HYPOXEMIC RESPIRATORY FAILURE

Cause of Hypoxemia	A-a Gradient
Decreased inspired O_2	Normal A-a gradient. Fully corrects w/ O_2.
Hypoventilation	
Diffusion disorder	↑ A-a gradient. Partially corrects w/ O_2.
V/Q mismatch	
Shunt	↑ A-a gradient. WON'T CORRECT w/ O_2.

CHEST®

ALVEOLAR GAS EQUATION

- How much O_2 in the alveolus

$$PAO_2 = [713 \times FiO_2] - (PaCO_2/0.8)$$

or

$$\mathbf{PAO_2 = [(P_{ATM} - P_{H2O}) \times FiO_2] - (PaCO_2/0.8)}$$

P_{ATM} = Atmospheric pressure

P_{H2O} = Partial pressure of water (humidity)

- Each of these components can affect oxygenation

A-a GRADIENT

- Classic method of assessing difficulties in oxygenation

$$\mathbf{A\text{-}a\ gradient = PAO_2 - PaO_2}$$

PAO_2 = Alveolar PO_2; PaO_2 = Arterial PO_2

- Normal A-a gradient is less than 20 mm Hg while breathing ambient air (FiO_2 0.21).

DECREASED INSPIRED OXYGEN

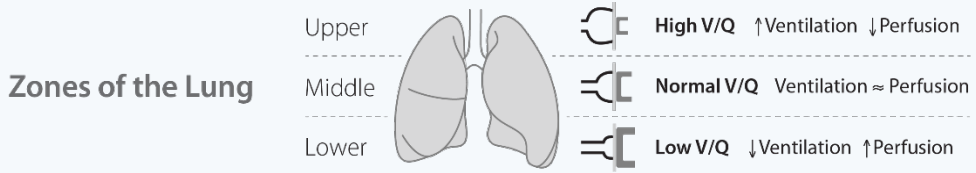
- Low P_{ATM} can decrease first part of alveolar gas equation
  - P_{ATM} = 760 mm Hg at sea level
  - P_{H2O} = 47 mm Hg in average settings
- Causes: High altitude (eg, climbing the Andes or Mount Everest)

HYPOVENTILATION

- Rising $PaCO_2$ decreases second part of alveolar gas equation
- Causes: Decreased respiratory drive due to neurologic injury or sedatives, obesity-hypoventilation syndrome, OSA

DIFFUSION DISORDER

- Difficulty diffusing oxygen across capillary-alveolar interface
- Less common than V/Q mismatch and shunt
- Improves with supplemental oxygen
- Causes: Interstitial lung diseases, pulmonary edema (most common cause of reversible diffusion defects)



VENTILATION/PERFUSION (V/Q) MISMATCH

- Most common cause of hypoxemic respiratory failure
- There are gravity-dependent gradients of both perfusion (Q) and ventilation (V) in the lungs
- Ideal gas exchange depends upon matching adequate ventilation with adequate perfusion
- Mismatching in either direction leads to hypoxemia
- Causes: Pneumonia, asthma, COPD, pulmonary embolus

SHUNT

- Occurs when blood is bypassing the lungs
- Causes: Intrapulmonary shunting (eg, pulmonary AVMs, hepatopulmonary syndrome), intracardiac shunting (eg, atrial or ventricular septal defects)
- **Does not improve** with supplemental oxygen