Ventilation vs. Perfusion
Oxygen is just a Pulse OX Band-Aid

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Ventilation/perfusion ratio
The ratio of the amount of air reaching the alveoli to the amount of blood reaching the alveoli. These two variables, V & Q, constitute the main determinants of the blood oxygen (O2) and carbon dioxide (CO2) concentration.

Terminology
Ventilation Mismatch
• An area with perfusion but no ventilation (and thus a V/Q of zero) is termed “shunt.”

Perfusion Mismatch
• An area with ventilation but no perfusion (and thus a V/Q undefined though approaching infinity) is termed dead space.
Pathophysiology

Ventilation
A lower V/Q ratio impairs pulmonary gas exchange and is a cause of low arterial partial pressure of oxygen (\(paO_2\)). Excretion of carbon dioxide is also impaired, but a rise in the arterial partial pressure of carbon dioxide (\(paCO_2\)) is very uncommon because this leads to respiratory stimulation (SOB) and the resultant increase in alveolar ventilation returns \(paCO_2\) to within the normal range. These abnormal phenomena are usually seen in chronic bronchitis (COPD), Asthma, hepatopulmonary syndrome (LIVER DISEASE), and pulmonary edema (CHF).

Perfusion
A high V/Q ratio decreases \(paCO_2\) and increases \(paO_2\). This finding is typically associated with pulmonary insufficiency, embolism (where blood circulation is impaired by an embolus). Ventilation is wasted, as it fails to oxygenate any blood. A high V/Q can also be observed in Emphysema, Pulmonary Fibrosis, and Lung Cancer as a maladaptive ventilatory overwork of the undamaged lung parenchyma.

Know the physiologic effects of your diseases
"V" – ventilation – the air that reaches the alveoli
- COPD
- ALS/Neuromuscular
- CHF (active fluid overload)
- Renal disease
- Liver disease
- Lung cancer
- Pulmonary fibrosis
- End of life depressed respiratory drive

"Q" – perfusion – the blood that reaches the alveoli
- CHF/Cardiac Dysfunction
- Lung cancer
- Pulmonary fibrosis
- Emphysema

Minute Volume
Respiratory Rate \(F\) x Tidal Volume \(VT\) = Minute Volume \(MV\)
\(F \times VT = MV\)
- \(MV\) is an Individualized autonomic “magic number” to regulate \(CO_2\) (<\(VT = F\)>)
- Dyspnea and hypoxia are most often secondary to < \(VT\)
- Increased supplemental passive oxygen flow (\(FiO_2\)) is merely an oxygen blood saturation (\(SaO_2\)) band aid when hypoxia and dyspnea are based on ventilation

Minute Volume
Pulse Oximeter

Unreliable Accuracy

- Circulatory Issues
- The measurement is taken at the most distal point of body
- Shunting
- Oxygenated blood will service major organs before peripheral
- Irregular cardiac rhythm
- Monitor must pick up a linear heart rate
- Obstructed nail beds

Non-Invasive Positive Pressure Ventilation

BIPAP

- Increased Volume in, Increase Volume out = CO2 removal
- Increasing the VT, decreases RR
- Decreases work of breathing WOB
- Decreases accessory muscle fatigue
- Increase energy
- Optimize caloric intake
- Decrease anxiety
- Slows cardiac output CO which allows normal kidney function to resume and can decrease fluid overload
- Compensates for diaphragmatic insufficiencies
- Overcomes abdominal abnormalities

Interventions for both Ventilation and Perfusion issues and their side effects

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Side Effect</th>
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</thead>
<tbody>
<tr>
<td>BIPAP</td>
<td>Decreased BP</td>
</tr>
<tr>
<td>Broncho-Dilators</td>
<td>&gt; CO &gt; fluid overload</td>
</tr>
<tr>
<td>Lasix</td>
<td>&lt; K and risk of renal failure</td>
</tr>
<tr>
<td>Opioids</td>
<td>&lt; LOC, &lt; ventilation, &lt; cough</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>&lt; LOC, &lt; ventilation, &lt; cough</td>
</tr>
<tr>
<td>Anticholinergic</td>
<td>Thicken glue like secretions</td>
</tr>
<tr>
<td>Oxygen therapy</td>
<td>CO2&gt;, psychological dependence</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>Termers, insomnia, aggression, laryngeal spasm</td>
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</tbody>
</table>
**Opti-flow**

Heated, Humidified High Flow Nasal Cannula Oxygen Therapy (HHFNC)

**Benefits compared to standard oxygen therapy**
- Pharyngeal dead space washout (CO2 expulsion)
- Reduction of nasopharyngeal resistance (increased humidification surface area)
- Positive expiratory pressure (PEEP): alveolar recruitment
- Humidification, great comfort and better tolerance
- Better control of FiO2 if blended and better mucociliary clearance
- Allows the patient to talk and take thing by mouth PO

**Limitations**
- Not supported in outpatient setting well
- Difficulty in decreasing level of support
- No significant ventilatory support
- No significant decrease of hypercapnia
- No benefit for CHF or renal related pulmonary edema

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**BIPAP**

Biphasic Positive Airway Pressure

**Benefits**
- Exceeds all physiologic benefits of Opti-flow
- Supported in outpatient settings
- Effective with chronic and acute SOB symptom management
- Decreases SOB secondary to CHF and renal related pulmonary edema
- Supports inadequate ventilatory status

**Limitations**
- Compliance issues (Positive pressure vs. normal passive ventilation)
- Decreases cardiac output, (Risk of MI in severely hypotensive patients)
- Comfort issues
- Communication limitations

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**Think Before You Treat**

- Oxygen and nebulizer treatments are usually not going to effectively manage most Hypoxic and Breathing issues.
- Start with increasing their ventilation and everything else will take care of themselves
<table>
<thead>
<tr>
<th>Interventions</th>
<th>Effects</th>
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<tbody>
<tr>
<td>Non-Rebreather Mask</td>
<td>Increased O2 content, no ventilatory support or flow relief</td>
</tr>
<tr>
<td>Oxymizer Cannula</td>
<td>Increased O2 content, no ventilatory support or flow relief</td>
</tr>
<tr>
<td>HF Nasal cannula</td>
<td>Increased O2 content and flow relief, no ventilatory support</td>
</tr>
<tr>
<td>Venti-Mask</td>
<td>Increased O2 content, partial flow relief, no ventilatory support</td>
</tr>
<tr>
<td>Opti-flow</td>
<td>Increased O2 content and flow relief, no ventilatory support</td>
</tr>
<tr>
<td>BiPAP</td>
<td>Increased O2 content, flow relief, and ventilatory support</td>
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</tbody>
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