

Suctioning: Artificial Airway During Mechanical Ventilation (Respiratory Therapy)

ALERT

Suction airways during mechanical ventilation only when clinically indicated and not as a routine, fixed-schedule treatment.

If the patient develops respiratory distress or cardiac decompensation during the suctioning procedure, immediately withdraw the catheter, supply additional oxygen, and deliver manual breaths as needed.

Suctioning can cause elevations in intracranial pressure (ICP) in patients with head injuries.

Don appropriate personal protective equipment (PPE) based on the patient's signs and symptoms and indications for isolation precautions.

OVERVIEW

Endotracheal (ET) and tracheostomy tubes are used to maintain a patent airway and to facilitate mechanical ventilation. ET 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 mainstem bronchi. Suctioning also may be performed to obtain samples of tracheal secretions for laboratory analysis.

ET and tracheostomy tubes prevent effective coughing and natural secretion removal, which necessitates the need for periodic suctioning to remove pulmonary secretions. In acute care situations, suctioning is always performed as a sterile procedure to prevent hospital-acquired pneumonia.

Indications for suctioning include:

- Auscultation of adventitious lung sounds (rhonchi) or coarse crackles over the trachea, mainstem bronchi, or both
- Gradual or sudden decrease in oxygen saturation
- Increase in peak airway pressures when the patient is receiving mechanical ventilation
- Identification of a sawtooth waveform pattern on the ventilator⁵
- Increased respiratory rate, frequent coughing, or both
- Secretions in the artificial airway
- Sudden onset of respiratory distress when airway patency is questioned
- Suspected aspiration of gastric or upper-airway secretions

There are two basic methods of suctioning. In the open-suction technique, after disconnection of the ET or tracheostomy tube from any ventilatory circuit or oxygen sources, a sterile 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 multiuse suction catheter inside a sterile plastic sleeve is inserted through a special diaphragm attached to the end of the ET or tracheostomy tube. 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. Use of the closed-suction technique should be considered in patients who develop

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cardiopulmonary instability during suctioning with the open-suction technique; in patients who have high levels of positive end-expiratory pressure (PEEP), inspired oxygen, or both; or in patients who have grossly bloody pulmonary secretions or in whom airborne transmission of disease, such as active pulmonary tuberculosis, is suspected.

100% oxygen should always be provided before and after each pass of the suction catheter into the ET tube, whether suctioning is done with the open- or the closed-suction method.³

The suction catheter should not be any larger than one half of the internal diameter of the ET or tracheostomy tube.³ Closed or in-line suction catheters are available in two lengths: a longer one for ET tubes and a shorter one for tracheostomy tubes.

Adequate systemic hydration and supplemental humidification of inspired gases help thin secretions for easier aspiration from airways. Instillation of a bolus of sterile 0.9% sodium chloride solution is not a recommended routine practice.²

Complications associated with artificial airway suctioning during mechanical ventilation include:

- Bronchospasm
- Cardiac arrest
- Cardiac arrhythmias (premature contractions, tachycardia, bradycardia, heart blocks)
- Decreases in mixed venous oxygen saturation (SVO₂)
- Hypertension or hypotension
- Hypoxemia
- Increased ICP
- Pain and anxiety
- Tracheal mucosal trauma
- Pulmonary hemorrhage or bleeding
- Respiratory arrest

Tracheal mucosal damage (e.g., 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.

Suctioning is a necessary procedure for patients with artificial airways. No absolute contraindication to suctioning exists when clinical indicators point to the need for it.

EDUCATION

- Provide developmentally and culturally appropriate education based on the desire for knowledge, readiness to learn, and overall neurologic and psychosocial state.
- Explain that suctioning may be uncomfortable and may cause the patient to experience shortness of breath.
- Explain the patient's role in assisting with secretion removal by coughing during the procedure.
- Encourage questions and answer them as they arise.

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ASSESSMENT AND PREPARATION

Assessment

1. Perform hand hygiene before patient contact and don PPE as indicated for needed isolation precautions.
2. Introduce yourself to the patient.
3. Verify the correct patient using two identifiers.
4. Assess for signs of airway obstruction.
 - a. Cyanosis
 - b. Decreased breath sounds
 - c. Decreased level of consciousness
 - d. Expiratory crackles
 - e. Hypertension or hypotension
 - f. Ineffective coughing
 - g. Inspiratory wheezes
 - h. Restlessness
 - i. Secretions in the airway
 - j. Shallow respirations
 - k. Tachycardia or bradycardia
 - l. Tachypnea
 - m. Ventilator high-pressure alarm sounding
5. If peak airway pressures on the ventilator are high, expect that mucus is partially occluding the patient's airway and that suctioning is required.
6. Evaluate the patient's oxygen saturation.
7. Assess for signs of inadequate breathing patterns.
 - a. Dyspnea
 - b. Frequent triggering of ventilator alarms
 - c. Increased respiratory rate
 - d. Intercostal and suprasternal retractions
 - e. Shallow respirations
 - f. Patient-ventilator dyssynchrony

Preparation

1. Unless medically contraindicated, keep the head of the patient's bed elevated 30 to 45 degrees to prevent aspiration and reduce the risk of ventilator-associated pneumonia.^{4,6}
2. Open-suction technique only: Secure additional personnel to assist with the manual resuscitation bag (MRB) to provide supplemental breaths with 100% oxygen.

PROCEDURE

1. Perform hand hygiene and don gloves and appropriate PPE based on the patient's signs and symptoms and indications for isolation precautions. Don gown, mask, and eye protection or face shield if the risk of splashing exists.
2. Verify the correct patient using two identifiers.
3. Explain the procedure to the patient and ensure that he or she agrees to treatment.
4. Turn on the suction apparatus and set the vacuum regulator to less than 150 mm Hg.³ Follow the manufacturer's directions for suction pressure levels when using closed-suction catheter systems.

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Rationale: The amount of suction applied should be only enough to effectively remove secretions. High negative-pressure settings may increase tracheal mucosal damage.¹

5. Secure one end of the connecting tube to the suction source and place the other end within reach.
6. Prepare to suction.
 - a. Open-suction technique:
 - i. Open the sterile catheter package on a clean surface, using the inside of the wrapping as a sterile field.
 - ii. Depending upon the manufacturer, set up the sterile solution container or sterile field. Use a prefilled solution container or an open empty container, being careful not to touch the inside of the container. Fill the container with sterile 0.9% sodium chloride solution or sterile water.
 - iii. Don sterile gloves over gloved hands.

If one sterile glove and one nonsterile glove are used, don the nonsterile glove on the nondominant hand and the sterile glove on the dominant hand. Handle all nonsterile items with the nondominant hand.

- iv. Pick up the suction catheter, being careful to avoid touching nonsterile surfaces. With the nondominant hand, pick up the connecting tubing. Secure the suction catheter to the connecting tubing.

Do not allow the dominant hand to come in contact with the connecting tubing. Wrap the suction catheter around the sterile dominant hand to prevent inadvertent contamination of the catheter.

- v. Check equipment for proper functioning by suctioning a small amount of sterile solution from the container.
 - b. Closed-suction technique: Connect the suction tubing to the closed system suction port or unlock the thumb valve, according to manufacturer's guidelines.
7. Administer 100% oxygen to the patient for 30 to 60 seconds¹ using one of these methods:

Rationale: The administration of 100% oxygen helps prevent a decrease in arterial oxygen levels during the suctioning procedure.¹

- a. Press the 100% suction button on the ventilator with the nondominant hand.¹
 - b. Increase the baseline fraction of inspired oxygen (FIO₂) level on the mechanical ventilator.

Return the FIO₂ to the baseline level after completing suctioning.

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- c. Open-suction technique only: Disconnect the ventilator or gas-delivery tubing from the end of the ET or tracheostomy tube and attach the MRB to the tube with the nondominant hand. Attach a PEEP valve to the MRB if the patient is receiving PEEP. Verify that the MRB has a reservoir to deliver the highest level of oxygen possible.

Rationale: Some models of MRBs (without reservoirs) entrain room air and deliver lower levels of oxygen.

8. Remove the ventilator circuit or MRB with the nondominant hand (open-suction technique).
 - a. With the control vent of the suction catheter open, gently but quickly insert the catheter with the dominant hand into the artificial airway.

Do not instill 0.9% sodium chloride solution into the artificial airway before suctioning.²

- b. Advance the catheter to the predetermined depth.

In select patient populations (those with a lung transplant or pulmonary surgery), the depth of suctioning may be restricted. Advance the catheter to the identified depth using the markings on the catheter.

- i. In a patient at high risk for suction-related complications, insert the catheter into the ET or tracheostomy tube until it emerges out of the end of the airway.²
 - ii. In a patient, not at risk for suction-related complications, insert the catheter into the ET or tracheostomy tube until resistance is met and then pull back 1 to 2 cm.²
 - c. If the catheter does not advance past the end of the ET tube, it may be caught in the side hole at the distal end of the ET tube or there may be a mucous plug at the end of the ET tube. Rotate the catheter to reposition it away from the side hole or withdraw it slightly and reinsert it with the next inhalation.

Rationale: In most cases, the catheter meets resistance at the carina. Acute onset of coughing is one indication the catheter is at the carina because it contains many cough receptors.

9. Place the nondominant thumb over the control vent of the suction catheter to apply continuous suction.
 - a. Place and maintain the catheter between the dominant thumb and forefinger while completely withdrawing the catheter for 15 seconds or less^{1,2} into the sterile catheter sleeve (closed-suction technique) or out of the open airway (open-suction technique).
 - b. In cases when repeated suction is needed, use caution when withdrawing the suction catheter. Do not allow the catheter to touch the patient's face or other nonsterile surfaces.

Rationale: 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.

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Keep suction periods brief to keep decreases in oxygen saturation to a minimum.¹

10. Administer 100% oxygen again for 1 minute.¹

Rationale: The administration of 100% oxygen helps prevent a decrease in arterial oxygen levels during the suctioning procedure.¹

11. If secretions remain in the airway and the patient is tolerating the procedure, consider performing one or two more passes with the suction catheter. Administer 100% oxygen for 1 minute before and after each pass of the suction catheter.³

Rationale: The number of suction passes should be based on the amount of secretions and the patient's clinical assessment. Arterial oxygen desaturation and cardiopulmonary complications increase with each successive suction catheter pass.

Rationale: The administration of 100% oxygen helps prevent a decrease in arterial oxygen levels during the suctioning procedure.¹

12. If the patient does not tolerate suctioning despite the administration of 100% oxygen, try these steps:

- a. Ensure that 100% oxygen is being delivered to the patient.¹
- b. Ensure that PEEP is maintained on the mechanical ventilator during suctioning.
- c. Ensure that the PEEP valve is attached properly to the MRB if using that method for oxygen administration.
- d. Switch to another method of suctioning (e.g., closed-suction technique), if needed, and allow longer recovery intervals between suction passes.
- e. Consider hyperventilation only in situations in which the patient does not tolerate suctioning with the administration of 100% oxygen alone, using either the MRB or the ventilator.

Rationale: Use of a different suctioning technique may be physiologically less demanding.

f. Rinse the catheter and connecting tubing with sterile saline or sterile water until clear.

13. Closed-suction technique only: Cleanse the suction catheter.

- a. Align the suction port of the catheter with the side port.
- b. Apply continuous suction, and simultaneously instill sterile saline or water into the side port of the in-line catheter with a syringe or saline bullet, taking care not to lavage down the ET tube.
- c. Repeat until the catheter is clear.

Rationale: Rinsing the catheter removes secretion buildup in the connecting tubing and, when using the closed-suction catheter system, in the in-line suction catheter.

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14. Open-suction technique only: Remove sterile glove(s) and dispose of catheter after completion of upper-airway suctioning.
 - a. Wrap the catheter around the dominant hand.
 - b. Pull off sterile glove from the dominant hand inside out. The catheter should remain in the glove. Discard the glove and the catheter.
 - c. Pull off the sterile glove from the nondominant hand in same fashion and discard it.
15. Turn off the suction device.
16. Discard suction collection tubing and canisters when completely full. Suction collection tubing and canisters may remain in use for multiple suctioning episodes.

Rationale: Solutions and catheters, which come in direct contact with the lower airways during suctioning, must be sterile to decrease the risk for hospital-acquired pneumonia. Devices that are not in direct contact with lower airways have not been shown to increase infection risk.

17. Discard supplies, remove PPE, and perform hand hygiene.
18. Document the procedure in the patient's record.

MONITORING AND CARE

1. Monitor the patient's cardiopulmonary status before, during, and after the suctioning period for signs of complications and return to baseline.
2. Reassess the patient for signs of suctioning effectiveness.
3. Observe the patient for signs or symptoms of pain. If pain is suspected, report it to the authorized practitioner.

EXPECTED OUTCOMES

- Removal of secretions from the large airways
- Improved gas exchange
- Airway patency
- Amelioration of clinical signs or symptoms that indicated need for suctioning
- Sample obtained for laboratory analysis

UNEXPECTED OUTCOMES

- Cardiac arrhythmias
- Hypoxemia
- Bronchospasm
- Excessive increases in arterial blood pressure
- Increase in ICP
- Cardiopulmonary distress
- Decreased level of consciousness
- Airway obstruction
- Ventilator-associated pneumonia

DOCUMENTATION

- Education
- Presuctioning and postsuctioning assessment
- Clinical indication for suctioning

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- Suctioning of ET or tracheostomy tube
- Type of oxygenation method used
- Volume, color, and consistency of secretions obtained
- Any difficulties during catheter insertion
- Patient's tolerance of suctioning procedure
- Ventilator pressures before and after suctioning
- Vital signs including oxygen saturation before, during, and after suctioning
- Cardiac rhythm before, during, and after suctioning
- Unexpected outcomes and related interventions

HOME CARE CONSIDERATIONS

- Family members or caregivers should perform this procedure in the home setting only if they have been well-educated and trained in suctioning. Explain suctioning and the risks associated with the procedure thoroughly to patients, family members, and caregivers. Recommend that they request extra education from their home health nurses or therapists.

REFERENCES

1. American Association for Respiratory Care (AARC). (2010). Endotracheal suctioning of mechanically ventilated patients with artificial airway 2010. *Respiratory Care*, 55(6), 758-764. (classic reference)* ([Level VII](#))
2. Chaseling, W. and others. (2014). Suctioning an adult ICU patient with an artificial airway: A clinical practice guideline (version 2.2). Chatswood, NSW, Australia: Agency for Clinical Innovation. Retrieved March 25, 2020, from http://www.aci.health.nsw.gov.au/data/assets/pdf_file/0010/239554/ACI14_Suction_2-2.pdf (classic reference)* ([Level VII](#))
3. La Vita, C.J. (2021). Chapter 37: Airway management. In R.M. Kacmarek, J.K. Stoller, A.J. Heuer (Eds.), *Egan's fundamentals of respiratory care* (12th ed., pp. 748-787). St. Louis: Elsevier.
4. Larrow, V., Klich-Heartt, E.I. (2016). Prevention of ventilated-associated pneumonia in the intensive care unit: Beyond the basics. *Journal of Neuroscience Nursing*, 48(3), 160-165. doi:10.1097/JNN.000000000000195 ([Level VII](#))
5. Sole, M.L., Bennett, M., Ashworth, S. (2015). Clinical indicators for endotracheal suctioning in adult patients receiving mechanical ventilation. *American Journal of Critical Care*, 24(4), 318-324. doi:10.4037/ajcc2015794 ([Level IV](#))
6. Weber, C.D. (2016). Applying adult ventilator-associated pneumonia bundle evidence to the ventilated neonate. *Advances in Neonatal Care*, 16(3), 178-190. doi:10.1097/anc.0000000000000276

*In these skills, a "classic" reference is a widely cited, standard work of established excellence that significantly affects current practice and may also represent the foundational research for practice.

Elsevier Skills Levels of Evidence

- Level I - Systematic review of all relevant randomized controlled trials
- Level II - At least one well-designed randomized controlled trial
- Level III - Well-designed controlled trials without randomization
- Level IV - Well-designed case-controlled or cohort studies
- Level V - Descriptive or qualitative studies

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- Level VI - Single descriptive or qualitative study
- Level VII - Authority opinion or expert committee reports

Supplies

Open-Suction Technique

- Gloves, sterile gloves and PPE, as indicated
- Sterile suction catheter of appropriate size
- Sterile 0.9% sodium chloride solution or sterile water
- Sterile solution container
- Source of suction (wall-mounted or portable) with connecting tube
- MRB connected to an oxygen flowmeter with a PEEP valve, if needed

Closed-Suction Technique

- Gloves and PPE, as indicated
- Closed-suction setup with a catheter of appropriate size
- Sterile single-use 0.9% sodium chloride solution lavage containers
- Source of suction (wall-mounted or portable) with connecting tube

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