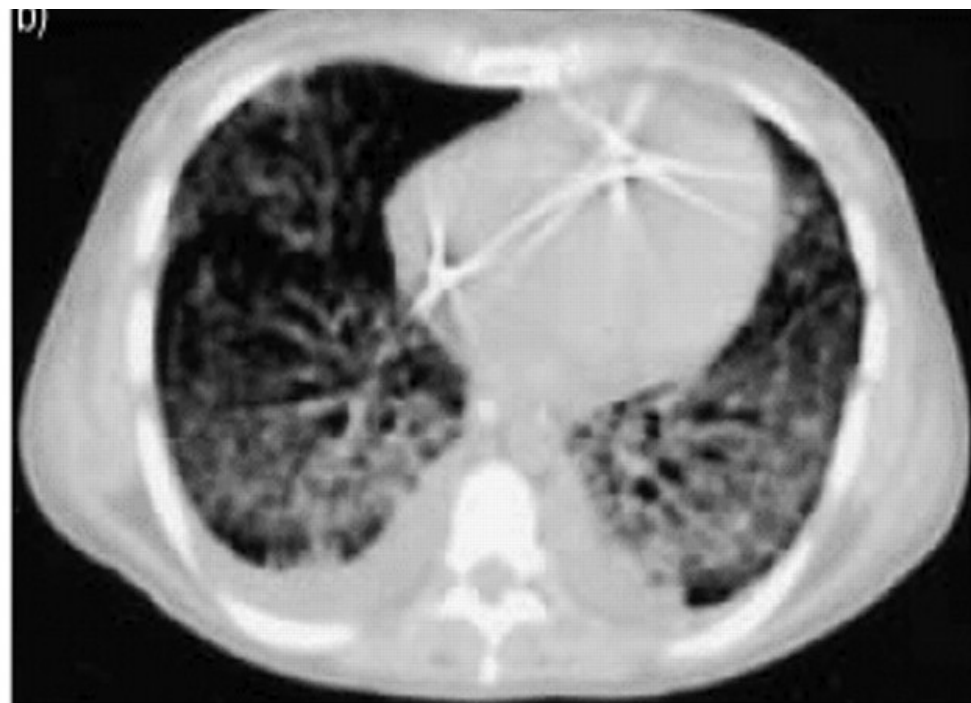
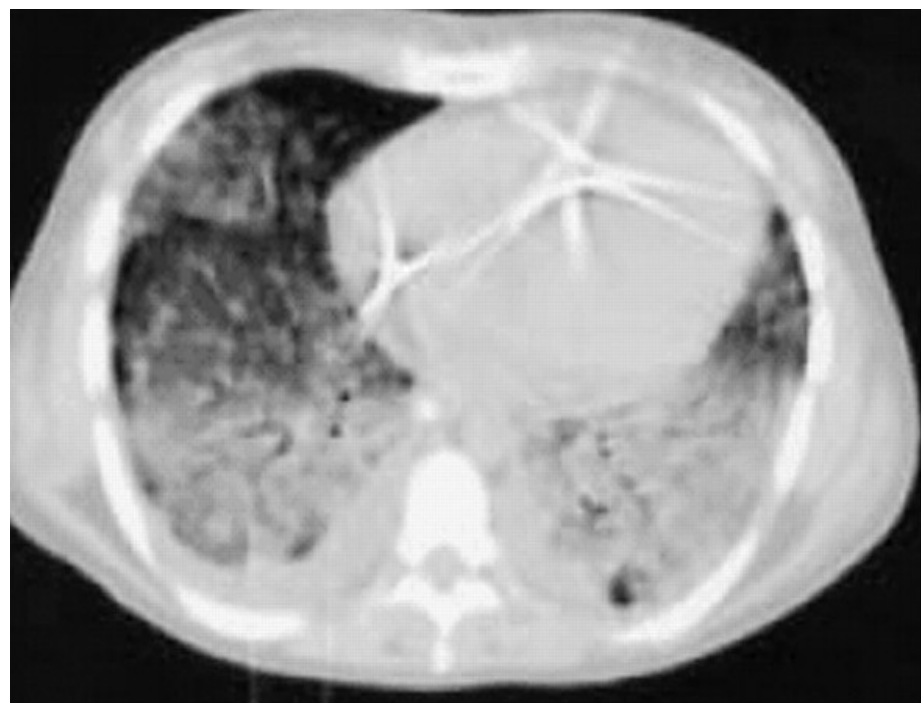


**C. Prone Position
Normal Lung**



**D. Prone Position
ARDS Lung**





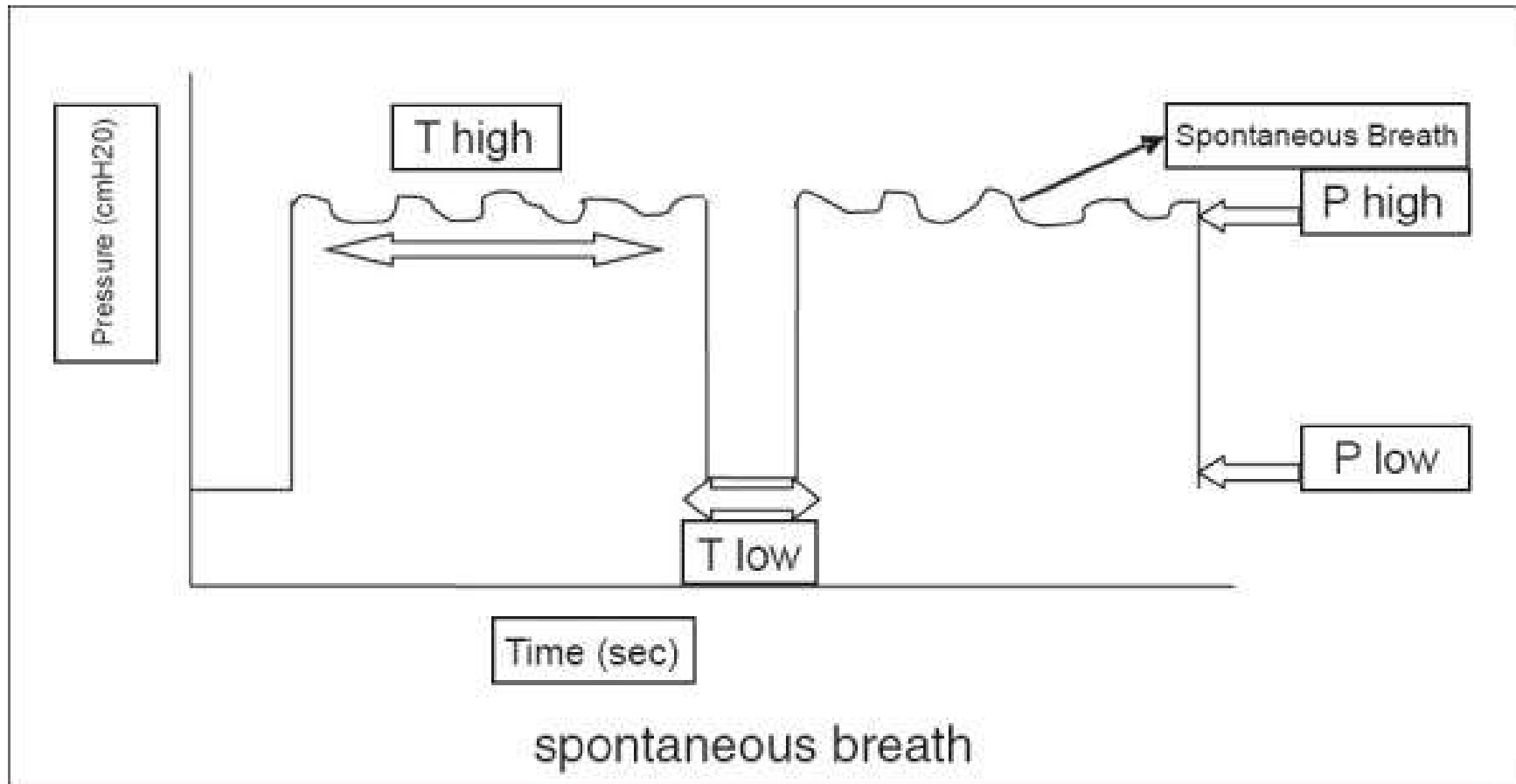
What does the evidence say?

- 3 Things beneficial in ARDS:
 - Lower Tv
 - Neuromuscular blocking agents
 - Prone ventilation

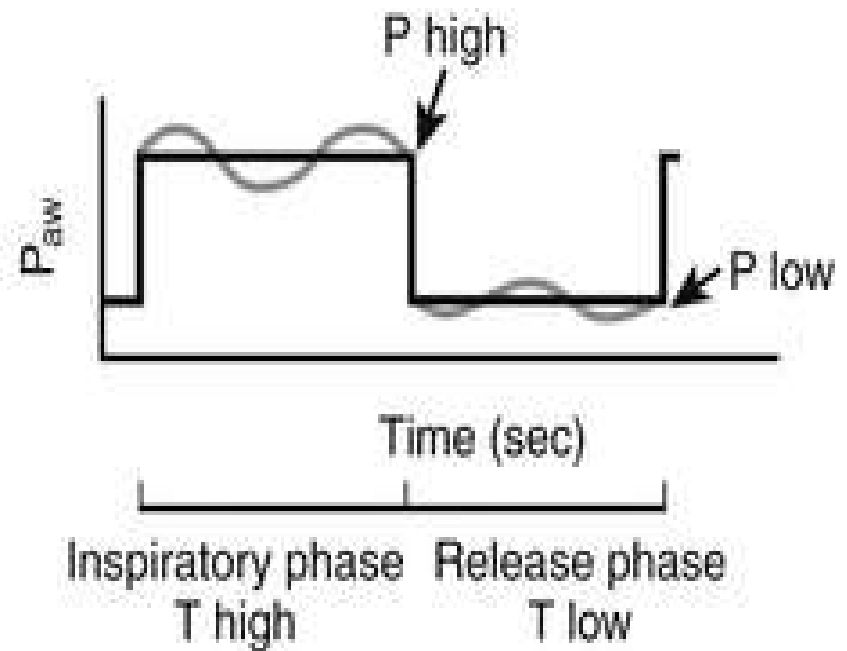
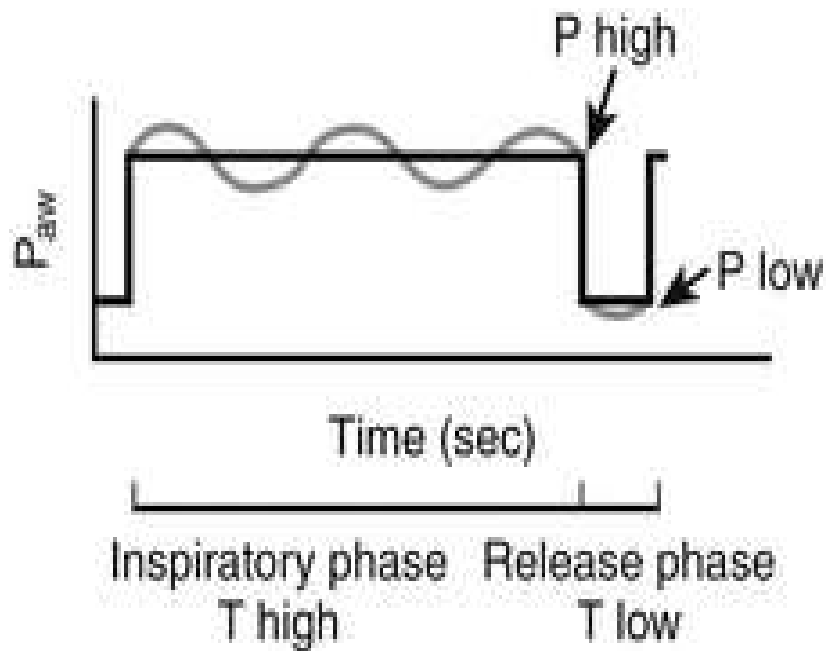
ACURASYS and PROSEVA Trial

Prone Ventilation in ARDS. European Respiratory Review 2014 23: 249-257

APRV



APRV vs BiPAP



APRV

- Advantages:
 - Alveolar recruitment and improved ventilation
 - Preservation of spontaneous breathing
 - Decreased LV transmural pressures
 - Potential lung protective effect
 - Better ventilation of dependent areas
 - Lower sedation

APRV

- Disadvantages
 - Volutrauma
 - Increased work of breathing
 - Increased energy expenditure
 - Worsening of air leaks
 - Increased RV workload, pulmonary hypertension
 - Intracranial hypertension

APRV

- No evidence to improve outcome

Ventilation

- Independent lung ventilation
 - anatomical
 - physiological separation
 - One lung
 - two lung ILV (synchronous/asynchronous)



Ferdinand R. Rico, Julius D. Cheng. Mechanical ventilation strategies in massive chest trauma. Crit Care Clin 23 (2007) 299 -315.

Indications

- Hyperinflation of normal lung
- Fall in PaO₂
- Increase in shunting

Ferdinand R. Rico, Julius D. Cheng. Mechanical ventilation strategies in massive chest trauma. Crit Care Clin 23 (2007) 299 -315.

Use:

- Maintain P_{plat} less than 30cmH₂O
- Use end tidal CO₂ for gas exchange
- P_{plat} and Static compliance for lungfunction
- Equalization of TV and end tidal CO₂ – TL ILV to normal mechanical ventilation

Ferdinand R. Rico, Julius D. Cheng. Mechanical ventilation strategies in massive chest trauma. Crit Care Clin 23 (2007) 299 -315.

HFOV:

- Derdak et al, Am J Resp 2002
148 pst with ARDS
 - Randomised to CV and HFOV
 - Median of 2 days of CV



Median duration of HFOV = 6 days

Switched to CV when

$FiO_2 < 0.5$, $mP_{aw} < 24$, $SaO_2 > 88\%$

Ventilation Strategy		CV	HFOV
Settings		VT = 6-10ml/kg PEEP>10cmH ₂ O	mP _{aw} = CV + 5cmH ₂ O Freq =5Hz Amplitude = titrated
Oxygenation	8h	131	178
PaO ₂ /FiO ₂	16h	143	205
	24h+	No Difference	No Difference
Hemodynamic Parameters		No Difference	No Difference
Complications		No Difference	No Difference
30 Day Mortality		52%	37%

HFOV in ARDS

Summary:

- Derdak et al - HFOV in early ARDS
 - significant oxygenation benefit
 - Possible mortality benefit
 - Safe
- Mehta et al (2004) – HFOV in late ARDS
 - Significant oxygenation benefit
 - 12% not tolerated, 33% pneumothorax
- Level 2 evidence for its use

HFOV in trauma:

- When mechanical ventilation fail
- Few studies
- Beneficial when instituted early

HFOV in trauma

- No prospective, two retrospective studies
- Limited numbers
- Improved in pulmonary function and oxygenation, safe
- Mortality 18%
- Duration 4.9 ± 1.5 days

Funk DJ et al. The use of high frequency Oscillatory ventilation for severe pulmonary contusion. JTrauma 2008; 65: 390 -395

ECMO

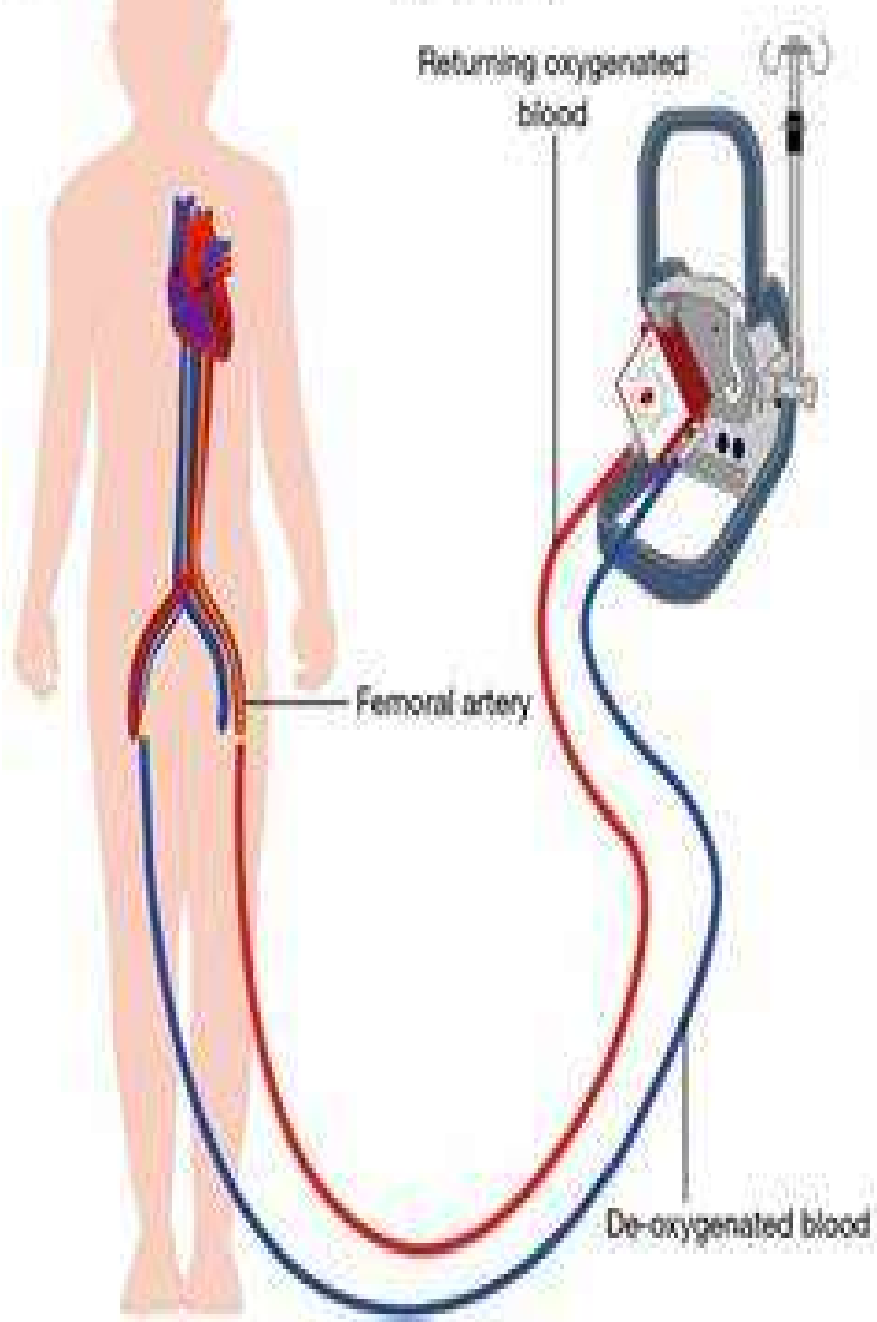
- Complication of bleeding in polytrauma patient
- Only to be used in extreme situations
- Very expensive

*Andrea Compione, Marco Agostini.
J thorac Cardiovasc Surg
2007; 133: 1673 – 1674.*



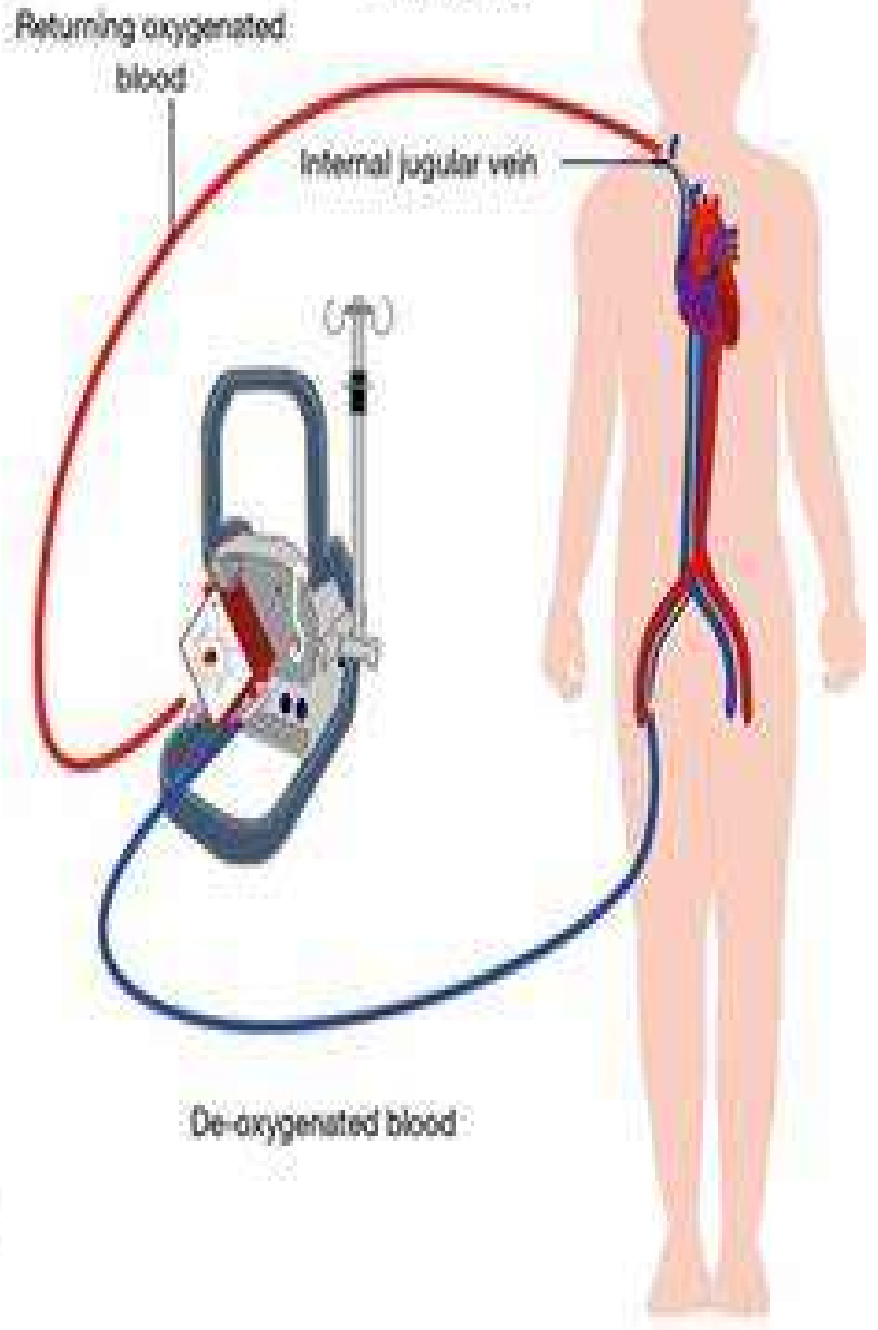
A

VA-ECMO



B

VV-ECMO



Other therapies:

- **Surfactant/ Bronchial lavage:**

2005 – 20pigs unilateral contusion

- Surfactant lavage 30min post injury
- Decreased PaO₂/FiO₂ from 500- 250
- 4hrs later control group still decreased
- Total compliance decreased by 50%

- *Strohmaier W, Trupka A et al: Bilateral lavage with diluted surfactant improves lung function after unilateral lung contusion in pigs. Critical Care Med 33; 2431-2433,2005*

- *Renata Bastos, John Colhoon. Flail chest& pulmonary contusion. Semin Thoracic Cardiovasc Surg 20:39-45. 2008*

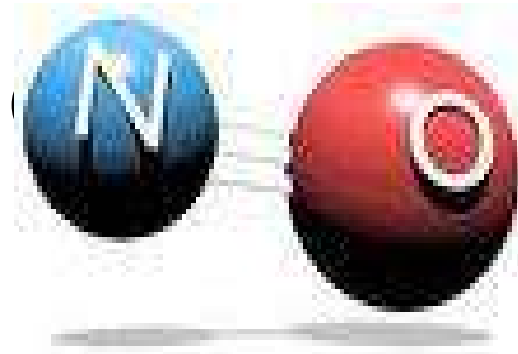
Other therapies



- **Steroids:**
 - animal studies = decreased injury
 - small retrospective study = decreased mortality
 - not enough evidence

East guideline for pulmonary contusion-flail chest. 2006

Other Therapi



- **Nitric oxide:**

- Vasodilate normal ventilated areas
- Johannigman – greatest improvement in normal or both lungs
- Also in bilateral patchy contusions

Ferdinand R. Rico, Julius D. Cheng. Mechanical ventilation strategies in massive chest trauma. Crit Care Clin 23 (2007) 299 -315.

Other therapies

- **Partial liquid ventilation**

Perfluorocarbon solution

- Surfactant properties
- Anti – inflammatory
- Splinting aveoli

Studies fail to show benefits

Role of surgery:

- Bleeding
- Lethal triad damage control
- Bronchopleural fistula
- Fixation of ribs



Fixation of ribs:

- Decreased pain
- Improved mechanics
- Decreased mechanical ventilation
- Decreased hospital stay



“What does the studies say?”

- No clear answer
- Conclusion:
 - Benefit for patients with flail segment
 - No benefit for patients with flail segment with pulmonary contusion

- East guideline for pulmonary contusion-flail chest. 2006

- Renata Bastos, John Colhoon. Flail chest& pulmonary contusion. Semin Thoracic Cardiovasc Surg 20:39-45. 2008

Rib fixation:

- Recommended:
 - > 5 rib flail chest requiring mechanical ventilation
 - Symptomatic non-union
 - Severe displacement found thoracotomy for another reason

- Consider:

- > 3 rib flail not requiring ventilation
- > 3 rib with severely displaced fractures
- > 3 rib fractures (minimal displacement) with 50% reduction FVC

- **Absolute contraindications:**

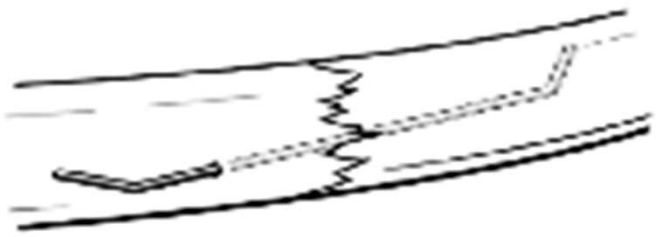
- Contaminated field

- **Relative contraindications**

- Severe lung contusion required prolonged ventilation
- High cervical spine requiring ventilation



Wire



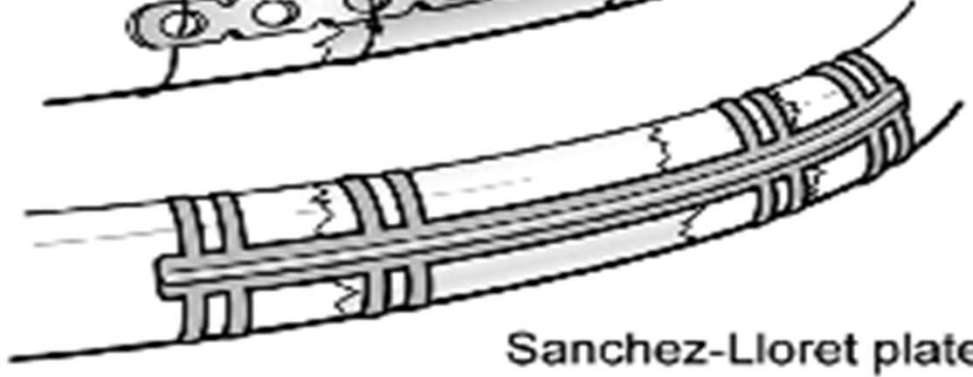
Intermedullary wire brace



U-plate



Plate



Sanchez-Lloret plate

19 17:30:10

KP SUPINE

Institution Name

Manufacturer's

L

F

Tools

Workflow

Token View

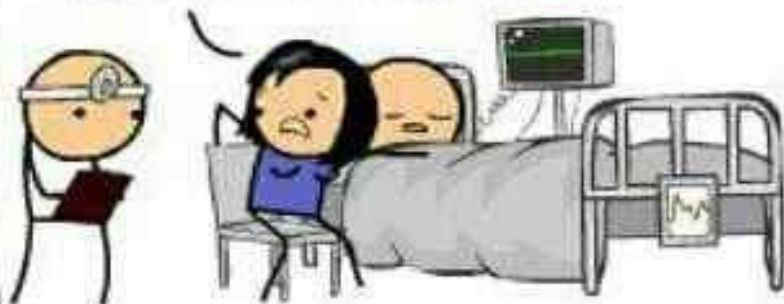
PHILIPS

Conclusion:

- Large SIRS
- Restrict fluid administration
- Analgesia
- Ventilation
- Limited evidence

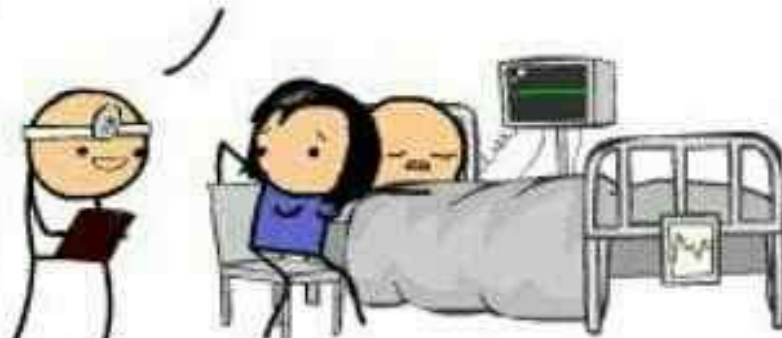
**BLEEP... BLEEP... BLEEP...
BLEEEEEEEEEEEEEEEEEEEEEEE...**

OH MY GOD! WHAT DOES
THAT BEEPING SOUND
MEAN?! IS HE OK?!



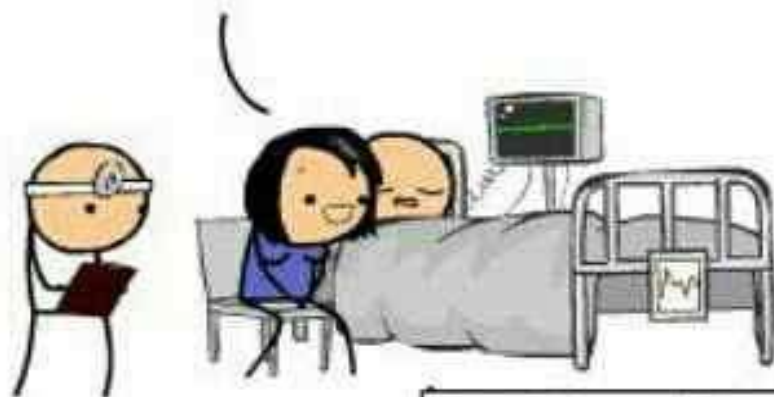
EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE

DON'T WORRY, IT'S
MORSE CODE! HE'S
COMMUNICATING WITH US



EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE

REALLY? WHAT'S HE SAYING?



EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE

"I'M DEAD"

