VENTILATION – PERFUSION RELATIONSHIPS

Ventilation / Perfusion Ratio

Ventilation 4 L/M
Perfusion 5 L/M
Ratio 4/5 = 0.8

The value of 0.8 reoccurs in other relationships:

Internal respiration (Respiratory Quotient) is 0.8
External respiration (Respiratory Exchange Ratio) is 0.8

The lung regions can be visualized as zones based on the degree of perfusion to those regions, which is greatly influenced by gravity. The zones are positional, with the uppermost zone being zone one, and the lower or dependent area as zone three. So, Zone 1 in the upright lung, might shift to the lateral area of the lung if the patient lays on their side.
Perfusion (as ventilation) is gravity dependent. Zones of perfusion indicate gravitational effects but are also influenced by cardiac output and pulmonary vascular resistance. Changes in cardiac output and resistance can thus alter the zones of perfusion.
Figure 4-12. Generalized disturbances of pulmonary perfusion. © W. B. Saunders. 1995: Clinical Blood Gases: Application and Non-invasive Alternatives.
Figure 5-18
Relationship between gravity, alveolar pressure ($P_a$), pulmonary arterial pressure ($P_a$), and pulmonary venous pressure ($P_v$) in different lung zones. Note: The +2 cm H$_2$O pressure in the alveoli (e.g., during expiration) was arbitrarily selected for this illustration.
In the upright lung:

Apices – receive more ventilation than perfusion (high ventilation/perfusion ratio), > 0.8

Bases – more perfusion than ventilation (low ventilation/perfusion ratio) < 0.8
Shunt versus Dead space

Variations in the distribution of ventilation in conjunction with distribution of perfusion, can run the gamut of perfusion without ventilation (known as physiologic dead space) to anatomic shunt (blood bypasses the lungs and directly enters the systemic circulation).

Anatomic shunt cause deoxygenated blood to transfer into the systemic circulation without passing through the pulmonary circulation:

Bronchial and Thebesian Veins

Accounts for 75% of the difference between alveolar $O_2$ and arterial $O_2$. 

![Diagram showing physiological shunting and physiological deadspace](image)
V/Q infinite:

ventilation with 0 perfusion – alveolar dead space

High V/Q:

$P_{A\text{O}_2}$ high, $P_{A\text{CO}_2}$ low

ventilation > normal, or perfusion < normal

Low V/Q: $P_{A\text{O}_2}$ low, $P_{A\text{CO}_2}$ high

Ventilation < normal, or Perfusion > normal

V/Q = 0

0 ventilation with perfusion – alveolar shunt