

RELATIONSHIP OF VENTILATION / PERFUSION

Ventilation: Process by which gases are moved in and out of the lung.

Perfusion: Circulation to the lungs with transport of CO₂ and O₂ in the blood.

Diffusion: Passive movement of O₂ and CO₂ between lungs and blood stream at the cellular level.

Ventilation / Perfusion defect: a disorder in which one or more areas of the lung receive ventilation but no blood flow, or blood flow but no ventilation.

Ventilation / Perfusion (V/Q) Ratio: the ration of pulmonary alveolar ventilation to pulmonary capillary perfusion, measure in similar units

Causes of ventilation / perfusion problems:

- Pulmonary emboli
- Atelectasis, pneumonia, emphysema, fibrosis
- ARDS

Types of Ventilation / Perfusion Abnormalities:

1. **Dead space unit:** airway or lung that is ventilated but not perfused
Example: pulmonary embolus prevents blood flow through pulmonary capillary
 - Anatomical dead space (True dead space)
The conducting airways
 - Alveolar dead space
Air space in the lung that is ventilated but not perfused. (Apices of normal lungs in standing man.)
 - Physiological dead space
Perfused but not ventilated (shunt)
2. **Shunt unit:** No ventilation to an alveolar unit but perfusion continues however, unoxygenated blood continues to circulate.
Example: atelectasis, pneumonia, ARDS causes the alveoli to collapse
3. **Silent Unit or Total Shunt:** No ventilation, no perfusion.
Example: Emboli combined with ARDS

Adult Respiratory Distress Syndrome (ARDS)

ARDS is not considered a specific disease but rather a syndrome of manifestations of deteriorating pulmonary status associated with a variety of conditions.

http://www.nhlbi.nih.gov/health/dci/Diseases/Ards/Ards_WhatIs.html

Definition: A rapidly progressive, diffuse pulmonary condition characterized by a **non-cardiogenic**, high permeability pulmonary edema, resulting in **hypoxemia**, decreased lung compliance, and acute respiratory failure (**dyspnea**).

- Pulmonary edema in the absence of cardiac failure is the hallmark of ARDS.
- One of the criteria cited for helping diagnose ARDS is the presence of a **clinical risk factor**. May result from a direct pulmonary insult, or indirect systemic insult. (See below)
- There is usually a latent period of 18 –24 hours from the time of lung injury until the development of symptoms.
- Pulmonary injury in ARDS is a result of the accumulation of protein-rich fluid in the interstitial spaces of the capillaries and in the alveoli, secondary to increased microvascular permeability.

Clinical Risk Factors:

Direct (primary, pulmonary insult)

Aspiration
Embolism
Inhaled toxins
Radiation treatments
Near drowning
Pulmonary contusion
Pneumonia

Indirect (secondary)

Burns
DKA
DIC
Pancreatitis
Sepsis
Multisystem trauma
Shock

Pathophysiology:

- Exudative phase
- Proliferative phase
- Fibrotic phase

Diagnosis:

- Based on three distinguishing characteristics:
 1. **Refractory hypoxemia** associated with previously normal lungs
 2. Presence of pulmonary edema (evident by diffuse infiltrates on chest x-ray)
 3. Decreased lung compliance (stiff lungs)

Clinical Manifestations:

- Acute respiratory distress (tachycardia, dyspnea, accessory muscle breathing, and cyanosis)
- Dry cough and fever that develop over a few hours or days
- Fine crackles in the lung bases
- Altered sensorium ranging from confusion and agitation to coma
- Chest x-ray reveals diffuse, bilateral and usually symmetric interstitial and alveolar infiltration “WHITE OUT”
- ABG’s :
 - Hypoxemia, PaO₂ less than 50mm Hg
 - Hypocapnia resulting from compensatory hyperventilation of the functional alveoli resulting in....
 - Respiratory alkalosis
 - End stage: hypercapnia, respiratory acidosis and death

Treatment

- Endotracheal intubation and mechanical ventilation
 - Increase alveolar ventilation
 - Normalization of blood gases, permissive hypercapnia
 - Better distribution of inspired air
- Lung protective ventilation strategies
 - Low tidal volumes
 - Protect the lungs from overdistension
 - Avoid end-expiratory collapse
- Antibiotics to treat confirmed or suspected underlying infection
- Diuretic to increase renal excretion of water
- Sedation as appropriate
- Nutritional support with adequate calories and protein
- Prone positioning

Nursing Care for ARDS

Goals:

1. Reverse the initiating insult
2. Provide adequate oxygenation while minimizing the risk of O₂ toxicity
3. Avoid preventable complications that could be fatal
4. Decrease the energy spent on respiration
5. Prevent further systemic insult
6. Encourage coughing
7. Appropriate repositioning
8. Prevent pressure breakdown
9. Monitor closely
10. Treat anxiety