# La NIV nel trauma toracico

**Paolo Groff**
PS-MURG
Ospedale «Madonna del Soccorso»
San Benedetto del Tronto

**NAPOLI 2016**

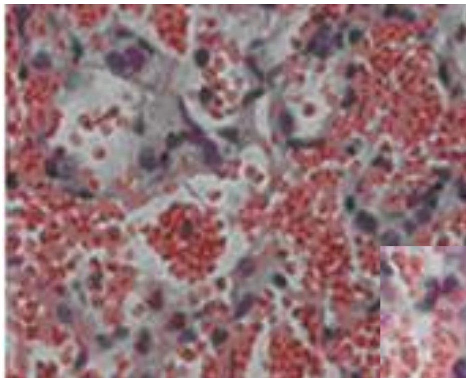
x congresso nazionale
simeu
NAPOLI 18-20 NOVEMBRE 2016

# Epidemiology

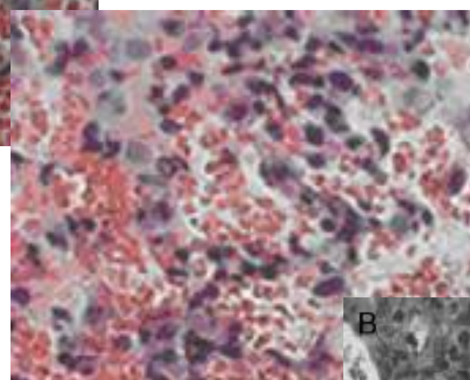
- **Severe thoracic injury in 47,4% of pts arriving alive to the hospital for major traumas (RITG)**
- **Penetrating, open, <u>blunt chest trauma</u>**
- **BCT: involved in nearly 30% of all trauma admissions to hospital**
- **An independent risk factor for ALI, ARDS and ventilator associated pneumonia**
- **Estimates of mortality at 10-25%**

# Pathology

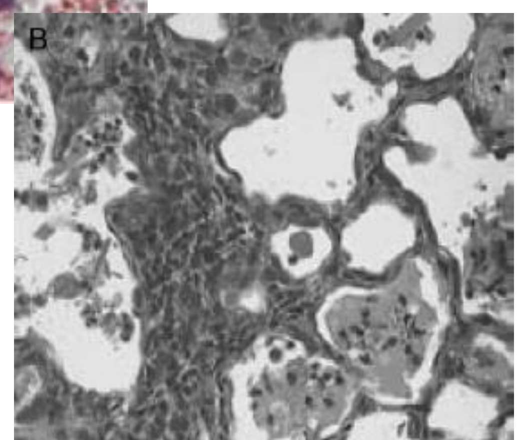
J.J. Hoth et al. Shock 2009



3-6 hrs

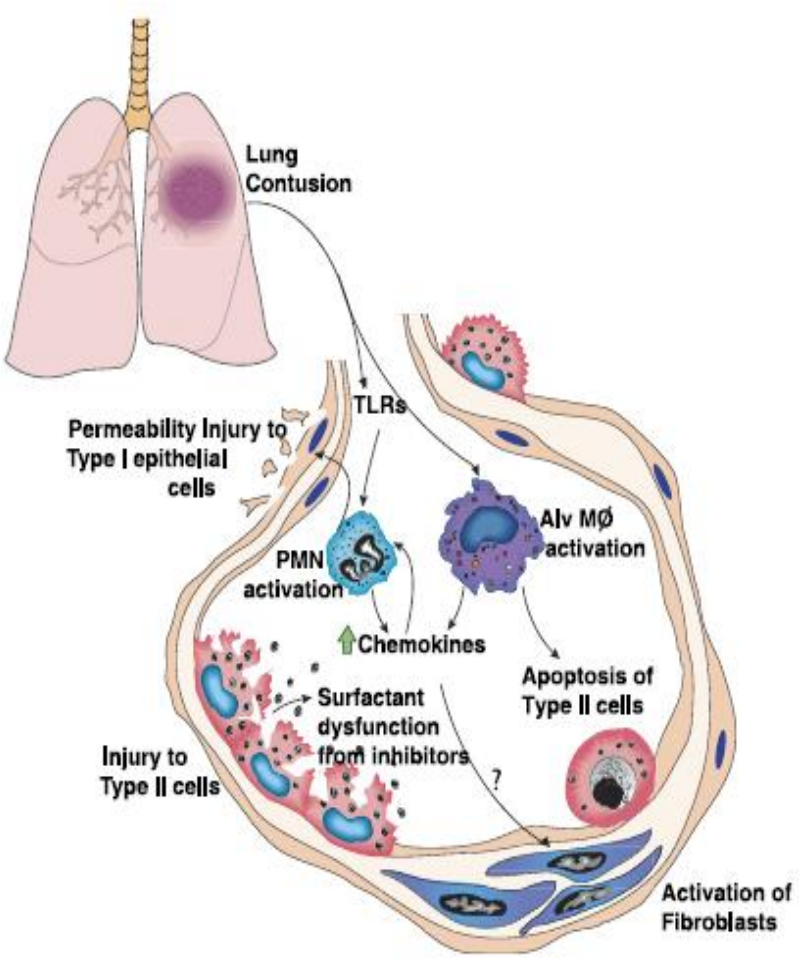


24 hrs




> 48 hrs

# Pathophysiology

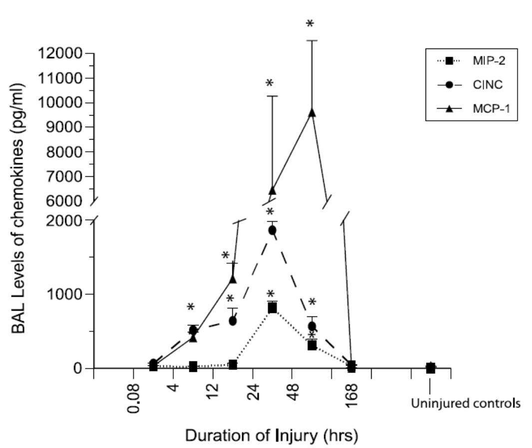


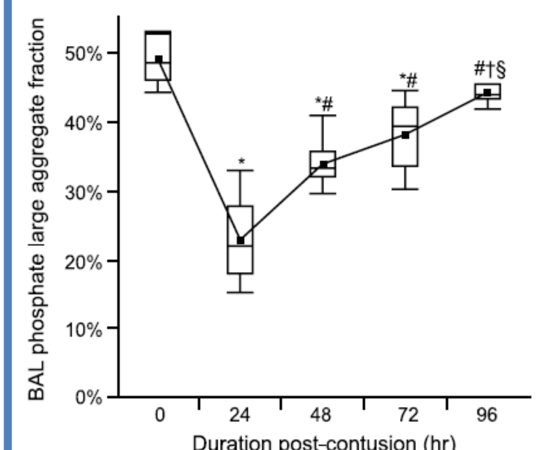

- Innate immunity activation by endogenous ligands via toll-like receptors on alveolar epithelium-MyD88-NFkB-chemokines
- Qualitative-quantitative surfactant alterations by inhibitors with increased surface tension. The role of superimposed noxae (gastric aspiration)
- Type II cells/PMN apoptosis, a factor of progression to ALI-ARDS?

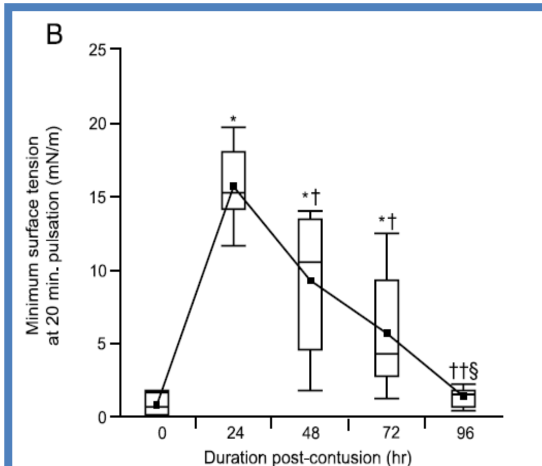
K. Raghavendran et al. SHOCK 2008 and 2009

Table 1. **Biochemical analysis of whole cell-free BAL, enumeration of RBC extravasation into the lung air space (BAL RBCs), and whole lung MPO activity from rats at various times after LC injury**

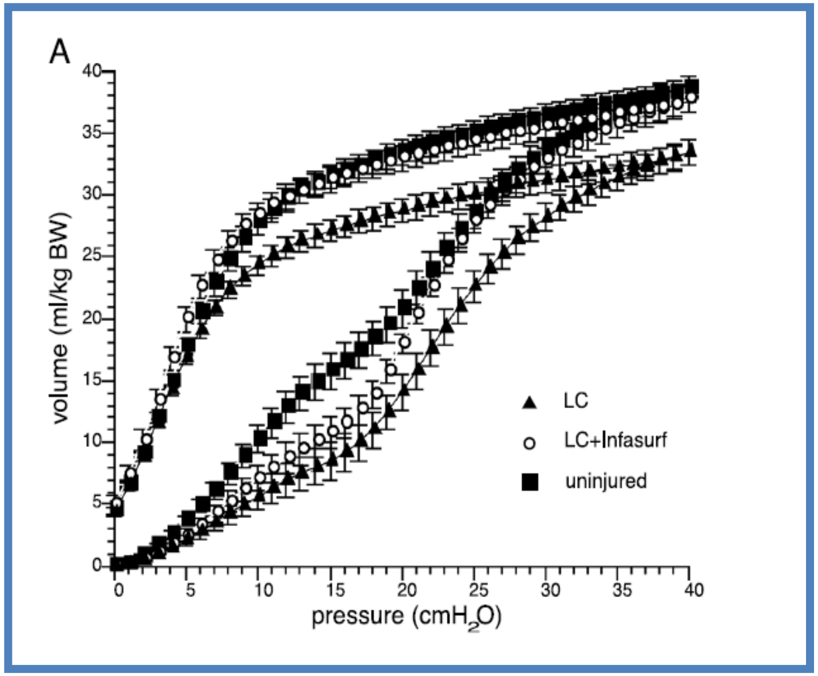
| Injury group | BAL total protein, μg/mL | BAL albumin, μg/mL | BAL total PL, μg/mL | BAL total protein-PL ratio, % | BAL RBCs | Whole lung MPO, units per lung |
|---|---|---|---|---|---|---|
| Uninjured | 38 ± 2 (38) | 4.9 ± 0.4 (5.1) | 34.9 ± 1.9 (33.6) | 110 ± 7 (117) | $4.9 \pm 1.7 \times 10^5$ ($3.9 \times 10^5$) | 0.15 ± 0.02 (0.14) |
| LC 24 h | 726 ± 154 (612)* | 36.2 ± 6.5 (31.5)* | 54.0 ± 8.6 (49.0) | 1,280 ± 90 (1,299)* | $1.5 \pm 0.4 \times 10^8$ ($1.2 \times 10^8$)* | 1.16 ± 0.31 (0.92)* |
| LC 48 h | 184 ± 40 (210)*,† | 20.4 ± 3.6 (22.3)* | 41.7 ± 3.4 (38.8) | 435 ± 90 (486)*,† | $2.4 \pm 1.1 \times 10^7$ ($1.4 \times 10^7$)*,† | 0.51 ± 0.11 (0.51)*,† |
| LC 72 h | 92 ± 8 (93)*,† | 17.5 ± 3.6 (17.0)*,† | 36.1 ± 7.0 (38.2) | 336 ± 67 (267)*,† | $1.3 \pm 0.5 \times 10^7$ ($9.0 \times 10^6$)*,† | 0.34 ± 0.06 (0.31)*,† |
| LC 96 h | 51 ± 8 (52)*,†,‡,§ | 7.3 ± 1.0 (6.9)†,‡,§ | 38.7 ± 2.4 (39.8) | 130 ± 16 (125)†,‡,§ | $3.6 \pm 1.1 \times 10^6$ ($2.8 \times 10^6$)*,†,‡,§ | 0.16 ± 0.03 (0.16)†,‡,§ |

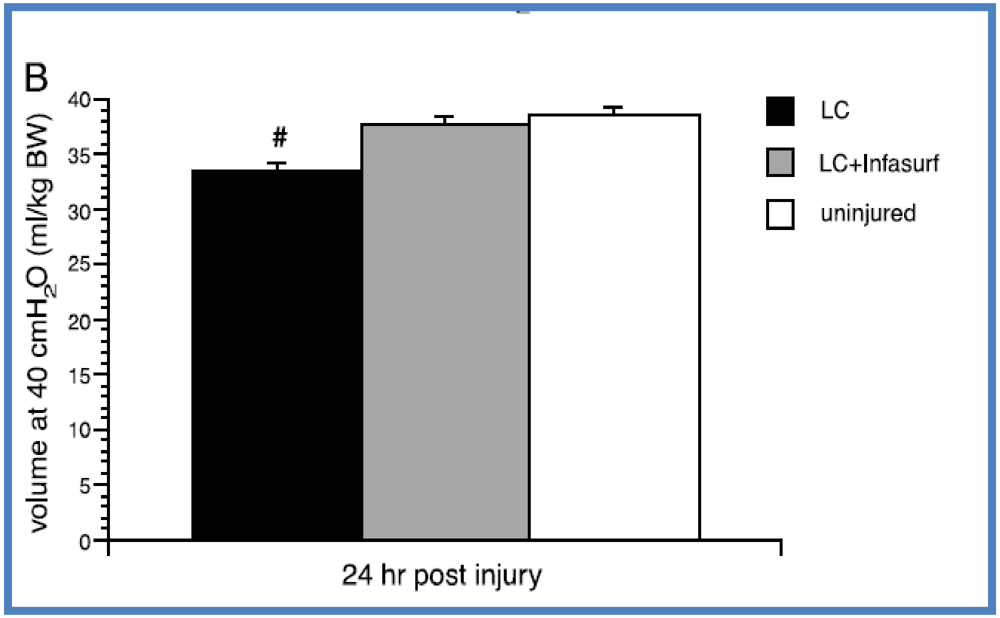



**K. Raghavendran et al. SHOCK 2008 and 2009**



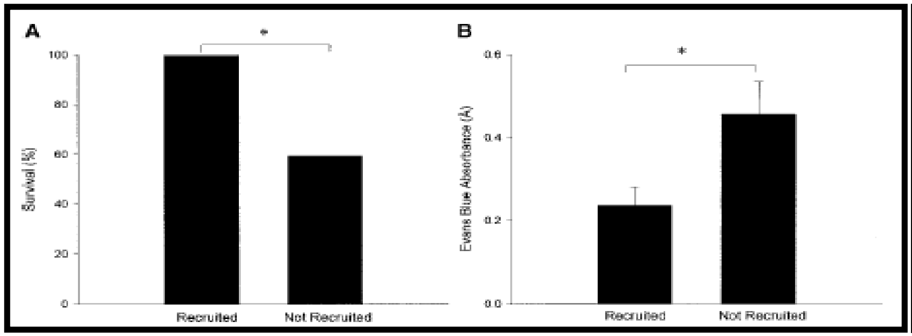

K. Raghavendran et al. SHOCK 2008

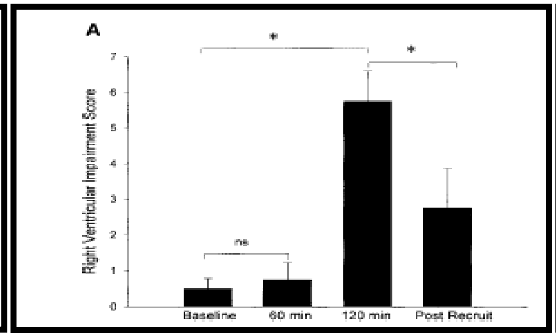
# Atelectasis: a common pathway to alveolar damage

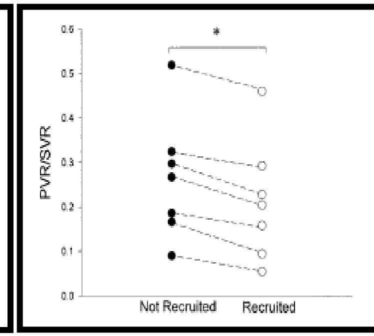
## Atelectasis Causes Vascular Leak and Lethal Right Ventricular Failure in Uninjured Rat Lungs

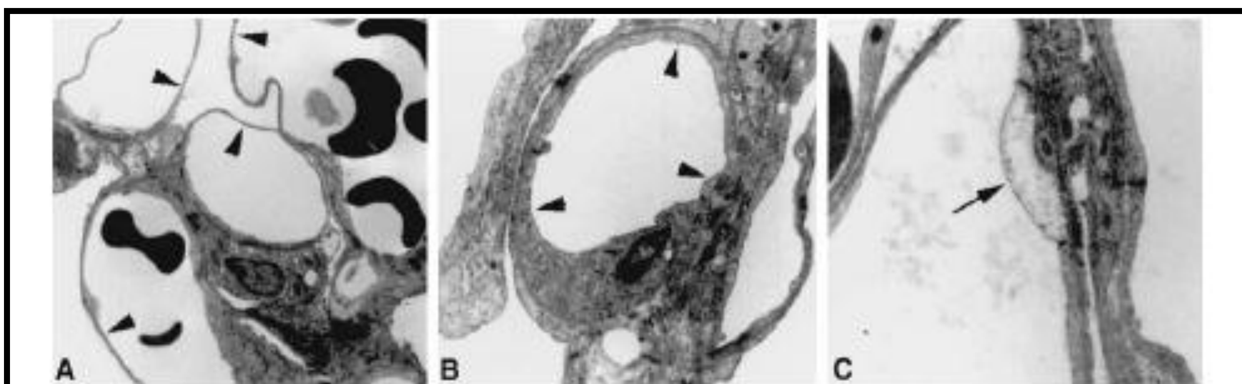
Michelle Duggan, Conán L. McCaul, Patrick J. McNamara, Doreen Engelberts, Cameron Ackerley, and Brian P. Kavanagh

AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 167 2003



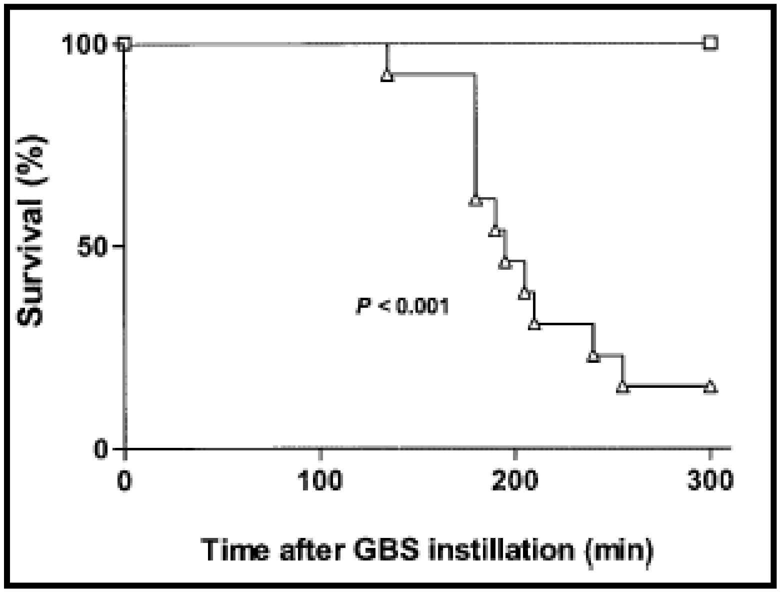



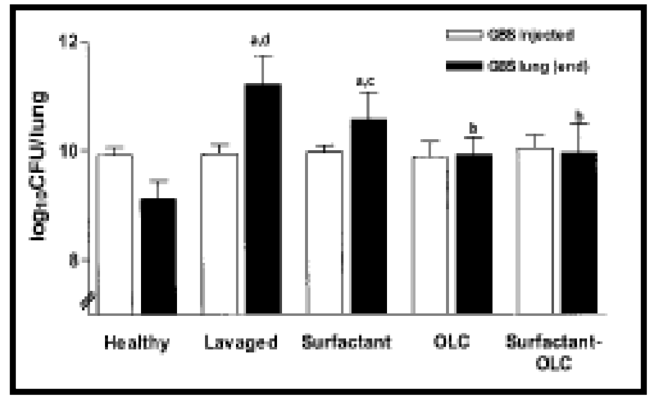



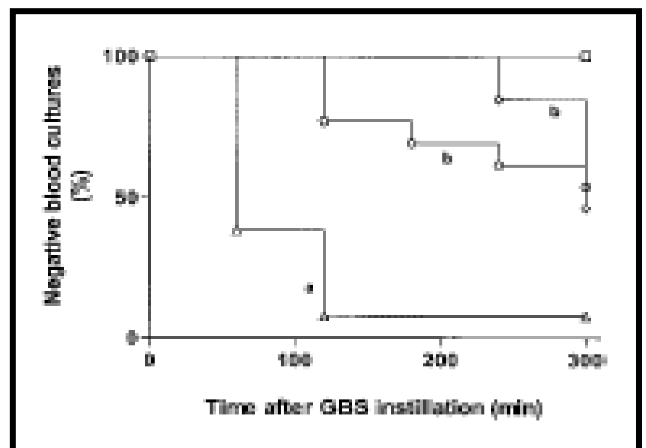
# Reducing Atelectasis Attenuates Bacterial Growth and Translocation in Experimental Pneumonia

Anton H. van Kaam, Robert A. Lachmann, Egbert Herting, Anne De Jaegere, Freek van Iwaarden, L. Arnold Noorduyn, Joke H. Kok, Jack J. Haitsma, and Burkhard Lachmann

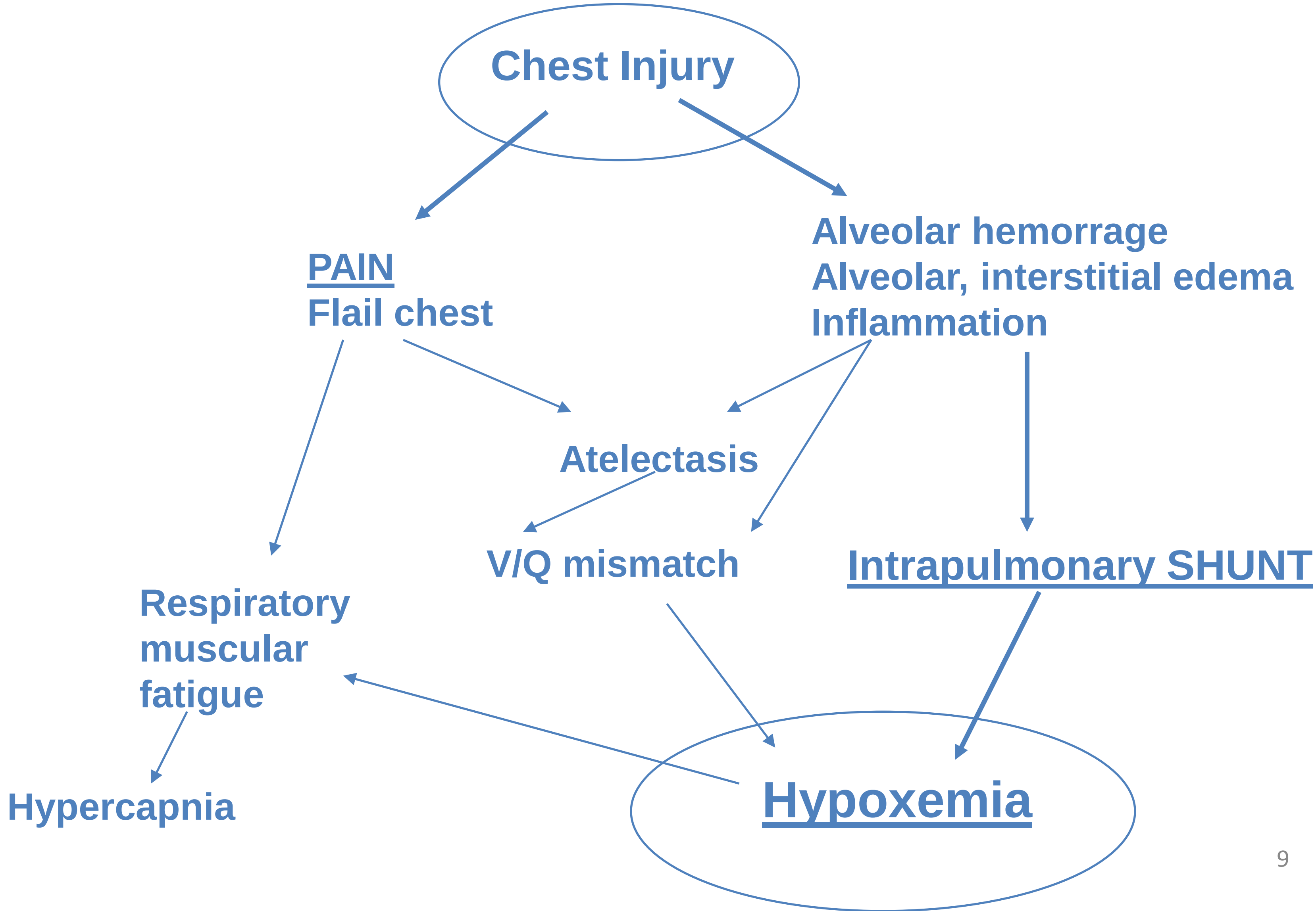
AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 169 2004

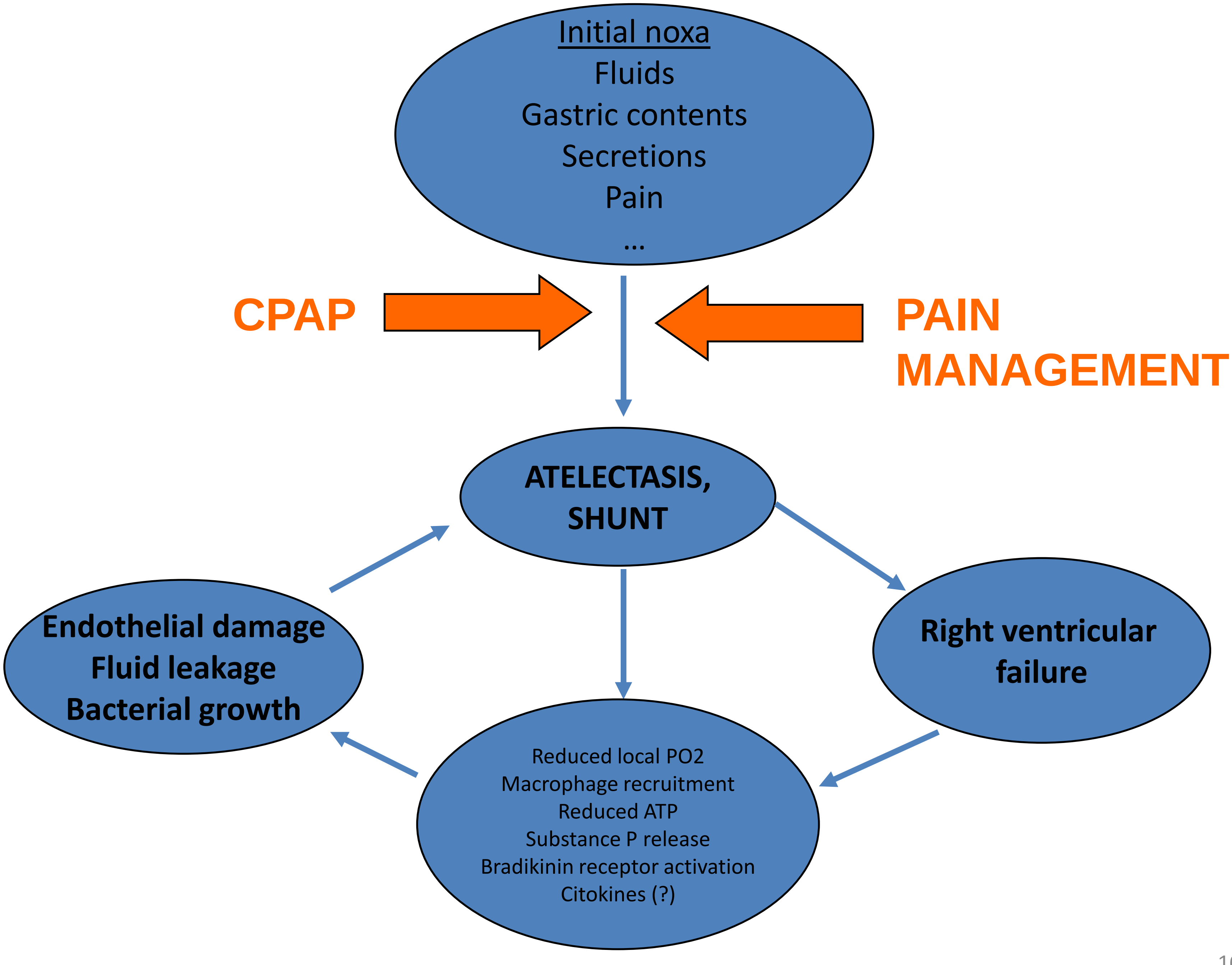


# Acute Respiratory Failure in BCT




Initial noxa
Fluids
Gastric contents
Secretions
Pain
...
CPAP
PAIN MANAGEMENT
ATELECTASIS, SHUNT
Endothelial damage
Fluid leakage
Bacterial growth
Right ventricular failure
Reduced local PO2
Macrophage recruitment
Reduced ATP
Substance P release
Bradikinin receptor activation
Citokines (?)

# Safety and efficacy of noninvasive ventilation in patients with blunt chest trauma: a systematic review

CRITICAL CARE

Abhijit Duggal[1], Pablo Perez[2], Eyal Golan[3,4], Lorraine Tremblay[2,3,5] and Tasnim Sinuff[2,3*]

**Table 1 Study characteristics.**[a]

| Study (design) | Patients (*n*)/ country | Study intervention | Control intervention | Severity of hypoxemia | Quantification of severity of chest injury | Strategy for pain control |
|---|---|---|---|---|---|---|
| I. Early interventions: CPAP/NPPV compared to supplemental oxygen | | | | | | |
| Hernandez *et al.* (2010) (RCT) | 50/Spain | NPPV | High-flow oxygen | $PaO_2/FiO_2 \leq 200$ for >8 h | Thoracic AIS, ISS, lung contusions/quadrant, thoracolumbar vertebral trauma, flail chest | Epidural analgesia (bupivacaine and fentanyl)<br>Remifentanil infusion |
| II. Late interventions: CPAP/NPPV after development of respiratory distress | | | | | | |
| Xirouchaki *et al.* (2004) (case series) | 22/Greece | NPPV | None | $PaO_2/FiO_2 \leq 140$ | AIS, ISS | Epidural analgesia<br>IV analgesia (not specified) |
| Tanaka *et al.* (2001) (case series) | 59/Japan | CPAP | None | Not Reported | AIS, ISS, flail chest | Epidural analgesia (not specified) |
| Walz *et al.*, 1998 (case series) | 30/Germany | CPAP | None | $PaO_2 \leq 70$ | Isolated or accompanying chest trauma on one or both sides | Epidural analgesia<br>Intercostal nerve blocks<br>IV analgesia |
| Hurst *et al.* (1985) (case series) | 33/USA | CPAP | None | $PaO_2/FiO_2 < 150$ or $PaO_2 < 65$ | Chest trauma (lung contusions, rib fractures)<br>No severity score used | Not specified |
| III. Patient safety assessment: CPAP/NPPV compared to mechanical ventilation after development of respiratory distress | | | | | | |
| Gunduz *et al.* (2005) (RCT) | 43/Turkey | CPAP | Mechanical ventilation | $PaO_2/FiO_2 \leq 300$ | TTSS, five or more rib fractures in a row, three or more segmental rib fractures, flail chest | Morphine patient Controlled analgesia |
| Bolliger and Van Eeden (1990) (RCT) | 69/South Africa | CPAP | Mechanical ventilation | $PaO_2/FiO_2 \geq 150$ | ISS, more than three rib fractures, pulmonary contusion | Lumbar epidural analgesia (buprenorphine)<br>Intercostal nerve blocks |
| Vidhani *et al.* (2001) (retrospective cohort) | 75/Australia | NPPV | Mechanical ventilation | $PaO_2 < 65$ or $PaO_2/FiO_2 \leq 300$ | ISS, unilateral or bilateral lung contusion, flail chest | Epidural analgesia<br>Patient-controlled analgesia<br>Oral analgesics |
| Linton *et al.* (1982) (retrospective cohort) | 26/South Africa | CPAP | Mechanical ventilation | $PaO_2/FiO_2 \geq 150$ | Number of rib fractures, bilateral rib fractures, flail chest | Epidural analgesia (buprenorphine and morphine) |

[a]AIS: Abbreviated Injury Score; CPAP, continuous positive airway pressure; ISS: Injury Severity Score; IV, intravenous; NPPV: noninvasive positive pressure ventilation; $PaO_2/FiO_2$: partial pressure of oxygen to fraction of inspired oxygen ratio; RCT: randomized controlled trial; TTSS: Thorax Trauma Severity Score.

CHEST | Original Research
CRITICAL CARE MEDICINE

CHEST 2010; 137(1):74–80

# Noninvasive Ventilation Reduces Intubation in Chest Trauma-Related Hypoxemia

## A Randomized Clinical Trial

Gonzalo Hernandez, MD, PhD; Rafael Fernandez, MD, PhD; Pilar Lopez-Reina, MD; Rafael Cuena, MD; Ana Pedrosa, MD; Ramon Ortiz, MD; and Paloma Hiradier, MD

**Allocation within 6 hrs of fulfilling inclusion criteria**

Table 1—Baseline Clinical Characteristics of Patients

| | NIMV Group (n 5 25) | Control Group (n 5 25) | P Value |
|---|---|---|---|
| Epidemiologic variables | | | |
| Age, y | 44.5 6 16.8 | 42.3 6 19 | .7 |
| Male gender | 19 (76%) | 21 (84%) | .5 |
| Comorbidities | | | |
| Chronic heart failure | 5 (20%) | | |
| Chronic airflow limitation | 4 (16%) | | |
| Mechanism of trauma | | | |
| Thoracic compression | 5 (20%) | | |
| Pedestrian road traffic injury | 0 (0%) | | |
| Car crash | 10 (40%) | | |
| Motorbike accident | 3 (12%) | | |
| Fall | 7 (28%) | | |
| Severity scores and associated injuries | | | |
| APACHE II on admission, points | 17.5 6 4.7 | | |
| Shock on admission | 7 (28%) | | |
| • 2 units RBC transfused (first 48 h) | 4 (16%) | | |
| Thoracic AIS, points | 4.1 6 0.7 | | |
| ISS, points | 34 6 11.4 | | |
| Lung contusion, quadrants | 2.3 6 1.1 | | |
| Thoracolumbar vertebral trauma | 10 (40%) | | |
| Flail chest | 4 (16%) | | |
| Pain control | | | |
| Regional anesthesia | 10 (40%) | | |
| Length of regional anesthesia, d | 9 (5-15) | | |
| Gasometric variables at randomization | | | |
| $Pao_2/Fio_2$, mm Hg | 108 6 34.5 | | |
| $Paco_2$, mm Hg | 36 6 8.4 | | |
| Arterial pH | 7.3 6 0.3 | | |

AIS 5 Abbreviated Injury Scale; APACHE 5 Chronic Health Evaluation; ISS 5 Injury Se noninvasive mechanical ventilation.

Table 2—Intubation and Secondary Outcome Variables of Patients

| | NIMV Group (n 5 25) | Control Group (n 5 25) | P Value |
|---|---|---|---|
| Intubation rate | 3 (12%) | 10 (40%) | .02 |
| Causes of intubation | | | |
| Signs of exhaustion | | | |
| Refractory hypoxemia | | | |
| Inability to clear respiratory secretio | | | |
| Major agitation | | | |
| Pneumothorax post randomization | | | |
| Ventilator-associated pneumonia | | | |
| ARDS | | | |
| Sepsis | | | |
| Multiorgan failure | | | |
| ICU stay, d[a] | | | |
| ICU mortality | | | |
| Hospital stay, d[a] | | | |
| Hospital mortality | | | |

See Table 1 for expansior
[a]Expressed as median (2!

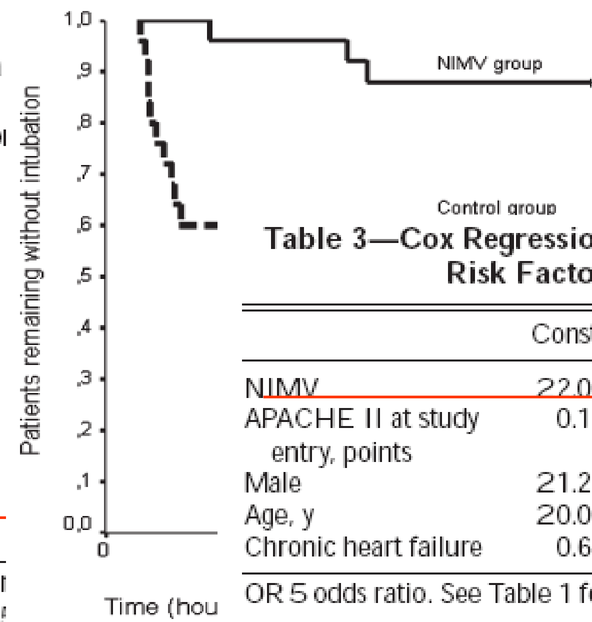



Table 3—Cox Regression Multivariate Analysis of the Risk Factors for Intubation

| | Constant | OR (95% CI) | P Value |
|---|---|---|---|
| NIMV | 22.06 | 0.12 (0.02 - 0.61) | .01 |
| APACHE II at study entry, points | 0.11 | 1.1 (0.98 - 1.27) | .08 |
| Male | 21.26 | 0.28 (0.02 - 2.87) | .3 |
| Age, y | 20.01 | 0.98 (0.95 - 1.02) | .4 |
| Chronic heart failure | 0.65 | 1.9 (0.18 - 20.41) | .6 |

OR 5 odds ratio. See Table 1 for expansion of other abbreviations.

# Drawbacks: exclusion criteria

- Orotracheal i.  indication for another reason
- Need for emergency intubation
- Contraindications for NIV: active ge bleeding; low level of consciousness; multiorgan failure; airway patency problems; lack of cooperation; Hemodynamic instability
- Severe traumatic brain injury
- Facial trauma; skull/orbit base fracture
- Cervical injury preventing the use of a FM
- Gastrointestinal trauma

# Criteri per iniziare la NIV

**Dispnea grave a riposo con reclutamento della muscolatura accessoria**
**discinesia toraco-addominale**

**FR > 25/min**

**Pa CO2 >45-50 mmHg**
**Incremento improvviso di PaCO2 >15-20 mmHg**

**$PAO_2/FiO_2 < 300$**

**pH < 7.35 (ma > 7.10)**

# Approccio al paziente

- **Preparare materiale per IOT**
- **Prevedere un'intubazione difficile**
- **Tronco del paziente a 45°**
- **Adattare la maschera prima di stringerla**
- **Adattamento e riposizionamento**
- **Evitare di stringerla eccessivamente**
- **Idrocolloidi di protezione**
- **Spiegare al paziente quello che facciamo**
- **RX-torace appena possibile**
- **Notificare il caso all'ICU**

# NIV: Criteri di esclusione/sospensione

- **Apnea, bradipnea <12 atti/min.**
- **Coma**
- **Necessità di proteggere le vie aeree**
- **Grave instabilità emodinamica**
- **Aritmie gravi**
- **PNX, pneumomediastino**
- **Impossibilità di adattare la maschera**
- **Impossibilità del paziente a cooperare**
- **Necessità di IOT immediata**

# Thoracic Trauma Severity score on admission allows to determine the risk of delayed ARDS in trauma patients with pulmonary contusion

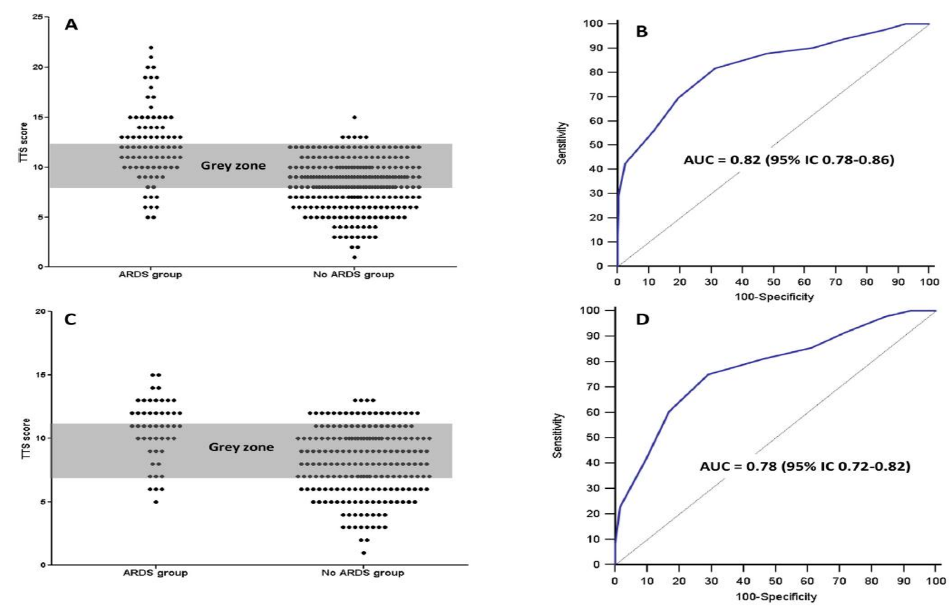
Aurélien Daurat[a], Ingrid Millet[b], Jean-Paul Roustan[a], Camille Maury[a], Patrice Taourel[b], Samir Jaber[c,d], Xavier Capdevila[a,d], Jonathan Charbit[a,*]

Injury, Int. J. Care Injured 47 (2016) 147–153


**Table 1**
Thoracic Trauma Severity (TTS) score.

| $PaO_2/FiO_2$ | Rib fracture | Contusion | Pleural involvement | Age (years) | Points |
|---|---|---|---|---|---|
| >400 | 0 | None | None | <30 | 0 |
| 300–400 | 1–3 | 1 lobe | Pneumothorax | 30–41 | 1 |
| 200–300 | 4–6 unilateral | 1 lobe bilateral or 2 lobes unilateral | Unilateral HT or HPT | 42–54 | 2 |
| 150–200 | >3 bilateral | <2 lobes bilateral | HT or HPT bilateral | 55–70 | 3 |
| <150 | Flail chest | ≥2 lobes bilateral | Tension pneumothorax | >70 | 5 |

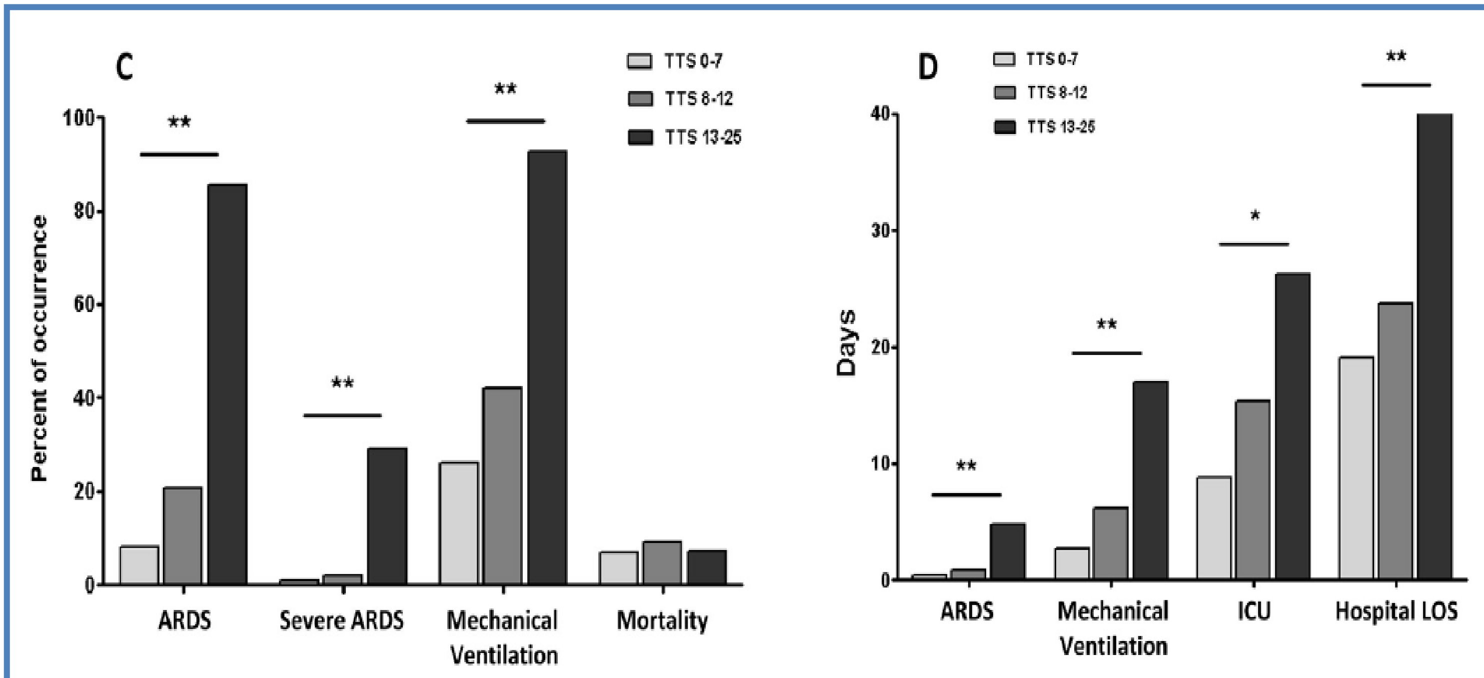
All categories have to be added to achieve a score ranging from 0 to 25. HT, haemothorax; HPT, hemopneumothorax.



# Thoracic Trauma Severity score on admission allows to determine the risk of delayed ARDS in trauma patients with pulmonary contusion

Aurélien Daurat[a], Ingrid Millet[b], Jean-Paul Roustan[a], Camille Maury[a], Patrice Taourel[b], Samir Jaber[c,d], Xavier Capdevila[a,d], Jonathan Charbit[a,*]

Injury, Int. J. Care Injured 47 (2016) 147–153

# Location

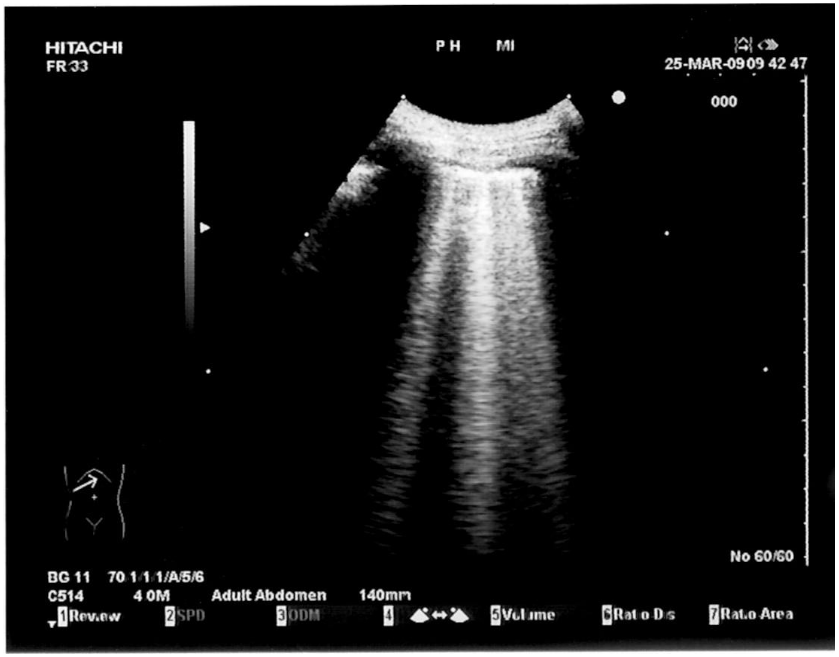
# Monitoraggio di I livello

- Esame obiettivo (1:4)
- Frequenza respiratoria
- EGA
- Saturimetria
- Monitoraggio ECG e PA non invasiva
- Volume corrente espirato
- Score clinici
- Ecografia

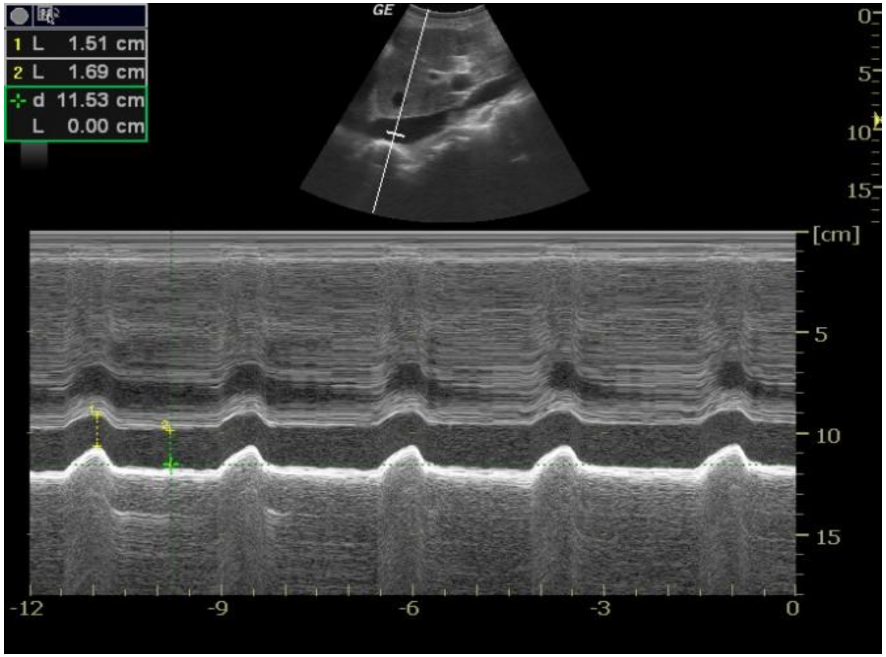
Il monitoraggio di I° livello va eseguito in tutti i pazienti ventilati non invasivamente

- ➢Facile utilizzo
- ➢Basso costo
- ➢Interpretazione non specialistica
- ➢Bassa invasività

# Ecografia polmonare




**Linee B**




**Indice di collassabilità della VCI**

# Quando ricorrere alla IOT

- I BENEFICI DELLA NIV SI MANIFESTANO NELLE PRIME DUE ORE PER POI NON SUBIRE ULTERIORI SIGNIFICATIVI MIGLIORAMENTI ANCHE SE SI CONTINUA IL TRATTAMENTO PER LE SUCCESSIVE 96 ORE

- SE DOPO 1-2 ORE: $SPO_2 \leq 90\%$ $PAO_2 < 60mmHg$
  PH < 7.30 P/F< 200 Fr> 30/min
  Peggioramento stato di coscienza

**Necessario ricorrere alla IOT**

# La NIV nel trauma: peculiarità

- Importanza del preallertamento
- Approccio ABCD del trauma grave
- Gestione multidisciplinare (trauma team) da subito
- Diagnostica estesa a identificare il carattere multisistemico delle lesioni (ECT, Rx, TC)
- Identificare le priorità di trattamento ed eventuale necessità di centralizzazione
- Avvio della NIV in casi selezionati (indicazioni non univoche dalla letteratura)
- Necessità di una efficace sedo-analgesia

# Conclusions

- Chest trauma is a frequent condition, often accompanied by Lung contusion
- This lesion, based on complex and evolutive inflammatory mechanisms, is charachterized by ongoing acute hypoxemic failure and may lead to ALI/ARDS or pneumonia
- Early application of NIV and pain control may be effective in reducing the need for intubation, complication rate and duration of ICU/H stay
- Further and larger studies are needed in order to determin wether CPAP or NIPPV is the best technique, wich kind of patient should be properly treated, and the effect on mortality

# Grazie.

Paolo Groff
Groff.paolo64@gmail.com