Low-flow Devices

• Nasal cannula
  – the ___________ used O₂ administration device
  – used to treat spontaneously breathing, hypoxemic patients
  – have two 1/2 inch prongs that fit into the external nares
  – secured by either an elastic strap or over-the-ear tubing
  – available in infant, child and adult sizes

Low-flow Devices

• Nasal cannula
  – with adult patients, nasal cannulas can produce FİO₂ of ___________ , using O₂ flow rates of _________ L/min
  – flow rates greater than ______ L/min are poorly tolerated because they can cause drying of the nasal mucosa and nasal bleeding
  – with neonatal patients, O₂ flows of 0.25 to 1 L/min can produce FİO₂ of 0.35 to 0.70
Low-flow Devices

- Nasal cannula
  - $\text{FiO}_2$ depends on the patient’s $V_r$, $f$ and whether breathing is mostly through the nose or mouth
  - $\text{FiO}_2$ approximately 0.04 (4%) with every liter of flow increase
  - these values are approximate only – the need to start and/or continue $O_2$ therapy should be based on observation of the patient’s breathing pattern, the level of comfort and arterial blood gas analysis or ______________

Approximate $\text{FiO}_2$s

<table>
<thead>
<tr>
<th>Nasal Cannula</th>
<th>L/min 100% $O_2$</th>
<th>Approximate $\text{FiO}_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0.28</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>0.32</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>0.36</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>0.40</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Pulse Oximetry

Pulse oximetry provides continuous or intermittent non-invasive measurement of arterial ______________.

Arterial saturation ($\text{SaO}_2$) refers to the amount of $O_2$ being carried in the arterial blood by the ______________. If Hb saturation is measured by pulse oximetry, the abbreviation is ______________.
Low-flow Devices

- Nasal cannula
  - advantages
    - inexpensive, lightweight, comfortable – tolerated by most patients
    - patient can eat, drink, talk with cannula in place

Low-flow Devices

- Nasal cannula
  - disadvantages
    - nasopharyngeal-mucosal irritation
      - occurs most often with high flows and straight prongs
      - use < 6 L/min (or lowest therapeutic flow)
      - use cannulas with curved prongs
      - adding ____________ may also help
    - skin irritation at contact points
      - at nares, cheeks and ears
      - at cheeks and ears, padding may help
      - at nares, a ____________ lubricant can be used

Low-flow Devices

- Nasal cannula
  - disadvantages
    - twisting or kinking of supply tubing
      - avoid excessive lengths of tubing
      - ensure tubing does not rest behind patient's head
      - periodically check tubing for patency
Low-flow Devices

• Transtracheal catheter
  – thin Teflon catheter inserted surgically by a physician via a guide wire directly into the ____________ between the 2nd and 3rd tracheal rings - secured by a custom-sized chain necklace
  – since it resides directly in the trachea, O₂ builds up there and in the upper airways during expiration increasing FiO₂ at any given flow

Low-flow Devices
Transtracheal catheter

Low-flow Devices

• Transtracheal catheter
  – O₂ flows range from ____________ L/min
  – FiO₂s range from 0.22-0.35 and depend on the patient’s V̇, f, and set O₂ flow
  – as with nasal cannulas, ABG analysis and/or pulse oximetry should be used to document the need for O₂ therapy
  – patient selection must be done carefully and comprehensive patient education and professional follow-up must be provided
Low-flow Devices

- **Transtracheal catheter**
  - advantages
    - require 40-60% less \(O_2\) flow to achieve a given \(\text{PaO}_2\) - some patients require flows of only 0.25 L/min to achieve adequate oxygenation
    - increased patient __________
    - increased patient __________ with \(O_2\) therapy
    - decreased nasal mucosa irritation

- **Transtracheal catheter**
  - disadvantages
    - requires __________ for placement
      - may cause hemoptysis, infection, subcutaneous emphysema
    - requires greater __________
      - catheter lumen must be kept clean and clear
      - saline instillation by patient is also required

Reservoir Devices

- **Reservoir cannulas**
  - used for __________ patients
  - can reduce oxygen usage by as much as ______
  - nasal reservoir (mustache) cannula
    - holds about 20 ml of \(O_2\)
    - \(O_2\) fills a membrane reservoir during __________
    - initial inspiration draws from this reservoir
    - as reservoir collapses, device functions like a nasal cannula
    - adds a 20 ml bolus of 100% \(O_2\), reducing required \(O_2\) flow
Reservoir Devices

Reservoir cannulas

- Pendant reservoir cannula
  - operate in a similar manner as nasal reservoir cannulas
  - reservoir is located in a pendant that hangs below the chin
  - with tubing, the reservoir holds approximately ____ ml
  - most patients prefer the pendant reservoir cannula since it can be hidden under clothing and is not as obvious as the nasal reservoir cannula

- Reservoir cannulas
  - FiO$_2$ depends on the patient’s $V_r$, $f$, set O$_2$ flow and the size of the reservoir
  - these devices add to patients’ mobility and lengthen the time they can be away from home
Reservoir Devices

- Simple mask (Medium Concentration Mask)
  - used to treat spontaneously breathing, hypoxemic patients
  - design virtually unchanged since the late 1700s
  - cone-shaped devices that fit over the nose and mouth
  - secured by either an elastic strap or over-the-ear tubing

- Simple mask
  - can provide $\text{FiO}_2$ of approximately ________ with $\text{O}_2$ flow rates of ____ L/min
  - during inspiration, patient draws gas from both the $\text{O}_2$ flowing into the mask and from room air through side ports (also serve as exhalation ports)
  - typical adult mask has a volume of 100-200 ml
  - because of this “reservoir” masks can achieve __________ $\text{FiO}_2$ than nasal cannulas

Approximate $\text{FiO}_2$'s

<table>
<thead>
<tr>
<th>Simple mask</th>
<th>Approximate $\text{FiO}_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>L/min 100% $\text{O}_2$</td>
<td></td>
</tr>
<tr>
<td>5-6</td>
<td>0.35</td>
</tr>
<tr>
<td>6-7</td>
<td>0.45</td>
</tr>
<tr>
<td>7-8</td>
<td>0.55</td>
</tr>
</tbody>
</table>
Reservoir Devices

Simple masks
- O₂ flow into the mask must be high enough to
  ___________ exhale CO₂ from this
  “reservoir”
- FiO₂ depends on the patient’s Vₚ, f, set O₂ flow
  and the size of the mask

Simple masks
- advantages
  • reliable and easy to set up
  • available in infant, child and adult sizes
  • ideal for use during minor surgical procedures and
    emergencies

Simple masks
- disadvantages
  • FiO₂ can ___________ significantly
    – should not be used where a constant FiO₂ is needed
  • CO₂ can build up if ___________ is not sufficient
    – set flow at > 5 L/min
  • confining and may not be tolerated well
  • must be removed for eating, drinking and conversation
    – may need to have cannula available
  • skin irritation
  • risk of aspiration if patient ___________
Reservoir Devices

- Partial-rebreathing mask
  - derived from the BLB mask of the 1940s
  - consists of a mask, reservoir bag and one-way valves
  - during the 1st part of ______________, expired gas enters reservoir
  - when patient inhales, gas is drawn from this reservoir bag (rebreathing part of the exhaled gas) along with gas from the flowmeter, resulting in a higher FiO\textsubscript{2} than with a simple mask

Partial-rebreathing Mask

Typically, the first exhaled gas is relatively high in O\textsubscript{2} and low in CO\textsubscript{2}, since that gas was not in the alveoli where gas exchange occurs. This gas enters reservoir which is then filled with 100% O\textsubscript{2}.

Reservoir Devices

- Partial-rebreathing mask
  - one-way valves on the exhalation ports prevent room air from being drawn in during inhalation, but allow gas to pass through during exhalation
  - range of FiO\textsubscript{2} is approximately 0.60-0.80 and depends on the patient’s V\textsubscript{T}, f, set O\textsubscript{2} flow and the size of the mask and reservoir bag
  - O\textsubscript{2} flow will generally be ______ L/min, but should be set so that the reservoir bag does not completely deflate during inhalation
Reservoir Devices

- **Non-rebreathing mask**
  - similar in appearance to the PRB mask
  - consists of a mask, reservoir bag, one-way valves on the exhalation ports and a one-way valve ________ the mask and reservoir bag which prevents exhaled gas from flowing into reservoir
  - when patient inhales, gas is drawn from this reservoir bag (100% O\textsubscript{2}) along with gas from the flowmeter, resulting in a higher FiO\textsubscript{2} than with a PRB mask

Reservoir Devices

- **Non-rebreathing mask**
  - one-way valves on the exhalation ports prevent room air from being drawn in during inhalation, but allow gas to pass through during exhalation
  - FiO\textsubscript{2} is theoretically 1.0 and depends on the patient’s V\textsubscript{T}, f, set O\textsubscript{2} flow and the size of the mask and reservoir bag
  - O\textsubscript{2} flow will generally be _______ L/min, but should be set so that the reservoir bag does not completely deflate during inhalation

Non-rebreathing Mask

Theoretical because it assumes that the mask is extremely tight and well fitted and that the patient is only inhaling gas from the flowmeter and from the reservoir bag.

In reality, a mask that well fitted would probably not be worn because of its too-snug fit and as a precaution, NRB masks are now supplied with a valve on only one exhalation port. So, in most cases, room air is drawn in during inhalation. Actual FiO\textsubscript{2} is probably in the 0.70-0.90 range.
Reservoir Devices

- PRB and NRB masks disadvantages
  - confining and may not be tolerated well
  - skin ______________
  - risk of aspiration if patient ______________
  - because of possible problems with the one-way valves, these devices should probably be used on a ______________ basis