MECHANICALLY VENTILATED PATIENT’S WITH ARDS

Presenter: Samuel N. Matata
Kenyatta National Hospital
KCCNC, ASA, ACCC
Outline

• Describe ARDS
• Describe the pathophysiology of ARDS
• Discuss the management of ARDS
• List the complications of ARDS
• Prone positioning in ARDS management
• Case study on prone positioning
Definition

- Diffuse pulmonary parenchymal disease with non-cardiogenic pulmonary oedema and resulting in severe respiratory distress and hypoxaemia
- Caused by a variety of both direct and indirect insults.
- Life threatening and often lethal
- Clinical diagnosis made using a criteria
### Table 1. ARDS Berlin definition.

<table>
<thead>
<tr>
<th>The Berlin definition of acute respiratory distress syndrome</th>
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<tbody>
<tr>
<td><strong>Timing</strong></td>
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<tr>
<td><strong>Chest imaging(^a)</strong></td>
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<tr>
<td><strong>Origin of edema</strong></td>
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<tr>
<td><strong>Oxygenation(^b)</strong></td>
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<td><strong>Mild</strong></td>
<td>$200 \text{ mmHg} &lt; \frac{\text{PaO}_2}{\text{FIO}_2} \leq 300 \text{ mmHg}$ with PEEP or CPAP $\geq 5 \text{ cmH}_2\text{O}$</td>
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<td><strong>Moderate</strong></td>
<td>$100 \text{ mmHg} &lt; \frac{\text{PaO}_2}{\text{FIO}_2} \leq 200 \text{ mmHg}$ with PEEP $\geq 5 \text{ cmH}_2\text{O}$</td>
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<td><strong>Severe</strong></td>
<td>$\frac{\text{PaO}_2}{\text{FIO}_2} \leq 100 \text{ mmHg}$ with PEEP $\geq 5 \text{ cmH}_2\text{O}$</td>
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Abbreviations: CPAP, continuous positive airway pressure; $\text{FIO}_2$, fraction of inspired oxygen; $\text{PaO}_2$, partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure; \(^a\)Chest radiograph or computed tomography scan; \(^b\)If altitude is higher than 1,000 m, the correction factor should be calculated as follows: $\left[\frac{\text{PaO}_2}{\text{FIO}_2} \times \left(\frac{\text{barometric pressure}}{760}\right)\right]$; \(^c\)This may be delivered noninvasively in the mild acute respiratory distress syndrome group.
Etiology

• Any insult that causes a systemic inflammatory response can cause ARDS
  
  - **Direct injury**
    - Aspiration
    - Pulmonary infections
    - Pulmonary contusions
    - Smoke inhalation
  
  - **Indirect injury**
    - Shock
    - Sepsis
    - Trauma, abdominal or multisystem
    - Pancreatitis
Pathophysiology of ARDS

Injury to alveolar-capillary membrane

- Damaged type II alveolar cell
  - ↓ Surfactant production
  - ↓ Alveolar compliance and recoil
    - Atelectasis
- Hyaline membrane formation
- ↓ Lung compliance

- Release of inflammatory mediators
  - ↑ Alveolar-capillary membrane permeability
  - Outward migration of blood cells and fluids from capillaries
    - Pulmonary edema
  - Bronchoconstriction

- ARDS
- Pulmonary hypertension

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Mechanical ventilation

Biochemical injury
- Cytokines, complement
- Prostanoids, leukotrienes
- Reactive oxygen species
- Proteases

Biophysical injury
- Shear
- Overdistention
- Cyclic stretch
- ↑Interathoracic pressure

Bacteria

Neutrophils

Distal organs
- Tissue injury secondary to inflammatory mediators/cells
- Impaired oxygen delivery
- Cyclic stretch
- Bacteremia

MODS

Source: Dean R. Hess, Robert M. Kacmarek: Essentials of Mechanical Ventilation, 3rd Edition
www.accessanesthesiology.com
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Clinical manifestation

- Early signs/symptoms
  - Restlessness
  - Dyspnea
  - Low blood pressure
  - Confusion
  - Extreme tiredness
  - Change in patients behavior
    - Mood swing
    - Disorientation
    - Change in LOC
  - If pneumonia is causing ARDS then client may have
    - Cough
    - Fever
Clinical manifestations cont...

- Late signs/syndromes
  - Severe DIB
  - Tachycardia
  - Cyanosis
  - Metabolic acidosis
  - Abnormal breath sounds (Crackles)
  - ↓ PaCo2 with respiratory alkalosis
  - ↓ PaO2
Diagnostic evaluation

- History of above symptoms
- On physical examination
  - Auscultation reveals abnormal breath sounds
- Tests like:
  - ABGA
  - Blood tests
  - Chest x-ray
  - Bronchoscopy
  - Sputum cultures and analysis
  - Chest CT scan
  - Echocardiogram

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Medical management

- Admission and management in an ICU
- No specific therapy for ARDS
- Supportive measures:
  - Supplemental oxygen
  - Mechanical ventilation: Low Tidal Volume Ventilation, Permissive Hypercapnea, Inverse Ratio Ventilation, High PEEP levels
  - APRV (Airway Pressure Release Ventilation)
Medical management cont.

• Closed circuit suctioning
  ➢ Positioning strategy:
    ✓ prone positioning
    ✓ lateral positioning

• Fluid therapy

• Medications:
  ➢ Antibiotics
  ➢ Anti-inflammatory drugs; such as corticosteroids
  ➢ Diuretics
Management cont...

- Inotropic support
- Anxiolytics
- Muscle relaxers
- Inhaled drugs (Bronchodilators)
- DVT prophylaxis, Stress Ulcer prophylaxis. Pressure sore prevention and management

- Early Enteral Nutrition
- ECMO (Extra Corporal Membrane Oxygenation)
- INO (Inhaled Nitric Oxide)
Case Presentation

• MWN 28yr old F
• Admitted on 18/5/2018 with Hx of acute onset of dyspnea, productive cough, chest pain and easy fatigability
• 2/52 post partum (CS). Elective CS. 1 previous scar at Term.
• Initial diagnosis PTE
Physiology of ventilation in prone position

1. Gas exchange
Cont..

I. Isolated Lung Affected by Gravity (Neglecting the Chest Wall)

Supine Chest

Ventral

Dorsal

Gravity

Dorsal Gravimetric Compression

II. Lung Expansion Constrained by the Chest Wall.

Ventral Expansion

Dorsal Chest Wall Compression

Prone Chest

Dorsal

Ventral

Gravity

Ventral Gravimetric Compression

Dorsal Chest Wall Compression

Ventral Expansion
Cont..

2. Lung Protection

• Prone positioning reduces Ventilator Induced Lung Injury (VILI)

• Prone position decreases barotrauma and atelectrauma

• Reduction in inflammatory biomarkers

• Improved secretion clearance- reduced incidence of VAP

• Complimentary benefits of Prone positioning and high PEEP
3. Cardiac Effects.
   i. Augmentation of cardiac output
   ii. Decrease in RV afterload due to relief of hypoxic pulmonary vasoconstriction

4. Prone Positioning in the obese patient,
   i. Obesity worsens dependent dorsal atelectasis
   ii. Prone position improves oxygenation in obese patients undergoing surgery
   iii. Abdominal hypertension: risk of Kidney and Hepatic dysfunction
   iv. Decreased tolerance of enteral feeds
Complications

- Unplanned extubation
- Selective intubation into main bronchus
- Endotracheal tube obstruction
- Loss of venous or arterial access
- Thoracotomy tube dislodgement or kinking
- Facial and airway edema
- Pressure ulcers
- Hypotension and arrhythmias
- Difficulty in initiating CPR
- Nerve injury: Brachial plexopathy
- Ophthalmologic Complications
Thank You
References


References