CHAPTER 8

Ventilation-Perfusion Relationships
Normal Ventilation-Perfusion Ratio (V/Q Ratio)

Fig. 8-1. The normal ventilation-perfusion ratio (V/Q ratio) is about 0.8.
HOW THE VENTILATION-PERFUSION RATIO AFFECTS THE ALVEOLAR GASES
Upright Lung and V/Q Ratio

Fig. 8-2. In the upright lung, the V/Q ratio progressively decreases from the apex to the base.
INCREASED V/Q RATIO
When the V/Q Ratio Is High

Fig. 8-3. When the V/Q ratio is high, the alveolar oxygen pressure (PAO₂) increases and the alveolar carbon dioxide pressure (PACO₂) decreases.
DECREASED V/Q RATIO
When the V/Q Ratio Is Low

Fig. 8-4. When the V/Q ratio is low, the alveolar oxygen pressure (PAO₂) decreases and the alveolar carbon dioxide pressure (PACO₂) increases.
The $O_2-CO_2$ Diagram

Fig. 8-5. The $O_2-CO_2$ diagram.
HOW VENTILATION-PERFUSION RATIO AFFECTS END-CAPILLARY GASES
Pulmonary Capillary Blood Gases (PcO$_2$ and PcCO$_2$)

Fig. 8-6. The mixing of pulmonary capillary blood gases (PcO$_2$ and PcCO$_2$) from the upper and lower lung regions.
Fig. 8-7. How changes in the V/Q ratio affect the PAO$_2$ and the PcO$_2$, the PACO$_2$, and the pH of pulmonary blood.
Respiratory Quotient

• Internal respiration
  – Gas exchange between systemic capillaries and cells
  – Normally, 250 mL of $O_2$ consumed by tissue cells in one minute
  – In exchange, cells produce about 200 mL of $CO_2$
Respiratory Quotient (RQ)

• Clinically, it is the ratio between the volume of $O_2$ consumed ($VO_2$) and the volume of $CO_2$ produced ($VCO_2$)
Respiratory Quotient

\[ RQ = \frac{V_{CO_2}}{V_{O_2}} \]

\[ = \frac{200 \text{ mL CO}_2/\text{min}}{250 \text{ mL O}_2/\text{min}} \]

\[ = 0.8 \]
Respiratory Exchange Ratio

• External respiration
  – Gas exchange between the pulmonary capillaries and the alveoli

• Respiratory exchange ratio (RR)
  – Quantity of $O_2$ and $CO_2$ exchanged during a period of one minute

• Normally, the RR and RQ are equal
HOW RESPIRATORY DISORDERS AFFECT THE V/Q RATIO
Alveolar $O_2$ and $CO_2$ Pressure Changes

Fig. 8-8. Alveolar $O_2$ and $CO_2$ pressure changes that occur as a result of V/Q ratio changes caused by respiratory disorder. (A) shunt unit; (B) normal unit; (C) dead space unit.
Clinical Application 1 Discussion

• How did this case illustrate …
  – An increased ventilation-perfusion ratio caused by an excessive amount of blood lost as a result of trauma?
Clinical Application 1:
A 34-year-old male impaled by a steel enforcement rod.
Clinical Application 2 Discussion

- How did this case illustrate …
  - A decreased V/Q ratio caused by an upper airway obstruction?
Clinical Application 2: A 4-year-old boy who aspirated a quarter.