**Mechanical Ventilation & Acute Respiratory Distress Syndrome (ARDS)**

**ARDS definition:** acute, diffuse inflammatory lung injury causing non-cardiogenic pulmonary edema

**Causes:**
- Direct lung injury: COVID-19, pneumonia, aspiration, smoke inhalation, lung contusion, etc.
- Indirect lung injury: sepsis, polytrauma, pancreatitis, drug-induced, etc.

**Diagnostic criteria** (Berlin definition 2012)
1. Acute onset: within 1 week
2. Bilateral airspace opacities
3. Must rule out CHF or fluid overload as cause of infiltrates
4. PaO2:FiO2 ratio < 300 with a minimum of 5 cm H2O PEEP (i.e. if patient is not intubated, he or she does not meet diagnostic criteria)

<table>
<thead>
<tr>
<th>ARDS Severity</th>
<th>PaO2/FiO2</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>&lt; 300</td>
<td>27%</td>
</tr>
<tr>
<td>Moderate</td>
<td>&lt; 200</td>
<td>32%</td>
</tr>
<tr>
<td>Severe</td>
<td>&lt; 100</td>
<td>45%</td>
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**Lung Protective Ventilation** (ARDSNet 2000)
- Low tidal volumes (6 mL/kg predicted body weight) decreased mortality AND patients where extubated on average 2 days earlier
- Peak pressure kept below 35 cm H2O, plateau pressure kept below 30 cm H20
- Permissive hypercapnia → **target pH 7.20 – 7.45**
- PEEP vs. FiO2 table

<table>
<thead>
<tr>
<th>Principle for FiO2 and PEEP Adjustment</th>
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<tbody>
<tr>
<td>FiO2</td>
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<tr>
<td>PEEP</td>
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**Neuromuscular Blockage** (ROSE 2019) → only use if necessary (i.e. not routinely used)
- Early neuromuscular blockade does not reduce mortality and is associated with an increase in ICU-acquired weakness and serious adverse cardiovascular events

**Volume status** (FACTT 2006)
- Among patients with ARDS, a conservative fluid strategy resulted in improved lung function, decreased ventilator days, reduced ICU stay
- **Consider** diuresis if hemodynamics and renal function allows for it. If patients are hypotensive AND hypoxemic, consider using Lasix + albumin 25% 100 mL in combination

**Proning** (PROSEVA 2013)
- Patients with moderate-severe ARDS (P:F ratio < 150), proning reduces 28-day mortality
- Now standard of care for refractory hypoxemia (patients DO NOT get considered for ECMO unless he or she has failed proning)
- Typically **proned x 16 hrs/day** (proned in the evening, placed supine the next morning)
Clinical Pearls

- **Hypoxemia** (low PaO2)
  - Things to adjust on the ventilator
    - FiO2
    - PEEP
    - Recruitment manoeuvres (30-40 cm H2O for 30-60 seconds)

- **Hypercapnia** (only care if causing respiratory acidosis)
  - Things to adjust on the ventilator
    - Increase **respiratory rate** (but be cognisant of “breath stacking”)
    - Increase **tidal volume** → aim for 6-8 mL/kg PBW, then lower to 4-6 mL/kg PBW once pH above 7.20
  - Other things to try
    - Ventilator dysynchrony?
      - if the patient is fighting the ventilator, consider deepening **sedation**
      - if sedation fails, or if patient is too hypotensive to tolerate increases in sedation, consider **paralysis** (typically cisatracurium is the paralytic of choice in the ICU)

Intubating the ARDS patient

- How to deal with **Severe Hypoxemia**
  - Potential solutions:
    - **apneic oxygenation** with nasal prongs or Airvo
    - apply CPAP via a tight mask seal + add **PEEP valve** to Ambu bag
    - **elevate head-of-bed** to increase **functional residual capacity (FRC)**

- Caution if Severe **Hypercapnea**
  - Potential additional problems:
    - Hypercapnia will get worse during apneic period
    - If patient is acidemic → **watch for hyperkalemia** when using succinylcholine EVEN if K+ was relatively normal
  - Choice of muscle relaxants → no perfect medication

- If using **rocuronium**
  - Onset: **60-80 seconds** in the 1-1.2 mg/kg dose
  - Duration: **60-75 MINUTES**
  - Reversal: sugammadex 16 mg/kg (~$1000/dose, not always readily available)

- If using **succinylcholine**
  - Know your **contraindications**: hyperkalemia, malignant hyperthermia, muscle myopathies, acute burns (unsafe after 48hrs from burn), upper motor neuron injury (e.g. stroke, GBS, degenerative nervous system disorders)
  - Watch for hyperkalemia if patient is severely acidotic EVEN if K+ was recently normal
  - Still the fastest onset: **30-45 seconds** in the 1-2 mg/kg dose
  - Duration: wears off in **5-7 minutes**