Oxygen Topics

Pitfalls With Pulse Oximetry
Oxygen Delivery Systems
Humidified Oxygen
Oxygen Tank Tricks
Pitfalls With Pulse Oximetry

Difficult to Obtain or Inaccurate Readings

• Peripheral vasoconstriction and/or poor perfusion (CHF, hypothermia, severe PVD e.g.)
• Ambient light
• Some nail polishes (especially metallics), false nails
• Dark skin pigmentation
• Carboxy/methemoglobinemia (falsely high reading)
• Severe anemia (falsely high reading sometimes)
• Patient movement
Pitfalls With Pulse Oximetry

Helpful Hints

• Always correlate oximeter reading with pulse
  – Visual waveform
  – Beeping

• Earlobe oximetry sometimes helpful when fingers are always vasoconstricted or poorly perfused

• Low threshold to obtain Arterial Blood Gases with questionable oximetry readings
Oxygen Delivery Systems

Low Flow vs. High Flow

• Refers to flow rate of O₂ delivered to patient compared to patient’s ventilatory demands
• Does NOT refer to flow rate of O₂ coming from tank or headwall (usual range 1-25 L/min)
• Normal inspiratory flow rate: 25-30 L/min

Low Concentration vs. High Concentration

• Refers to Fraction of Inspired Oxygen, or FiO₂
• Low FiO₂ range 21-50%, high FiO₂ range 51-100%
Quirks About Knowing $O_2$ Delivery

Some low flow systems can deliver high concentrations of $O_2$

- Example: Non-rebreather mask (low flow system) can deliver $FiO_2$ of 70%

Some high flow systems can deliver low concentrations of $O_2$

- Example: Venturi mask (high flow system) can be set to deliver $FiO_2$ as low as 24%
Oxygen Delivery Systems

Low Flow (Variable Performance) Systems

- Provide $O_2$ at flow rates < patient inspiratory demand
- If total ventilation exceeds maximum capacity of $O_2$ reservoir, room air drawn in
- Final FiO$_2$ delivered depends upon...
  - Ventilatory demands of patient
  - Size of $O_2$ reservoir
  - Rate at which $O_2$ reservoir is filled

Stroke. 2005; 36: 2066-2067
Oxygen Delivery Systems

High Flow (Fixed Performance) Systems

• Provide a constant FiO$_2$
• Provide all inspiratory flow to patient
• Work primarily by two methods...
  – Deliver O$_2$ at flow rates > patient peak inspiratory flow rate (usually 40-70 L/min)
  – Use a system that entrains a fixed proportion of room air

Stroke. 2005; 36: 2066-2067
Types of $O_2$ Delivery Systems

**Low Flow $O_2$ Systems**

- Nasal Cannula
- Simple Mask
- Reservoir (Non-Rebreather) Mask

**High Flow $O_2$ Systems**

- Venturi Mask
- Large Volume Aerosol/Nebulizer Mask
  - Not commonly used on Gen Med (trach/post-op patients)
Low Flow O₂ Delivery Systems

Nasal Cannula

• Curved prongs should point caudad ("down")
  – Point up if major discomfort issues
• Flow range 1-6 L/min, humidify at > 4 L/min
• Little bang for buck at flows > 6 L/min
• General rule: FiO₂ increases by 3-4% per L/min flow
  – But depends upon patient breathing pattern
• Delivers FiO₂ in the 22-44% range
• Tubing length up to 50 feet
Humidified O$_2$ vs. Aerosolized O$_2$

Humidity

- Addition of atomized/molecular water to a gas
- Maintains normal physiologic conditions in airways when air is cold and dry
- Helpful with supplemental O$_2$ running at higher flow rates (> 4L/min)
- No increased infection risk
Low Flow $O_2$ Delivery Systems

- 1L = 21-24% $FiO_2$
- 2L = 23-28% $FiO_2$
- 3L = 27-32% $FiO_2$
- 4L = 29-36% $FiO_2$
- 5L = 31-40% $FiO_2$
- 6L = 33-44% $FiO_2$
Low Flow O$_2$ Delivery Systems

Simple Mask

• No advantage over nasal cannula unless nasal cannula cannot be used
  – Patient discomfort
  – Nasal cannula dislodges easily, facial/nasal deformity
• Generally used in short term, emergency situations
• Delivers FiO$_2$ in the 31-44% range
• Will not reliably deliver > 35% FiO$_2$
Low Flow $O_2$ Delivery Systems

Hines Simple Mask (HudsonRCI)

- $5L = 31-40\% \text{ FiO}_2$
- $6L-8L = 33-44\% \text{ FiO}_2$
- Do not run at < 5L/min
  - CO2 will not flush out
Low Flow $O_2$ Delivery Systems

Reservoir (Non-Rebreather) Mask

- Used to deliver $\text{FiO}_2 > 40$
- Often mistakenly called a “100% Non-Rebreather”
- Will not reliably deliver more than 60-70% $\text{FiO}_2$
- $O_2$ Flow rate titrated to keep reservoir from deflating
- Generally used in short term, emergency situations
Low Flow $O_2$ Delivery Systems

Non-Rebreather Mask

- Always keep bag $\geq 1/3$ full
- 10-25L/min often needed
High Flow $O_2$ Delivery Systems

Venturi Mask System

- Air entrainment mask

Based Upon Venturi Effect

- Tube with drop in inside diameter increases velocity of fluid/gas flowing inside, thus decreasing pressure inside tube
- Described by 18th century Italian physicist Giovanni Battista Venturi
High Flow O₂ Delivery Systems

Venturi Mask System

• Used to draw a second fluid/gas inside tube
• 100% O₂ flow through “Venturi” within base of mask draws (entrains) room air into mask
• Amount of entrained air determined by size of entrainment port
• Allows for very precise/controlled FiO₂ delivery
• 24% to 50% FiO₂ range
  – Only reliable as High Flow system up to 40% FiO₂
High Flow $O_2$ Delivery Systems

Hines Venturi Mask (HudsonRCI)

- **Green diluter**
  - 24% at 3L/min
  - 26% at 3L/min
  - 28% at 6L/min
  - 30% at 6L/min

- **White diluter**
  - 35% at 9 L/min
  - 40% at 12 L/min
  - 50% at 15L/min

www.hudsonrci.com
Humidified Oxygen

Bubble humidifiers

• Molecular H₂O humidity (invisible)
• No infection risk
• Usually only needed with flow rates > 4L/min
• Recall normal inspiratory flow rate (25-30 L/min)
Oxygen Tank Tricks

• D, E, G, H, K, and M type cylinders most commonly used in healthcare
• Tanks deemed reliable down to a certain low limit pressure (known as “safe residual” pressure)
• Tank factor (in L/psi) exists to estimate remaining capacity in full/partially full tank
  – D cylinder: 0.16 L/psi
  – E cylinder: 0.28 L/psi
  – G cylinder: 2.41 L/psi
  – H cylinder: 3.14 L/psi
  – K cylinder: 3.14 L/psi
  – M cylinder: 1.56 L/psi
Oxygen Tank Tricks

Hines Oxygen Cylinders (Airgas Walk O\textsubscript{2}Bout)
Oxygen Tank Tricks

Hines Oxygen Cylinders

• Tank capacity 679 L (typically filled to 616 L)
• “Tank Factor” 0.28 L/psi
• Flow rates 0.25 L/min to 25 L/min
• Pressure gauge range 0-3000 psi
• “Red” range 0-500 psi, “Green” range 1800-2200 psi
• Full tank typically 2200 psi
• “Safe Residual” 300 psi
Oxygen Tank Tricks

Sample Scenario

- Your patient needs to go to CT...
- You estimate a 1 hour trip to/from floor to CT...
- You have an E cylinder (tank factor 0.28 L/psi, safe residual of 300 psi) at 900 psi...
- Your patient is on nasal cannula $O_2$ running at 4L/min, and desaturates to 75% if on room air...

Are You “Good to Go”?
Oxygen Tank Tricks

Calculations...

Duration (min) = \[ \frac{\text{cylinder pressure} - \text{safe residual (psi)} \times \text{tank factor (L/psi)}}{\text{oxygen flow (L/min)}} \]

Duration (min) = \[ \frac{[900 - 300 \text{ psi}] \times 0.28 \text{ L/psi}}{4 \text{ L/min}} = 42 \text{ minutes} \]

Conclusion: Get a New Tank!!!
# Oxygen Tank Tricks

<table>
<thead>
<tr>
<th>Flow L/min</th>
<th>Pressure Reading (psi) on E cylinder</th>
<th>Minutes of Operation to Safe Residual 300 psi (Rounded Down)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500</td>
<td>750</td>
</tr>
<tr>
<td>1</td>
<td>56</td>
<td>126</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td>63</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>42</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>5</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>