Lung protection and Ventilator associated Lung injury (VALI)

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Mechanism of lung injury by mechanical ventilation

- Barotrauma
- Volutrauma
- Atelectrauma
- Biotrauma

Incidence

- Incidence in Thailand – unknown
- Incidence by type - unclear
- Pneumothorax in Mechanical ventilation
  - 4-5% in general case
  - 30-87% in ARDS (10-15 times)
  - Also high in NB and prematurity

Factors influenced VALI

- **Diseases affected lung mechanics**
  - Decreased Lung compliance : ARDS
  - Increased Lung resistance : asthma
  - Unilateral lung disease
- **Inappropriate setting**
  - Over-ventilation
  - Patient-ventilator asynchrony
- **Disease affected lung pathology**
  - Pneumatocole
  - Lung bleb, Cystic lesions

Barotrauma

- Effect of direct pressure injury to the lung
- Overuse of pressure or too high pressure limit
- critical feature appears to be the degree of regional lung distention, rather than the absolute pressure reached
- In general: safety measures :
  - plateau pressure ≤ 30-35

Volutrauma

- Effect of direct volume injury to the lung
- Overuse of tidal volume or too high volume limit especially in ARDS or very differential lung compliance of lung pathology

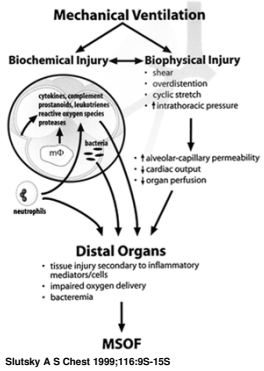
Atelectrauma

- low lung volumes may also contribute to injury
- Effect of the force by repeating open and close of the lung unit
- Opening of this airway would require relatively high forces and the shear stresses produced might cause epithelial disruption

Biotrauma

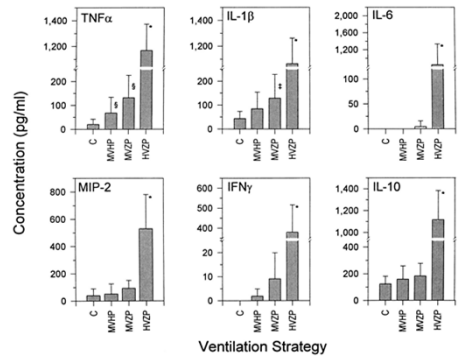
- Increase of the inflammatory cytokines such as TNF-α and macrophage inflammatory protein (MIP)-by positive pressure ventilation
- Too low PEEP and large tidal volume will magnify these markers

Mechanical ventilation: systemic effects and the development of multisystem organ failure (MSOF) by biophysical and biochemical mechanisms



Slutsky A S Chest 1999;116:9S-15S

Lung lavage cytokines after 2 h of mechanical ventilation in an ex vivo, nonperfused rat lung model.



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How to minimize VALI in general

- Adequate airway clearance.
- Adequate treatment of the lung pathology.
- Minimize patient ventilator asynchrony :
  - Appropriate trigger sensitivity
  - Adequate pain control and sedation
  - Muscle relaxant if indicated

How to minimize VALI in general

- Appropriate set of alarms and limits
- Use bedside pulmonary monitoring, curves and loops to monitor changes and adjustments : such as overinflation, optimum PEEP.
- Early detection of complication and re-evaluate plan.

How to minimize VALI in ARDS

- Set appropriate goal of treatment in ARDS
  - low tidal volume strategy : 6-8 ml/kg plus plateau pressure ≤ 30-35 cmH_2O
  - Accept oxygen saturation 88-92 %
  - Accept permissive hypercapnia : selected patient, slow raise acceptable CO2 level and closely monitored.
  - Consider high frequency oscillatory ventilation (HFOV) if indicated.
  - prone position, recruitment maneuver , fluid restriction, good VAP control, etc.

Clinical syndromes of PALS

- Pneumothorax
- Pneumomediastinum
- Pneumopericardium
- Pneumoperitoneum
- Subcutaneous emphysema
- Pulmonary interstitial emphysema

Clinical manifestation

- Sudden dyspnea or desaturation
- Rising of CO2 level
- Increased ventilator setting
- Decrease breath sound
- Swelling or crepitus of skin and soft tissue