

PROCEDURE

10

Suctioning: Endotracheal or Tracheostomy Tube

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PURPOSE: Endotracheal or tracheostomy tube suctioning is performed to maintain the patency of the artificial airway and to improve gas exchange, decrease airway resistance, and reduce infection risk by removing secretions from the trachea and main-stem bronchi. Suctioning also may be performed to obtain samples of tracheal secretions for laboratory analysis.

PREREQUISITE NURSING KNOWLEDGE

- Endotracheal and tracheostomy tubes are used to maintain a patent airway and to facilitate mechanical ventilation. The presence of these artificial airways, especially endotracheal tubes, prevents effective coughing and secretion removal, necessitating periodic removal of pulmonary secretions with suctioning. In acute-care settings, suctioning is always performed as a sterile procedure to prevent hospital-acquired infections.
- Suctioning is performed with one of two basic methods. In the open-suction technique, after disconnection of the endotracheal or tracheostomy tube from any ventilatory tubing or oxygen sources, a single-use suction catheter is inserted into the open end of the tube. In the closed-suction technique, also referred to as in-line suctioning, a multiple-use suction catheter inside a sterile plastic sleeve is inserted through a special diaphragm attached to the end of the endotracheal or tracheostomy tube (Fig. 10-1). The closed-suction technique allows for the maintenance of oxygenation and ventilation support, which may be beneficial in patients with moderate to severe pulmonary insufficiency. In addition, the closed-suction technique decreases the risk for aerosolization of tracheal secretions during suction-induced coughing and may reduce some hand and equipment cross contamination. Use of the closed-suction technique is preferred in patients who experience cardiopulmonary instability during suctioning with the open technique, who have high levels of positive end-expiratory pressure (PEEP; >10 cm H₂O) or inspired oxygen (>80%), who are at risk for derecruitment, who have grossly bloody pulmonary secretions, or in whom airborne transmission of disease with risk to the health-care worker, such as active pulmonary tuberculosis, is suspected.
- Indications for suctioning include the following:
 - ❖ Secretions in the artificial airway
 - ❖ Suspected aspiration of gastric or upper-airway secretions
 - ❖ Auscultation of adventitious lung sounds (rhonchi) over the trachea or main-stem bronchi or both
 - ❖ Increase in peak airway pressures when the patient is on mechanical ventilation
 - ❖ Increase in respiratory rate or frequent coughing or both
 - ❖ Gradual or sudden decrease in arterial blood oxygen (PaO₂), arterial blood oxygen saturation (SaO₂), or arterial saturation via pulse oximetry (SpO₂) levels
 - ❖ Sudden onset of respiratory distress, when airway patency is questioned
- Suctioning of airways should be performed only for a clinical indication and not as a routine fixed-schedule treatment.^{28,29}
- Hyperoxygenation should always be provided before and after each pass of the suction catheter into the endotracheal tube, whether with the open- or closed-suctioning method. Use of the ventilator to hyperoxygenate is preferred over manual ventilation to hyperoxygenate and is more effective at delivering a fraction of inspired oxygen (FiO₂) of 1.0.^{28,29} Note: Much of the research and guidelines regarding suctioning has been done with endotracheal or tracheostomy patients on mechanical ventilation. For tracheostomy patients who are not on mechanical ventilation, the need to preoxygenate or hyperventilate should be based on institutional protocol and individualized patient assessment including level of consciousness, ability to cough and manage secretions, SpO₂, and FiO₂.
- Suctioning is a necessary procedure for patients with artificial airways. When clinical indicators of the need for suctioning exist, there is no absolute contraindication to suctioning. In situations in which suctioning would be poorly tolerated by the patient, strong evidence of a clinical need for suctioning should exist and a specific plan for suctioning, developed with the healthcare team, should be implemented.
- Complications associated with suctioning of artificial airways include the following:
 - ❖ Hypoxemia
 - ❖ Respiratory arrest

- ❖ Cardiac arrest
- ❖ Cardiac dysrhythmias (premature contractions, tachycardias, bradycardias, heart blocks)
- ❖ Hypertension or hypotension
- ❖ Decreases in mixed venous oxygen saturation (SvO₂)
- ❖ Increased intracranial pressure
- ❖ Bronchospasm
- ❖ Pulmonary hemorrhage or bleeding
- ❖ Pain and anxiety
- Tracheal mucosal damage (epithelial denudement, hyperemia, loss of cilia, edema) occurs during suctioning when tissue is pulled into the catheter tip holes. These areas of damage increase the risk of infection and bleeding. Use of special-tipped catheters, low levels of suction pressure, or intermittent suction pressure has not been shown to decrease tracheal mucosal damage with suctioning.
- Postural drainage and percussion may improve secretion mobilization from small to large airways in chronic respiratory diseases with large mucus production (e.g., cystic

- fibrosis, bronchiectasis) but has not been shown in the literature to be effective for routine use in all patients.³⁴
- Adequate systemic hydration and supplemental humidification of inspired gases assist in thinning secretions for easier aspiration from airways. Instillation of a bolus of normal saline solution does not thin secretions, may cause decreases in arterial and mixed venous oxygenation, and may contribute to lower-airway contamination from the mechanical dislodgment of bacteria within the artificial airway or from contamination of saline solution during instillation.^{28,29}
 - The suction catheter should not be any larger than half of the internal diameter of the endotracheal or tracheostomy tube (Table 10-1).

EQUIPMENT

- Open technique
 - ❖ Suction catheter of appropriate size (see Table 10-1)
 - ❖ Sterile saline or sterile water solution
 - ❖ Sterile gloves
 - ❖ Sterile solution container
 - ❖ Source of suction (wall mounted or portable)
 - ❖ Connecting tube, generally 4 to 6 ft.
 - ❖ Goggles and mask, or mask with eye shield

Additional equipment, to have available as needed, includes the following:

- ❖ Manual self-inflating manual resuscitation bag-valve device connected to an oxygen flow meter, set at 15 L/min (not recommended for patients on mechanical ventilation as a routine method to deliver hyperoxygenation breaths)
- ❖ Positive end expiratory pressure (PEEP) valve (for patients on >5 cm H₂O PEEP and who must be hyperoxygenated with a self-inflating manual resuscitation bag)
- Closed technique
 - ❖ Closed-suction setup with a catheter of appropriate size (see Table 10-1)
 - ❖ Sterile saline solution lavage containers (5 to 10 mL)
 - ❖ Obtain (individually packaged) suction catheters for oral care.
 - ❖ Source of suction (wall mounted or portable)
 - ❖ Connecting tube, generally 4 to 6 ft
 - ❖ Nonsterile gloves
 - ❖ Goggles and mask, or mask with eye shield

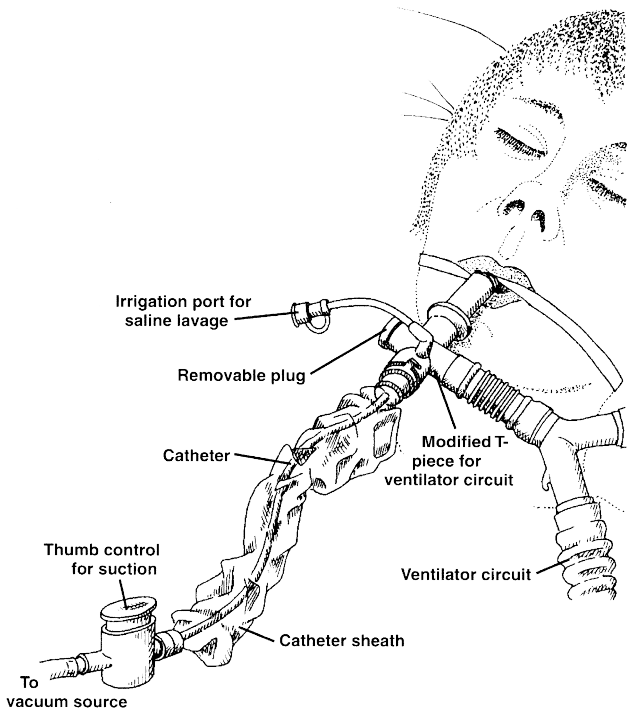


Figure 10-1 Closed-suction technique. (From Sills JR: *The comprehensive respiratory therapist exam review: Entry and advanced levels*, St. Louis, 2010, Elsevier, Mosby.)

TABLE 10-1 Guideline for Catheter Size for Endotracheal and Tracheostomy Tube Suctioning*

Patient Age	Endotracheal Tube Size (mm)	Tracheostomy Tube Size (mm, Inner Diameter)	Suction Catheter Size
Small child (2–5 years)	4.0–5.0	3.0–5.5	6F to 8F
School-age child (6–12 years)	5.0–6.0	4.0–6.5	8F to 10F
Adolescent to adult	7.0–9.0	5.0–9.0	10F to 16F

*This guide should be used as an estimate only. Actual sizes depend on the size and individual needs of the patient. Always follow manufacturer's guidelines. Adapted from St John RE, Seckel M: *Airway management. In AACN protocols for practice: care of the mechanically ventilated patient series*, Sudbury, MA, 2007, Jones and Bartlett Publishers, 41.

PATIENT AND FAMILY EDUCATION

- Explain the procedure for endotracheal or tracheostomy tube suctioning to the patient and family. **Rationale:** The explanation reduces anxiety and allows for family members to step out if uncomfortable with the procedure.
- Explain that suctioning may be uncomfortable and could cause the patient to experience shortness of breath. **Rationale:** This information reduces anxiety and elicits patient cooperation.
- Explain the patient's role in assisting with secretion removal by coughing during the procedure. **Rationale:** This information encourages cooperation and facilitates removal of secretions.

PATIENT ASSESSMENT AND PREPARATION

Patient Assessment

- Assess for signs and symptoms of airway obstruction, including secretions in the airway, inspiratory wheezes, expiratory crackles, restlessness, ineffective coughing, decreased level of consciousness, decreased breath sounds, tachypnea, tachycardia or bradycardia, cyanosis, hypertension or hypotension, and shallow respirations. **Rationale:** Physical signs and symptoms result from inadequate gas exchange associated with airway obstruction.
- Note increased peak inspiratory pressures during volume ventilation or decreased tidal volume during pressure ventilation. **Rationale:** These pressure changes may indicate

potential secretions in the airway, increasing resistance to gas flow.

- Evaluate SpO₂ and SaO₂ levels. **Rationale:** These values indicate potential secretions in the airway, impaired gas exchange.
- Assess signs and symptoms of inadequate breathing patterns, including dyspnea, shallow respirations, intercostal and suprasternal retractions, frequent triggering of ventilator alarms, and increased respiratory rate. **Rationale:** Respiratory distress is a late sign of lower-airway obstruction.

Patient Preparation

- Verify correct patient with two identifiers. **Rationale:** Prior to performing a procedure, the nurse should ensure the correct identification of the patient for the intended intervention.
- Ensure that the patient understands preprocedural teachings. Answer questions as they arise, and reinforce information as needed. **Rationale:** This communication evaluates and reinforces understanding of previously taught information.
- Assist the patient in achieving a position that is comfortable for the patient and nurse, generally semi-Fowler's or Fowler's, with the bed elevated to the nurse's waist level. **Rationale:** This positioning promotes comfort, oxygenation, and ventilation, and reduces strain.
- Secure additional personnel to assist with the self-inflating manual resuscitation bag-valve device to provide hyperoxygenation (open-suction technique only) if utilized. **Rationale:** Two hands are necessary to inflate the self-inflating manual resuscitation bag-valve device for adult tidal volume levels (>600 mL).

Procedure for Endotracheal or Tracheostomy Tube Suctioning		
Steps	Rationale	Special Considerations
1. HH		
2. PE		
3. Turn on suction apparatus and set vacuum regulator to 80–120 mm Hg. (Level D*)	The amount of suction applied should be only enough to remove secretions effectively. High negative-pressure settings may increase tracheal mucosal damage. ^{1,13,15,29,37}	Follow manufacturer's directions for suction pressure levels with closed-suction catheter systems. (Level M*)
4. Secure one end of the connecting tube to the suction source and place the other end in a convenient location within reach.	Prepares suction apparatus.	

*Level D: Peer-reviewed professional and organizational standards with the support of clinical study recommendations.

*Level M: Manufacturer's recommendations only.

Procedure continues on following page

Procedure for Endotracheal or Tracheostomy Tube Suctioning—Continued		
Steps	Rationale	Special Considerations
5. Monitor the patient's cardiopulmonary status before, during, and after the suctioning period. (Level B*)	Observes for signs and symptoms of complications: decreased arterial and mixed venous oxygen saturation, cardiac dysrhythmias, bronchospasm, respiratory distress, derecruitment, cyanosis, increased blood pressure or intracranial pressure, anxiety, pain, agitation, or changes in mental status. <small>1,6,8,9,13–17,23–25,28,29,34,37–39</small>	Development of cardiopulmonary instability, particularly cardiac dysrhythmias or arterial desaturation, necessitates immediate termination of the suctioning procedure.
6a. Open-suction technique only.		
A. Open sterile catheter package on a clean surface, with the inside of the wrapping used as a sterile field.	Prepares catheter and prevents transmission of microorganisms.	
B. Depending on manufacturer, set up the sterile solution container or sterile field. Use prefilled solution container or open empty container, taking care not to touch the inside of the container. Fill with approximately 100 mL of sterile normal saline solution or sterile water.	Prepares catheter flush solution.	
C. Don sterile gloves.	Prevents contamination of the open sterile suction catheter.	In the event that one sterile glove and one nonsterile glove are used, apply the nonsterile glove to the nondominant hand and the sterile glove to the dominant hand. Handle all nonsterile items with the nondominant (nonsterile) hand. The dominant (sterile) hand should not come into contact with the connecting tubing. Wrapping the suction catheter around the sterile dominant hand helps prevent inadvertent contamination of the catheter.
D. Pick up suction catheter, with care to avoid touching nonsterile surfaces. With the nondominant hand, pick up the connecting tubing. Secure the suction catheter to the connecting tubing.	Maintains catheter sterility. Connects the suction catheter and connecting tubing.	
E. Check equipment for proper functioning by suctioning a small amount of sterile solution from the container. Proceed to Step 7	Ensures equipment function.	
6b. Closed-suction technique only.		
A. Connect the suction tubing to the closed system suction port or unlock the thumb valve according to manufacturer's guidelines.	Readies the suction setup for suctioning.	

*Level B: Well-designed, controlled studies with results that consistently support a specific action, intervention, or treatment.

Procedure for Endotracheal or Tracheostomy Tube Suctioning—Continued		
Steps	Rationale	Special Considerations
7. Hyperoxygenate the patient for at least 30 seconds with one of the following three methods. (Level B*)	Hyperoxygenation with 100% oxygen is used to prevent a decrease in arterial oxygen levels during the suctioning procedure. ^{1,13,15,27–29,32,33}	Use of the ventilator to deliver the hyperoxygenation may be more effective in increasing arterial oxygen levels. ^{1,28,29}
A. Press the suction hyperoxygenation button on the ventilator with the nondominant hand.	Hyperoxygenation with 100% oxygen is used to prevent a decrease in arterial oxygen levels during the suctioning procedure. ^{1,13,15,27–29,33} (Level B)	
or		
B. Increase the baseline Fio ₂ level on the mechanical ventilator.	Hyperoxygenation with 100% oxygen is used to prevent a decrease in arterial oxygen levels during the suctioning procedure. ^{1,13,15,27–29,33} (Level B)	With this method, caution must be used to return the Fio ₂ to baseline levels after completion of suctioning.
or		
C. Disconnect the ventilator or gas-delivery tubing from the end of the endotracheal or tracheostomy tube, attach the self-inflating manual resuscitation bag-valvedevice to the tube with the nondominant hand, and administer five to six breaths over 30 seconds.	Attach a PEEP valve to the self-inflating manual resuscitation bag-valvedevice for patients on greater than 5 cm H ₂ O PEEP. Verify 100% oxygen delivery capabilities of manual resuscitation bag-valve device by checking manufacturer's guidelines or with direct measurement with an in-line oxygen analyzer when baseline ventilator oxygen delivery to the patient is greater than 60%. Some models of self-inflating manual resuscitation bag-valve device entrain room air and deliver less than 100% oxygen.	Use of a second person to deliver hyperoxygenation breaths with the self-inflating manual resuscitation bag-valvedevice significantly increases tidal volume delivery. ^{10–12,29} One-handed bagging rarely achieves adult tidal volume breaths (>500 mL).

*Level B: Well-designed, controlled studies with results that consistently support a specific action, intervention, or treatment.

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Procedure for Endotracheal or Tracheostomy Tube Suctioning—Continued		
Steps	Rationale	Special Considerations
8. Remove the ventilator circuit or self-inflating manual resuscitation bag-valve device with the nondominant hand. With the control vent of the suction catheter open to air, gently but quickly insert the catheter with the dominant hand into the artificial airway until resistance is met, then pull back 1–2 cm before applying suction. ^{9,13,15,28–34} (Level E*)	Suction should be applied only as needed to remove secretions and for as short a time as possible to minimize decreases in arterial oxygen levels.	Directional catheters are available for selective right or left mainstem bronchus placement. Straight catheters usually enter the right mainstem bronchus. ^{18,20,33} Saline solution should not be instilled into the artificial airway before suctioning. ^{1,3,8,13,15,27,32–34} (Level B*) In adult patients, there is no conclusive evidence to support the practice of minimally invasive suctioning versus deep suctioning due to inconsistencies in the definitions. There are several definitions of minimally invasive or shallow suctioning in the literature, including the following examples: the combination of suctioning without hyperoxygenation or hyperinflation, without normal saline instillation, and without the suction catheter passing beyond the end of the endotracheal tube, ^{22,28} the insertion of the suctioning catheter to a predetermined length of the airway and connector, ¹ or insertion of the suctioning catheter 2 cm beyond the endotracheal tube. ¹⁵ Deep suctioning has been defined as insertion of the suctioning catheter until resistance is felt ^{1,15} or the catheter is beyond the endotracheal tip. ⁹
9. Place the nondominant thumb over the control vent of the suction catheter to apply continuous or intermittent suction. Place and maintain the catheter between the dominant thumb and forefinger as you completely withdraw the catheter for less than or equal to 10 seconds into the sterile catheter sleeve (closed-suction technique) or out of the open airway (open-suction technique).	Tracheal damage from suctioning is similar with intermittent or continuous suction. ^{6,19,21,26,28,33} (Level C*) Decreases in arterial oxygen levels during suctioning can be kept to a minimum with brief suction periods. ^{1,7,15,29,32,33} (Level B)	

*Level B: Well-designed, controlled studies with results that consistently support a specific action, intervention, or treatment.

*Level C: Qualitative studies, descriptive or correlational studies, integrative reviews, systematic reviews, or randomized controlled trials with inconsistent results.

*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.

Procedure for Endotracheal or Tracheostomy Tube Suctioning— <i>Continued</i>		
Steps	Rationale	Special Considerations
10. Hyperoxygenate for 30 seconds as described in Step 7 .	Hyperoxygenation with 100% oxygen is used to prevent a decrease in arterial oxygen levels during the suctioning procedure. ^{1,13,15,27–29,33} (Level B*)	
11. One or two more passes of the suction catheter, as delineated in Steps 8 and 9 , may be performed if secretions remain in the airway and the patient is tolerating the procedure. Provide 30 seconds of hyperoxygenation before and after each pass of the suction catheter. See Step 7 .	The number of suction passes should be based on the amount of secretions and the patient's clinical assessment due to the risk of complications including pain and discomfort. ^{1,27–31,33} (Level E*) Hyperoxygenation with 100% oxygen is used to prevent a decrease in arterial oxygen levels during the suctioning procedure. ^{1,13,15,21,27–29} (Level B)	Consider allowing the patient rest and hemodynamic recovery time after several suction catheter passes. Discuss with the team the treatment plan for excessive secretions.
12. If the patient does not tolerate suctioning despite hyperoxygenation, try the following steps:	Use of a different suctioning technique may be physiologically less demanding. ³³ (Level E)	
A. Ensure that 100% oxygen is being delivered.	Hyperoxygenation with 100% oxygen is used to prevent a decrease in arterial oxygen levels during the suctioning procedure. ^{1,13,15,27–29,33} (Level B)	
B. Maintain PEEP during suctioning. Check that the PEEP valve is attached properly to the self-inflating manual resuscitation bag-valve device with use of that method for hyperoxygenation.	Maintenance of PEEP prevents collapse of alveoli during suctioning.	
C. Switch to another method of suctioning (e.g., closed-suctioning technique).	Other methods of suctioning may be more effective and safer for the patient.	
D. Allow longer recovery intervals between suction passes.	Allows the patient to regain prior oxygenation levels.	
E. Hyperventilation may be used in situations in which the patient does not tolerate suctioning with hyperoxygenation alone, with either the self-inflating manual resuscitation bag-valve device or the ventilator.	Due to the possibility of barotrauma, hyperventilation should be used only if the patient does not tolerate suctioning with hyperoxygenation alone.	Hyperinflation should be delivered by the ventilator to control pressures and avoid disconnection. ^{1,28,29}

*Level B: Well-designed, controlled studies with results that consistently support a specific action, intervention, or treatment.

*Level E: Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations.

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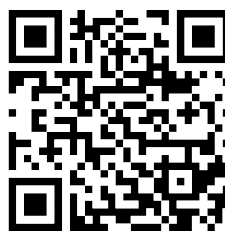
Procedure for Endotracheal or Tracheostomy Tube Suctioning—Continued		
Steps	Rationale	Special Considerations
<p>13. When the airway has been cleared adequately of secretions, perform oropharyngeal suctioning. (Level D*)</p> <p>A separate suction catheter must be opened for this step with the closed-suction technique.</p>	<p>Suctioning of the oropharyngeal area if secretions are present may enhance patient comfort and should be part of an oral hygiene program.^{2,3,35,36} After oropharyngeal suctioning, the suction catheter is contaminated with bacteria present in the oral cavity, potentially gram-negative bacilli, and should not be used for lower-airway suctioning.^{1,5,13,15,35,36}</p> <p>(Level D)</p>	<p>Care should be taken to avoid oropharyngeal tissue trauma and gagging during suctioning.</p>
<p>14. Rinse the catheter and connecting tubing with sterile saline or sterile water solution until clear.</p> <p>Open-suction technique: suction the unused sterile solution until tubing is clear.</p> <p>Closed-suction technique: instill sterile saline or water solution into side port of in-line suction catheter, taking care not to lavage down endotracheal tube, while applying continuous suction until catheter is clear.</p>	<p>Removes buildup of secretions in the connecting tubing and, with the closed-suction catheter system, in the in-line suction catheter.</p>	
<p>15. Open-suction technique only: on completion of upper-airway suctioning, wrap the catheter around the dominant hand. Pull glove off inside out. Catheter remains in glove. Pull off other glove in same fashion, and discard. Turn off suction device.</p>	<p>Reduces transmission of microorganisms.</p>	
<p>16. Suction collection tubing and canisters may remain in use for multiple suctioning episodes.</p>	<p>Solutions and catheters that come in direct contact with the lower airways during suctioning must be sterile to decrease the risks for hospital-acquired pneumonia. Devices that are not in direct contact with the lower airways have not been shown to increase infection risk.⁵ (Level D)</p>	<p>Check institutional standards on the discarding of multiuse sterile solution containers and equipment removal.</p>
<p>17. Remove PE and discard used supplies.</p> <p>18. HH</p>		

*Level D: Peer-reviewed professional and organizational standards with the support of clinical study recommendations.

Expected Outcomes		Unexpected Outcomes
<ul style="list-style-type: none"> • Removal of secretions from the large airways • Improved gas exchange • Airway patency • Amelioration of clinical signs or symptoms of need for suctioning (e.g., adventitious breath sounds, coughing, high airway pressures) • Sample for laboratory analysis 		<ul style="list-style-type: none"> • Cardiac dysrhythmias (premature atrial or ventricular contractions, tachycardias, bradycardias, heart blocks, asystole) • Hypoxemia • Bronchospasm • Excessive increases in arterial blood pressure or intracranial pressure • Hospital-acquired infections • Cardiopulmonary distress • Decreased level of consciousness • Airway obstruction • Pain or discomfort
Patient Monitoring and Care		
Steps	Rationale	Reportable Conditions
1. Monitor the patient's cardiopulmonary status before, during, and after the suctioning period. (Level B*)	Observes for signs and symptoms of complications. <small>1,4,14,16,17,19,25,27,28,33,34,37,38,43,44</small>	<p><i>These conditions should be reported if they persist despite nursing interventions.</i></p> <ul style="list-style-type: none"> • Decreased arterial or mixed venous oxygen saturation • Cardiac dysrhythmias • Bronchospasm • Respiratory distress • Cyanosis • Increased blood pressure or intracranial pressure • Anxiety, agitation, pain, or changes in mental status • Diminished breath sounds • Decreased oxygenation • Increased peak airway pressures • Coughing • Increased work of breathing
2. Reassess the patient for signs of suctioning effectiveness.	Assesses effectiveness of intervention and the possible indications for further suctioning.	
3. Follow institution standard for assessing pain. Administer analgesia as prescribed.	Identifies need for pain interventions.	<ul style="list-style-type: none"> • Continued pain despite pain interventions.
<p>*Level B: Well-designed, controlled studies with results that consistently support a specific action, intervention, or treatment.</p>		
Documentation		
<p><i>Documentation should include the following:</i></p>		
<ul style="list-style-type: none"> • Patient and family education • Presuctioning assessment, including clinical indication for suctioning • Suctioning of endotracheal or tracheostomy tube • Size of endotracheal or tracheostomy tube and suction catheter • Type of hyperoxygenation method used • Pain assessment, interventions, and effectiveness 		<ul style="list-style-type: none"> • Volume, color, consistency, and odor of secretions obtained • Any difficulties during catheter insertion or hyperoxygenation • Tolerance of suctioning procedure, including development of any unexpected outcomes during or after the procedure • Nursing interventions • Postsuctioning assessment

References and Additional Readings

For a complete list of references and additional readings for this procedure, scan this QR code with any freely available smartphone code reader app, or visit <http://booksite.elsevier.com/9780323376624>.



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