

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)

ARDS Severity	PaO ₂ /FiO ₂	Mortality
Mild	< 300	27%
Moderate	< 200	32%
Severe	< 100	45%

Lung Protective Ventilation (ARDSNet 2000)

- Low tidal volumes (**6 mL/kg** predicted body weight) decreased mortality AND patients were extubated on average 2 days earlier
- Peak pressure kept below 35 cm H₂O, plateau pressure kept below 30 cm H₂O
- Permissive hypercapnia → **target pH 7.20 – 7.45**
- PEEP vs. FiO₂ table

Principle for FiO ₂ and PEEP Adjustment								
FiO ₂	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
PEEP	5	5-8	8-10	10	10-14	14	14-18	18-24

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 manouvers** (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
 - K⁺ can shift out of the cell when 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**