Oxygen Therapy and Oxygen Delivery Principles

Extended Text

ALERT

A significant physical hazard of oxygen therapy is fire. Oxygen (O₂) supports combustion, and smoking should not be permitted anywhere O₂ is being used. Spark-producing appliances and volatile or flammable substances should also be removed from the area. Patients may need to be searched to ensure they do not have any matches or lighters.

In ill or injured patients, O₂ is never contraindicated. Insufficient O₂ administration may lead to hypoxia, which is a significant risk to the patient.

Administration of O₂ to some patients may result in hypoventilation, further hypercapnia, and possibly hypoxia and apnea.²

Maintain an O₂ saturation by pulse oximetry (SpO₂) of greater than 90%, but note that administering additional O₂ once the hemoglobin has fully saturated (SpO₂ 99% to 100%) increases the risk of toxic effects.

High concentrations of O₂ for extended periods can cause absorption atelectasis or pathologic changes in lung tissue.¹ Do not use excessive O₂ if these complications develop or after the patient stabilizes.

OVERVIEW

Supplemental oxygen (O₂) is provided to patients with adequate spontaneous respirations (ventilation) but inadequate oxygenation. The need for supplemental O₂ may be determined by clinical assessment of the patient, pulse oximetry, and arterial blood gas analysis or venous blood gas analysis when indicated. Supplemental O₂ is defined as delivery of O₂ in a concentration greater than room air O₂ concentration of 21% or a fraction of inspired O₂ (FiO₂) of 0.21.

The provision of supplemental O₂ should be treated with the same respect and caution as when administering any drug. Oxygen delivery has safe dosing ranges and may produce adverse effects; toxic effects are possible, especially with delivery of high concentrations or with prolonged use.

SUPPLIES

Click here for a list of supplies.

PATIENT AND FAMILY EDUCATION
- Tell the patient and family members not to smoke while supplemental O2 is in use.
- Explain that the mask should be removed only to eat, blow the nose, expectorate, or vomit, then replaced immediately; the mask may be replaced with a nasal cannula for eating.
- Explain the proper position of the mask and the importance of a snug fit. Explain that both prongs of the cannula must be in the nose.

**ASSESSMENT AND PREPARATION**

**Assessment**

1. Assess the patient's vital signs, including pulse oximetry and capnography when indicated.
2. Evaluate the adequacy of the patient's respiratory effort.

**Preparation**

1. Explain strict no smoking instructions to the patient and all visitors.
2. When not contraindicated, allow the patient to assume a comfortable position.

**PROCEDURE**

1. Perform hand hygiene and don gloves (if indicated).
2. Verify correct patient using two identifiers.
3. Attach the flowmeter or regulator to the O2 source.
4. Attach the nut and tailpiece to the flowmeter. If humidified O2 is required, attach the humidifier to the flowmeter. Humidification is not required for short-term use.
5. Attach the flared vinyl tip of the O2 tubing to the tailpiece or humidifier.

Verify that the tubing is connected to the O2, not air or another gas. Connecting the tubing to a gas other than O2 can have fatal consequences.

6. Adjust the O2 to the flow rate as directed by the equipment recommendations to deliver the prescribed amount of O2. The float ball in the flowmeter should be positioned so the flow rate line is in the middle of the ball.
7. Check to see that O2 is flowing through the cannula or mask.
8. For nonrebreather masks, the reservoir bag must be prefilled with O2 before it is applied to the patient. When using an O2 mask with a reservoir bag, adjust the flow rate so that the bag does not collapse, even with a deep inspiration. These masks require a tight seal to deliver the highest concentration of O2.

Removing the flaps covering the side ports of the nonrebreather mask will change the FIO2 of inspired gases. If the tight seal causes discomfort or feelings of claustrophobia or "being smothered," consider changing to an appropriate Venturi mask or turning on a room fan to provide a more breezy flow.

9. Place the cannula prongs into the nares or apply the mask to the face. If the patient is restless or has a head dressing that prevents secure placement of the cannula tubing, secure the tubing to the face with transparent dressing or tape to keep the prongs from slipping away from the nares. Oxygen masks have a malleable metal nose strip that can be adjusted for a better and more comfortable fit. Monitor to ensure that the side ports of a simple O2 mask do not become blocked.

Rationale: Masks come in standard sizes and may not fit all patients adequately and comfortably.
10. Pad straps with gauze or cotton if needed to help prevent irritation or discomfort.

   **Oxygen masks may impede care in patients with facial burns or trauma or who need frequent nursing care in the facial area. Gastric tubes may interfere with obtaining an adequate seal.**

11. If humidification (i.e., a nebulizer with corrugated tubing) is being used, periodically check the tubing and drain the tubing of excess water as needed.

12. Monitor for O2-induced hypoventilation (caused by suppression of the hypoxic respiratory drive), which can lead to further hypercapnia and possibly hypoxia and apnea.

   The small set of patients who develop this complication often have underlying chronic obstructive pulmonary disease (COPD), cystic fibrosis, sedation from medications, neuromuscular disease, morbid obesity, or extensive previous chest disease, and require more aggressive monitoring during O2 delivery.

   a. Titrate the O2 delivery to maintain an SpO2 between 90% and 92% in these patients.2
   b. If hypoxia persists, notify the practitioner, who may consider invasive or noninvasive mechanical ventilation.2

13. Discard supplies, remove gloves, and perform hand hygiene.


**MONITORING AND CARE**

1. Monitor all O2 delivery devices to ensure that they are functioning correctly and delivering the desired concentrations of O2.

   Rationale: O2 concentration delivery is highly variable, and factors such as O2 flow rate, ventilatory rate and depth, mask seal, and anatomic dead space all contribute to this variability (Table 1).

2. If the patient is not tolerating a mask and has high flow or O2 requirements, a special high-flow O2 cannula system with warming and humidification may be more suitable. Consult the respiratory care department.

3. Remove the mask while the patient is eating, drinking, expectorating, or blowing the nose.

   Rationale: Masks interfere with the patient's speech. Aspiration is a potential hazard when an O2 delivery mask is in use. Elevating the head of the bed may reduce this risk.

4. Monitor the oral and airway mucosa for excessive dryness.

   Rationale: Compressed air is dry, and standard humidification equipment delivers only 20% to 40% of humidity to the patient.

   a. Lubricate artificial airways, bougies, and stylets.
   b. If nitroglycerin is prescribed, nitroglycerin spray or IV nitroglycerin may be required if sublingual tablets do not dissolve because of dryness.

5. Assess, treat, and reassess pain according to institution standard.

**EXPECTED OUTCOMES**

- Improved oxygenation
UNEXPECTED OUTCOMES

- Aspiration may occur.
- The airway or oral mucosa may become excessively dry.
- The mask or cannula may be easily dislodged or removed.
- Masks come in standard sizes and may not fit all patients adequately and comfortably.
- Facial irritation and skin breakdown may result if a mask is too tight.
- Some patients may be poorly tolerant of tight-fitting masks.
- Oxygen-induced hypoventilation may result from suppression of the hypoxic respiratory drive.\(^2\)
- Pathologic lung tissue changes may occur with exposure to high concentrations of supplemental O\(_2\),\(^1\) as mucus clearance from the lungs is depressed. (Meta-analysis)
- Absorption atelectasis may occur as the usually more abundant nitrogen gas is "washed out" of the alveolus with breathing of high O\(_2\) concentrations. When the O\(_2\) is absorbed, the alveolus may collapse, further worsening the ability to oxygenate and ventilate the patient.\(^1\) (Meta-analysis)

DOCUMENTATION

- Delivery device used
- Oxygen flow rate
- Pulse oximetry reading (and capnography if applicable) postintervention; note any changes in these values that occur with activity change

PEDIATRIC CONSIDERATIONS

- Allow an alert child to maintain a position of comfort.
- Allow family members or caregivers to remain in the room with the child. Allow the family member or caregiver to hold the child if not contraindicated by the patient's condition.
- Introduce the O\(_2\) delivery devices in a nonthreatening manner. A family member or caregiver may hold the O\(_2\) delivery device to decrease the child's anxiety.
- If a child becomes too upset by the O\(_2\) delivery device, alternative methods may be attempted. A drinking cup decorated with colorful stickers and O\(_2\) supply tubing inserted into the bottom of the cup is such an alternative.
- All devices listed in this procedure are available in pediatric sizes.

GERIATRIC CONSIDERATIONS

- The geriatric patient may be neglectful of the delivery device's position, be more easily annoyed, or have "picking" behaviors such as pushing aside or removing the device. Frequent reorientation, the presence of a sitter, securing the tubing to the cheek, or the application of mitts may help.

REFERENCES
