

ELSEVIER Clinical Skills

Endotracheal Tube: Closed Suctioning (Neonatal) - CE

ALERT

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

Exert the lowest negative pressure on the endotracheal (ET) tube necessary to remove the secretions; do not exceed -100 mm Hg of negative pressure.³

To reduce the risk of hypoxemia, a duration of no more than 5 to 10 seconds per suction pass is recommended.¹ A longer duration is associated with increased risk of hypoxemia and bradycardia.⁴

Current evidence does not support routine suctioning in neonates.⁴ Perform suctioning when a clinical assessment of the neonate indicates that secretions are obstructing the airway.⁴

OVERVIEW

When a neonate suffers from respiratory distress, supporting his or her respiratory function may require the insertion of an ET tube and ventilator support. Intubation causes an increase in the production of secretions, which neonates are unable to clear. The purpose of suctioning the ET tube is to remove secretions that may accumulate and to maintain a patent airway. Successful removal of secretions helps promote oxygenation and ventilation. The frequency of suctioning is determined according to each neonate's needs.

The two methods of ET tube suctioning are the open-suctioning method and the closed-suctioning method. Open suctioning involves a sterile, single-use catheter and sterile gloves. The catheter is attached to suction tubing that connects to a suction regulator. Open suctioning requires disconnecting the neonate from the ventilator.

Closed suctioning involves insertion of a Y-connector into the ventilator circuit without disconnection from the ventilator.² Closed suction technique uses a specially designed, multiple-use catheter that is enclosed in a sterile plastic sleeve and attaches to suction tubing that is connected to a suction regulator. The catheter is placed inline between the ventilator circuit and the ET tube. Disconnecting the neonate from the ventilator results in loss of positive end-expiratory pressure (PEEP) and risk of contamination of the system, leading to ventilator-associated pneumonia. The closed suction system maintains PEEP and prevents contamination.² Manual ventilation between catheter passes with open suctioning can result in variable tidal volume and barotrauma. The closed system uses the preset ventilator breaths between passes.² Suctioning using either method can result in tachycardia, hypoxia, and derecruitment of alveoli. The closed suctioning system has been shown to result in much more rapid recovery of these effects.² The closed suctioning system is recommended as the standard of neonatal care.²

ET suctioning is a noxious procedure that may stress vulnerable neonates and should not be a routinely scheduled intervention. Suctioning is appropriate when a clinical assessment of the neonate indicates that secretions are obstructing the airway.

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Indications for suctioning include audible or visible secretions in the ET tube, coarse breath sounds, coughing, increased work of breathing, oxygen desaturation, and bradycardia.⁴

In addition to the listed indications, the nurse should assess for suctioning needs with these findings:¹

- Agitation and restlessness
- Apnea
- Changes in blood gas values
- Decreased breath sounds
- Color changes (pale, dusky, or cyanotic)
- Decreased chest wiggle for neonates on high-frequency ventilators⁴
- Increasing oxygen requirements
- Loss of or poor chest wall excursion with ventilator breaths
- Pattern change in ventilator graphics
- Tachycardia

An exception to suctioning when secretions are visible in the ET tube or breath sounds are coarse is the length of time following the instillation of artificial surfactant. To ensure maximal benefit from the artificial surfactant, tracheal suctioning is avoided immediately following surfactant administration if ventilation is adequately maintained. Avoiding suctioning for 1 to 2 hours following surfactant delivery is preferable unless ventilation or oxygenation is compromised.³

One strategy to minimize the risks associated with suctioning is to control the depth of catheter insertion. With deep suctioning, the catheter is inserted until resistance is met. Current evidence suggests that deep suctioning can damage the carina; therefore, shallow suctioning is recommended.⁴ With shallow suctioning, the catheter is inserted no farther than the sum of the ET tube length and adapter.

Suctioning may result in hypoxia or hyperoxia. No available evidence suggests that preoxygenation is a safe practice with premature neonates.^{3,4} Hyperoxia in the preterm neonate can result in retinopathy of prematurity and chronic lung disease. Current evidence suggests that increasing the inspired oxygen concentration before suctioning must be individualized based on the neonate's response. To prevent hyperoxia, avoid increasing the fraction of inspired oxygen (FIO₂) more than 10% to 20%⁴ above baseline. For the extremely low-birth-weight neonate, avoid increasing the FIO₂ more than 2% to 5%.⁴ Monitoring oxygen saturation levels is essential to protect the neonate from hypoxia and hyperoxia.

Risks associated with ET tube suctioning include:⁴

- Alterations in cerebral blood flow
- Atelectasis
- Barotrauma
- Bradycardia
- Bronchospasms
- Changes in blood pressure
- Hypoxemia
- Increased intracranial pressure (ICP)

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- Infection
- Intraventricular hemorrhage
- Pneumothorax
- Tachycardia
- Tracheal damage
- Trauma

Recommendations and parameters for suctioning the neonate:

- Instilling sterile 0.9% sodium chloride solution to facilitate suctioning of secretions is not recommended and may, in fact, contribute to bacterial colonization of the lower airway and impaired oxygenation.⁴
- Negative pressure exerted on the ET tube should be the lowest possible that removes the secretions.⁴ Suction should not exceed -100 mm Hg.^{1,4}
- There is no evidence that intermittent application of negative pressure, rotation of the catheter, or turning the neonate's head from side to side is beneficial.⁴ The neonate's head should be maintained in the midline position to prevent increased ICP, particularly in a preterm neonate.⁴
- To reduce the risk of hypoxemia, a duration of no more than 5 to 10 seconds per suction pass is recommended.¹ Longer duration is associated with hypoxia and bradycardia.⁴
- The size of the suction catheter should not exceed half the internal diameter of the ET tube size. This allows air to continue to enter the lungs during suctioning and limits mucosal trauma.^{1,5}
- Insertion depth should be limited to the length of the ET tube plus adapter.¹
- Catheter passes should be limited to only the number of times required to remove secretions. If more than one catheter pass is required, then the neonate must be allowed recovery time between passes.²
- Suction should be applied only as the catheter is removed (unless the neonate is ventilated with a high-frequency jet ventilator). Suction applied while inserting the suction catheter does not aid in removal of secretions and may increase the negative effects associated with suctioning (i.e., desaturation and bradycardia).

FAMILY EDUCATION

- Provide individualized, appropriate education to the family based on the desire for knowledge, readiness to learn, and overall psychosocial state.
- As time permits, explain the procedure and what to expect, including the purpose, steps, and rationale.
- Explain to the family that suctioning may be uncomfortable and may cause coughing or shortness of breath for a brief time.
- Explain the plan for pain assessment and management.
- Encourage questions and answer them as they arise.

ASSESSMENT AND PREPARATION

Assessment

1. Perform hand hygiene and don PPE as indicated for needed isolation precautions.
2. Introduce yourself to the family, if they are present at the bedside.
3. Verify the correct neonate using two identifiers.
4. Assess the family's understanding of the reasons for and risks and benefits of the procedure.

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5. Assess the neonate for signs of airway secretions and inadequate oxygenation and ventilation.

Rationale: The decision to suction a neonate should be made on the basis of individual assessment and clinical signs.

Suction only as needed.

- a. Visible secretions in the airway
- b. Inspiratory wheezes
- c. Expiratory crackles
- d. Restlessness
- e. Diminished breath sounds
- f. Tachypnea
- g. Tachycardia or bradycardia
- h. Cyanosis
- i. Hypertension or hypotension
- j. Shallow respirations

6. Check the integrity of the tape or securement device to ensure that the ET tube is secure and movement is minimal.

7. Determine the family's desire to be present during the procedure.

Preparation

1. Ensure that an appropriate-size bag and mask are connected to an oxygen source at the bedside.
2. Ensure that the oxygen source has the capability of being blended to provide a sufficient variety of oxygen concentrations to meet the neonate's needs.
3. Confirm that the inline catheter is the appropriate size or, if placing a new one, choose the proper catheter size.

a. Select a recommended suction catheter size:^{4,5}

- i. 5 Fr for 2.0 mm ET tube
- ii. 5 Fr for 2.5 mm ET tube
- iii. 6 Fr for 3.0 mm ET tube
- iv. 8 Fr for 3.5 mm ET tube
- v. 8 Fr for 4.0 mm ET tube

b. Alternatively, calculate the proper size suction catheter by doubling the ET tube size in millimeters and choosing the suction catheter French size closest to the doubled number.⁵

Rationale: The size of the suction catheter should not exceed 50% of the ET tube's internal diameter.^{1,5} This allows air to continue to enter the lungs during suctioning and limits mucosal trauma.⁵

4. Set the suction control at -60 to -100 mm Hg for suction.³

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Use the least amount of negative pressure necessary to remove secretions.³

5. Prepare sterile 0.9% sodium chloride solution for rinsing the catheter.

Do not instill sterile 0.9% sodium chloride solution as a routine procedure to facilitate suctioning of secretions since this may lead to impaired oxygenation and contribute to bacterial colonization of the lower airway.³ Sterile 0.9% sodium chloride solution is only for rinsing the catheter.

PROCEDURE

1. Perform hand hygiene and don gloves and appropriate PPE based on the patient's signs and symptoms and indications for isolation precautions.

Rationale: Sterile gloves are not required because the catheter is enclosed in a sterile covering throughout the procedure.

2. Verify the correct neonate using two identifiers.

3. Explain the procedure to the family (if they are present at the bedside) and ensure that they agree to treatment.

4. Provide developmentally appropriate containment (e.g., swaddling) for comfort during the procedure.

5. Increase the F_{IO_2} by a maximum of 10%, if needed, to maintain target oxygen saturation levels.⁴

Rationale: Increasing F_{IO_2} by 10% when clinically indicated may offset hypoxemia related to disruption of ventilation.⁴

6. Secure the suction tubing from the suction source to the closed system suction port per the manufacturer's directions.

7. Remove the cap and attach the sterile 0.9% sodium chloride solution to the irrigation port.

8. Determine the proper catheter length for suctioning by adding the length of the ET tube and the length of the adapter.

9. Document the measured catheter length and, when suctioning, do not advance the catheter beyond the point where this measurement can be seen in the catheter window.⁴

Rationale: If the suction catheter is advanced beyond the end of the ET tube, airway damage may result. Correctly measuring for and adhering to the appropriate catheter depth decreases the risk of damaging the airway.

When suctioning, do not insert the catheter more than 1 cm (0.4 in) beyond the documented measurement.¹ Post the calculated catheter measurement at the bedside.

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10. Unlock the suction control valve on the suction catheter by lifting and turning the valve to the open position.
11. Stabilize the ET tube with one hand while advancing the catheter with the other to the predetermined distance.
12. If the neonate is ventilated with a high-frequency jet ventilator, suction with the ventilator either on or off. If suctioning with the jet on, apply suction while inserting and when withdrawing the catheter.³

Rationale: If the jet is on, applying suction during both insertion and withdrawal of the catheter prevents overpressurization of the circuit and alveolar rupture.³

13. Maintain the neonate's head in the midline position.⁴

Rationale: The midline position prevents increased ICP, particularly in preterm neonates. There is no evidence indicating that intermittent application of negative pressure, rotation of the catheter, or turning the neonate's head from side to side is beneficial. These interventions may increase the negative effects associated with suctioning, such as desaturation and bradycardia.

14. Suction secretions by depressing the control valve while withdrawing the catheter from the ET tube. Continue to stabilize the tube.

Do not apply suction for longer than 5 to 10 seconds.¹

15. Withdraw the black tip of the catheter into the middle of the cleaning chamber.
16. Depress suction first and then gently squeeze sterile 0.9% sodium chloride solution into the chamber to clear secretions from the suction tubing.¹
17. Reassess breath sounds.

Rationale: Assessing breath sounds evaluates the effectiveness of suctioning and helps determine if additional passes are needed.

18. After each pass, monitor the neonate's tolerance of the procedure and allow him or her time to recover (as indicated by his or her oximetry and cardiopulmonary status) by providing positive pressure ventilatory support, as needed.³

Rationale: Allowing recovery time helps prevent long-term complications associated with hypoxemia.

19. Note the color, amount, and consistency of secretions removed.
20. Rinse the suction catheter with sterile 0.9% sodium chloride solution at the completion of the suctioning procedure.
21. Reconfirm the security and position of the ET tube.
22. Remove the 0.9% sodium chloride solution from the irrigation port and recap the port. Lock the control mechanism by lifting and turning to closed position.
23. Wean oxygen to preprocedure level as tolerated.
24. Discard supplies, remove PPE, and perform hand hygiene.

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25. Document the procedure in the neonate's record.

MONITORING AND CARE

1. Monitor oxygenation levels before, during, and after suctioning and adjust support to prevent extremes of oxygenation.

Rationale: Either extreme in oxygen levels may be detrimental to the neonate.

2. Assess breath sounds and chest excursion before, during, and after each suctioning pass.

3. Assess, treat, and reassess pain.

EXPECTED OUTCOMES

- Adequate removal of secretions from ET tube
- Comfort for the neonate
- Decreased work of breathing
- Secure ET tube
- Hemodynamic stability
- Improved gas exchange
- Improvement in the symptoms that indicated the need to suction
- No evidence of increased ICP

UNEXPECTED OUTCOMES

- Bradycardia
- Bronchospasm
- Hemodynamic instability
- Hypoxia
- Inability to clear secretions
- Inadvertent extubation
- Evidence of increased ICP
- Intracranial hemorrhage
- Respiratory instability
- Unmanaged agitation and irritability
- Ventilator-associated pneumonia

DOCUMENTATION

- Date and time of the procedure
- Physical assessment findings, including vital signs, breath sounds, and indicators of respiratory distress before and after the procedure
- Interventions necessary before, during, and after suctioning, including any changes to FI_{O_2}
- Color, amount, and consistency of secretions
- ET tube size and position
- Neonate's response to suctioning and care
- Family education
- Unexpected outcomes and related nursing interventions

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REFERENCES

1. Bailey, T. (2015). Chapter 15: Common invasive procedures. In M.T. Verklan, M. Walden (Eds.), *Core curriculum for neonatal intensive care nursing* (5th ed., pp. 282-315). St. Louis: Saunders. ([Level VII](#))
2. DiBlasi, R., Gallagher, J.T. (2017). Chapter 27: Respiratory care of the newborn. In J.P. Goldsmith and others (Eds.), *Assisted ventilation of the neonate: An evidence-based approach to newborn respiratory care* (6th ed., pp. 291-309). Philadelphia: Elsevier.
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5. Russian, C.J., Gonzalez, J.F., Henry, N.R. (2014). Suction catheter size: An assessment and comparison of 3 different calculation methods. *Respiratory Care*, 59(1), 32-38. doi:10.4187/respcare.02168 ([Level IV](#))

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

Supplies

- Bag-mask device (appropriate size) connected to oxygen source with a blender
- Gloves and PPE, as indicated
- Closed suction system (appropriate size)
- Oxygen saturation and cardiopulmonary monitors
- Sterile 0.9% sodium chloride solution
- Stethoscope
- Suction canister with vacuum-to-wall suction and connecting tubing
- Infant blanket for swaddling

Clinical Review: Justin Milici, MSN, RN, CEN, CPEN, TCRN, CCRN, FAEN
Revised: Marlene L. Bokholdt, MS, RN, CPEN, TCRN, CEN

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