ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS)
ACUTE LUNG INJURY (ALI)

Definitions

Acute lung injury is defined as a syndrome of acute lung inflammation with increased vascular permeability, characterized by the following:

1. Bilateral diffuse pulmonary infiltrates on chest radiograph
2. 200 mmHg $< PaO_2 / FiO_2 <$ 300 mmHg, irrespective of the level of PEEP
3. No clinical evidence of elevated left atrial pressure or pulmonary capillary wedge pressure <18 mmHg

Acute respiratory distress syndrome is defined as a syndrome of acute lung inflammation with increased vascular permeability, characterized by the following:

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3. No clinical evidence of elevated left atrial pressure or pulmonary capillary wedge pressure <18 mmHg

ARDS and ALI represent the same disease spectrum but differ in severity

Causes of ARDS/ALI:

<u>Direct Pulmonary injury</u>
Pneumonia
Aspiration of gastric contents
Pulmonary contusion
Fat emboli
Near-drowning
Inhalation of toxic gases
Reperfusion pulmonary oedema following dissolution of pulmonary emboli

<u>Extrapulmonary injury</u>
Sepsis
Severe trauma
Massive transfusion of blood
Cardiopulmonary bypass
Drug overdose
Acute pancreatitis

Pathophysiology

- Inflammation of alveoli with diffuse alveolar injury
- Release of pro-inflammatory cytokines
- Recruitment of neutrophils to lung to release reactive oxygen species and protease
- Loss of barrier to alveolar oedema

- Influx of protein rich fluid into alveoli
- Ventilation-perfusion mismatch, physiological shunting, ↑ dead space and impaired lung compliance
- Patchy heterogeneous collapsed and flooding of alveoli

Clinical features: dyspnea, cyanosis, cough

Laboratory findings: non-specific
Hypoxaemia
Elevated alveolar-arterial oxygen gradient

Complications:
- Barotrauma: pneumothorax, pneumomediastinum, interstitial emphysema
- Nosocomial pneumonia
- Biotrauma: Multi-organ failure resulting from injurious local and systemic inflammatory response to ventilator associated lung injury (VALI)

Management
1) Search and treatment of disorders precipitating ARDS/ALI eg pneumonia
2) Respiratory support – Strategy of mechanical ventilation – low tidal volume, appropriate PEEP and permissive hypercapnia
    - Low tidal volume to reduce "volutrauma", barotrauma
    - PEEP to reduce cyclic recruitment/derecruitment ("atelectrauma") of lung units and redistribute lung water
    - Permissive hypercapnia – frequent consequence of ventilation with low tidal volumes
    - In ARDS net trial, patientst with increased intracranial pressure were excluded

NIH ARDS Network Lower Tidal Volume Ventilation for ALI/ARDS Protocol Summary*

Variables	Protocol
Ventilator mode	Volume assist-control
Tidal volume	≤6 mL/kg predicted body weight†
Plateau pressure	≤30 cm H_2O
Ventilation set rate/pH goal	6–35/min, adjusted to achieve arterial pH ≥7.30 if possible

Inspiratory flow, I:E	Adjust flow to achieve I:E of 1:1–1:3
Oxygenation goal	55 ≤Pa_{O_2} ≤mm Hg or 88 ≤Sp_{O_2} ≤95%
F_{IO_2}/PEEP (mm Hg) combinations‡	0.3/5, 0.4/5, 0.4/8, 0.5/8, 0.5/10, 0.6/10, 0.7/10, 0.7/12, 0.7/14, 0.8/14, 0.9/14, 0.9/16, 0.9/18, 1.0/18, 1.0/22, 1.0/24
Weaning	Attempts to wean by pressure support required when F_{IO_2}/PEEP ≤.40/8

* Sp_{O_2} = oxyhemoglobin saturation by pulse oximetry.

†Predicted body weight for male subjects = 50 + (2.3 x [height in inches - 60]) or 50 + (0.91 x [height in centimeters - 152.4]); predicted body weight for female subjects = 4.5 + (2.3 x [height in inches - 60]) or 4.5 + (0.91 x [height in centimeters - 152.4]).

‡Further increases in PEEP to 34 cm H_2O allowed but not required

- May use pressure controlled ventilation mode (PCV), pressure-regulated volume control (PRVC) or SIMV
- Frequently needs intravenous sedation or even muscle relaxant
- Oxygen toxicity may cause absorption atelectasis and exacerbate lung injury. FiO_2 < 0.6 is usually considered safe

2b) Prone positioning

- May improve oxygenation in many patients (>60%) with ARDS allowing reduction in PEEP and FiO_2
- However, trials have not demonstrated improvement in mortality
- Risks: dislodgement of endotracheal tubes and intravascular catheters, pressure sores, injury to eyes, compromised general nursing care
- No consensus on when it should be used and the duration of prone positioning. One paper suggests the use of prone ventilation if the requirement of FiO2 ≥ 0.6, PEEP ≥ 10 cm water to maintain SpO2 ≥ 90%

2c) Recruitment manoeuvres

- Oxygenation of patients with ARDS can be improved by applying a sustained continuous airway pressure by recruiting collapsed alveoli
- No consensus which is the best recruitment manoeuvres
- For example 40 cm water for 40 seconds
- Can be used for patients who have lung derecruitment due to temporary disconnection from ventilators (eg during suctioning of ET tube)

- To assess PEEP responsiveness

3) Maintain intravascular volume at the lowest level that is compatible with adequate systemic perfusion to decrease pulmonary oedema, which can occur at lower pulmonary capillary pressure

References

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