



## Management of the Extremely Hypoxic Patient

### Key Article

- *Cavalcanti AB, et al. Effect of lung recruitment and titrated positive end-expiratory pressure (PEEP) vs low PEEP on mortality in patients with acute respiratory distress syndrome: A randomized clinical trial. JAMA. 2017; 318:1335-1345.*

### Background

- **Oxygenation** is one of the top priorities in mechanical ventilation
- **Definitions**
  - A-a gradient
    - Difference between alveolar concentration and arterial concentration of oxygen
    - Complicated equation – best to look it up using online calculator
  - PaO<sub>2</sub>/FiO<sub>2</sub> ratio
    - Mild 200-300 27% mortality
    - Mod 100-200 32% mortality
    - Severe < 100 45% mortality
- **Mechanisms of Hypoxemia**
  - 5 causes: low FiO<sub>2</sub>, hypoventilation, V/Q mismatch, R to L shunt, diffusion impairment
  - From the ED and ICU standpoint, the latter 3 make up the most common causes
  - V/Q mismatch, shunt, and diffusion impairment characterized by widened A-a gradient and abnormal PaO<sub>2</sub>/FiO<sub>2</sub> ratio

### An Approach to the Patient with Refractory Hypoxemia

1. Continue to treat the underlying cause: multilobar PNU, ARDS, interstitial lung disease, massive PE, etc.
2. Look at the CXR
  - a. Normal (or mildly abnormal) CXR
    - i. If ventilating patient on 100% and still hypoxic, consider massive PE.
    - ii. R to L shunt is the only other way that can have severe hypoxia with a normal CXR.
    - iii. Get bedside echo to look for signs of PE
    - iv. Consider treating presumptively w thrombolysis
  - b. Diffuse bilateral interstitial pattern (ARDS)
    - i. Lower demand – treat fever
    - ii. Paralyze patient for lower demand and better patient-vent synchrony

- iii. IV prostacyclin
- iv. Prone positioning – improves oxygenation for 24-48 hours
- v. PEEP- works by multiple mechanisms (recruitment of collapsed alveoli, improves V/Q mismatch, prevents further lung injury from opening and closing of alveoli)
  - 1. Start at 10 to 12
  - 2. Titrate up
  - 3. PEEP recruitment maneuver – (ramp up PEEP to approx. 35 or even higher (40 or 50) for a minute and then back down to around 20-25); this maneuver was formerly recommended in refractory hypoxia.
  - 4. This study in JAMA: large RCT in 120 ICUs (9 countries)
    - a. Severe ARDS patients randomized to usual ARDS vent strategy vs usual ARDS + PEEP recruitment maneuver with ramp up to as high as 45 and then back down
    - b. Higher 28 d mortality (55.3 vs 49.3%) and 6-month mortality (65.3 vs 59.9%)
    - c. Argues against PEEP recruitment maneuvers but does not argue against PEEP itself
- c. Unilateral (or patchy, multilobar) Pneumonia
  - i. Suction, clear secretions
  - ii. Place good side or region of lung down to increase perfusion to that lung or region
  - iii. PEEP likely not helpful and can worsen V/Q mismatch
- 3. Salvage/Rescue therapies
  - a. ECMO – demonstrated improvements in survival in severe flu epidemics
  - b. Alternate ventilator techniques
    - i. Partial liquid ventilation
    - ii. High frequency ventilation/oscillators