

ELSEVIER Clinical Skills

Endotracheal Tube: Closed Suctioning (Pediatric) - CE

ALERT

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

Do not exceed 5 seconds per suctioning pass for an infant or 10 seconds for a child.

Base the frequency of suctioning on the child's need. Routine or scheduled suctioning is not recommended.

Stop suctioning if cardiac arrhythmia, hemodynamic instability, or significant changes in oxygenation or ventilation occur.

OVERVIEW

The upper airway (nose, oropharynx, and trachea) filters, heats, and humidifies inspired air. When an endotracheal (ET) tube is placed, the upper airway is bypassed and the ability to clear secretions is disrupted, placing the child at a higher risk of secretion retention, infection, and mucus plugging of the ET tube and lungs. Using a humidification device or heat-moisture exchanger optimizes secretion management and keeps secretions thin. Heated humidification is preferred for children who are mechanically ventilated because it simulates normal physiologic airway conditions.

Suctioning may be performed using the open suctioning technique, which involves a disconnection from the ventilator circuit or oxygen source, or the closed suctioning technique, which involves a sterile, closed, inline suction catheter attached to the ventilator circuit. The closed suctioning technique allows passage of the suction catheter into the airway without disconnection from the ventilator. Disconnecting the child from the ventilator results in a loss of positive end-expiratory pressure (PEEP) and a risk of system contamination, leading to ventilator-associated pneumonia (VAP). 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 from these complications.² Another advantage of closed suctioning is reduced contamination of the health care personnel's gloves and hands, potentially reducing the risk of cross-contamination.

The anatomy and physiology of the pulmonary system and structural characteristics specific to the infant and child include:

- A child's airway is absolutely and relatively smaller in diameter and shorter than an adult's airway.
- The cricoid cartilage is the narrowest portion of the upper airway in a child until 8 to 10 years old.⁴ By age 8 to 10 years, the narrowest portion of the larynx becomes the glottic inlet at the level of the vocal cords.⁴
- Infants and children have higher metabolic and oxygen consumption rates.⁴

Endotracheal Tube: Closed Suctioning (Pediatric) - CE

- In the infant and toddler, the ribs are cartilaginous, and the intercostals and accessory muscles are less developed, making the diaphragm the primary muscle of respiration.⁴

Because the ET tube impairs coughing and secretion removal, periodic suctioning is necessary to remove secretions and promote ventilation and oxygenation. To reduce the likelihood of airway contamination and prevent health care–associated infection and VAP, the nurse should perform suctioning using sterile technique. The nurse should also elevate the head of the bed, suction oral secretions that pool above the (ET) tube cuff, and change the suction setup only when clinically indicated.

Indications for suctioning may include:⁶

- Secretions in the ET tube
- Auscultation of adventitious breath sounds
- Increased peak airway pressure with volume-controlled ventilation
- Decreased tidal volume during pressure-controlled ventilation
- Changes in flow and pressure graphics during mechanical ventilation
- Increased work of breathing
- Sustained coughing and a decrease in oxygen saturations (SpO₂)

Recommendations and parameters for suctioning include:

- Suctioning should be performed only when indications are present, based on individual need, not unit routine or schedule.¹
- Instilling sterile 0.9% sodium chloride solution to facilitate suctioning of secretions is not recommended and may contribute to bacterial colonization of the lower airway and impaired oxygenation.¹
- Negative pressure exerted on the ET tube should be the lowest possible level needed to clear the secretions. Suction should not exceed –60 mm Hg to –100 mm Hg for infants and children.¹
- No evidence supports applying intermittent negative pressure, rotating the catheter, or turning the child’s head from side to side.³
- A duration of no longer than 5 seconds for infants and no longer than 10 seconds for children per suction pass is recommended to reduce the risk of hypoxemia.¹
- The size of the suction catheter should not exceed half the internal diameter of the ET tube. This allows air to continue to enter the lungs during suctioning and limits mucosal trauma.¹
- Safe suction depth should be noted and displayed at the child’s bedside. Insertion depth should be limited to the length of the ET tube.¹
- Catheter passes should be limited to only the number of times required to clear secretions. If more than one catheter pass is required, the child must be allowed recovery time between passes.
- Suction should be applied only as the catheter is removed.

Adverse effects of ET suctioning include hypoxemia, atelectasis, elevated pulmonary artery pressure, arrhythmia, trauma to the trachea and bronchi, bronchospasm, infection, increased

Endotracheal Tube: Closed Suctioning (Pediatric) - CE

intracranial pressure (ICP), and elevated blood pressure or hypotension.⁶ Proper humidity, hydration, and temperature levels help maintain thinner secretions and facilitate suctioning.⁶

CHILD AND FAMILY EDUCATION

- Provide individualized, developmentally appropriate education to the family and the child based on the desire for knowledge, readiness to learn, and overall neurologic and psychosocial state.
- Explain the suctioning procedure, including the purpose, steps, and rationale.
- Explain that suctioning may be uncomfortable and cause coughing and shortness of breath.
- Explain the importance of having the child assist with secretion removal by coughing, if able, during the procedure.
- Encourage questions and answer them as they arise.

ASSESSMENT AND PREPARATION

Child and Family Assessment

1. Perform hand hygiene and don PPE as indicated for needed isolation precautions.
2. Introduce yourself to the child and family.
3. Verify the correct child using two identifiers.
4. Assess the child's developmental level and ability to interact.
5. Assess the child's and family's understanding of the reasons for and risks and benefits of the procedure.
6. Determine the family's desire to be present during the procedure.
7. Assess the signs and symptoms of airway secretions and inadequate oxygenation and ventilation.
 - a. Visible secretions in the airway
 - b. Inspiratory wheezes
 - c. Crackles
 - d. Restlessness
 - e. Diminished breath sounds
 - f. Tachypnea
 - g. Tachycardia or bradycardia
 - h. Cyanosis
 - i. Increased peak airway pressure
8. Review the child's history, using the child's record and the family as resources.
 - a. Size and type of ET tube
 - b. Safe suction catheter depth
 - c. Ventilator settings, including oxygen requirement, if applicable
 - d. Tolerance of brief periods without ventilator support
 - e. Characteristics and production of tracheal secretions, usual frequency of suctioning, and the last time the tube was suctioned

Endotracheal Tube: Closed Suctioning (Pediatric) - CE

9. Ensure that an appropriate-size bag and mask are connected to an oxygen source at the bedside.
10. Assess ET tube security, including tape integrity and tube movement.
11. Assess the child for pain and administer pain medication, as needed.
12. Reassess the child’s pain status, allowing for sufficient onset of action per medication, route, and the child’s condition.

Preparation

1. Ensure that all equipment and supplies, including an appropriate-size backup ET tube, are available ([Table 1](#)).

Table 1 Suction Catheter Size

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Age	Endotracheal (ET) tube size (mm) (cuffed or uncuffed)	Suction catheter size (Fr)
Newborn	3.0–3.5	6–8
6 months	3.5–4.0	8
2 years	4.5–5.0	10
4–7 years	5.5–6.5	12
>10 years	6.5–7.5	14

(Adapted from Hazinski, M.F. [Ed.]. [2013]. *Nursing care of the critically ill child* [3rd ed.]. St. Louis: Mosby.)

2. Select the proper size suction catheter.
 - a. Use a length-based resuscitation tape to find the correct size.
 - b. Calculate the suction catheter size by doubling the ET tube size in millimeters and selecting the suction catheter French size closest to the doubled number.⁵
3. Premedicate the child as needed.

A child who is especially vulnerable to physiologic changes during suctioning may need premedication.

PROCEDURE

1. Perform hand hygiene and don gloves and appropriate PPE based on the patient’s signs and symptoms and indications for isolation precautions.
2. Verify the correct child using two identifiers.
3. Explain the procedure to the child and family and ensure that they agree to treatment.
4. Assess breath sounds.
5. Secure the connecting tube to the closed system suction port and unlock the suction control mechanism, if required.

Endotracheal Tube: Closed Suctioning (Pediatric) - CE

6. Ensure that the suction device is on and set the vacuum regulator at the appropriate suction level while depressing the thumb port of the catheter. Suggested negative pressure settings are –60 to –100 mm Hg for infants and children.¹

Rationale: Setting the appropriate suction level minimizes damage to the tracheal epithelium. Sufficient pressure should be applied to remove secretions effectively.

Follow the manufacturer's directions for suction pressure levels for closed suction systems.

7. Verify the safe suction depth before inserting the catheter into the airway. If the safe suction depth is unknown, measure the length of an extra ET tube of the same size.

Rationale: Accurate measuring helps avoid tracheal tissue damage from inserting the catheter too deeply. The catheter should not be inserted until resistance is met; this causes damage and scarring to the carina.

8. Record the safe suction depth in the child's record and display it at the bedside, if it is not already displayed.

9. Preoxygenate, if indicated, using the ventilator or administering manual breaths via a bag, as indicated.

Rationale: Preoxygenation may increase the partial pressure of arterial oxygen (PaO₂) levels, decreasing the risk of desaturation with suctioning.

Do not preoxygenate with 100% FIO₂ if the child has certain congenital heart defects.¹

10. If the child is ventilated with an oscillator, pause oscillations before suctioning. Resume oscillations between suctioning passes.

Suctioning on high frequency oscillation ventilation can result in significant lung derecruitment.

11. Advance the catheter until the determined centimeter marking is aligned with the lavage port.

The most efficient catheter advancement occurs when the bag that covers the catheter bunches up behind the fingers.

12. When the catheter is at the correct depth, depress the thumb control valve and hold it while slowly withdrawing the catheter. Support the catheter at the ET tube with one hand while withdrawing the catheter with the other hand to prevent extubation.

To reduce the risk of hypoxemia, limit each suction pass to no longer than 5 seconds for infants and no longer than 10 seconds for children.¹

13. Assess breath sounds.

Endotracheal Tube: Closed Suctioning (Pediatric) - CE

14. After each suction pass, allow the child time to recover (as indicated by pulse oximetry and cardiopulmonary monitoring) by providing positive pressure breaths and oxygen as indicated.

15. Clean the catheter between each pass while watching the opening in the catheter sleeve that allows observation of secretions.

a. Withdraw the black tip of the catheter to the middle of the cleaning chamber.

b. Depress the thumb control valve and then gently squeeze the 0.9% sodium chloride solution into the chamber.

16. Lock the suction catheter.

Rationale: Locking prevents inadvertent suction.

17. When the ET tube is cleared of secretions, suction the oral and nasal pharynx. Avoid trauma to the nasal and oral passages and gagging during suctioning.

Rationale: Suctioning the oral and nasal pharynx prevents contamination of the lower airways with upper airway organisms.

18. Note the color, volume, and consistency of the secretions removed.

19. Wean the child to preprocedure levels of oxygen, as tolerated.

20. Discard supplies, remove PPE, and perform hand hygiene.

21. Document the procedure in the child's record.

MONITORING AND CARE

1. Change the closed suction system, tubing, and collection container as needed or per the organization's practice.

2. Monitor physiologic stability, including vital signs, indications of inadequate oxygenation and ventilation, ICP, and clinical appearance before, during, and after the procedure.

Reportable conditions: Persistent arrhythmia, hemodynamic instability, significant changes in SpO₂ and arterial or venous blood gas values, significant changes in oxygenation or ventilation indices, bronchospasm, unresolved increased work of breathing, changes in peripheral perfusion, cyanosis, increased ICP, anxiety, agitation, changes in mental status

3. Assess breath sounds and respiratory effort before and after suctioning for signs and symptoms of airway secretions and changes in oxygenation or ventilation.

Reportable conditions: Diminished or absent breath sounds, significant changes in SpO₂ and arterial or venous blood gas values, increased peak airway pressure, persistent coughing, increased work of breathing

4. Confirm the placement of the ET tube by auscultating breath sounds, looking for equal chest rise, and observing the carbon dioxide waveform on the bedside monitor.

Endotracheal Tube: Closed Suctioning (Pediatric) - CE

Rationale: Equal breath sounds, equal chest rise, and a visible carbon dioxide waveform indicate correct placement.

Reportable condition: Absent carbon dioxide waveform on the bedside monitor, unequal or no chest rise, unequal breath sounds, change in the position of the ET tube

5. Monitor the child for signs indicating suctioning is needed again.
6. Assess, treat, and reassess pain.

EXPECTED OUTCOMES

- Removal of airway secretions
- Alleviation of signs or symptoms of the need for suctioning
- Support of oxygenation and ventilation
- Maintenance of recruited lung and PEEP
- Hemodynamic stability
- Maintenance of ICP within acceptable limits
- Acceptable level of comfort

UNEXPECTED OUTCOMES

- Inability to clear secretions
- Respiratory instability
- Inadequate oxygenation and ventilation, including hypoxemia
- Bronchospasm
- VAP
- Cardiac arrhythmia and hemodynamic instability
- Increased ICP
- Inadequately managed pain and irritability

DOCUMENTATION

- Physical assessment findings, including vital signs, breath sounds, comfort level, and indicators of respiratory distress before and after the procedure
- Date and time of the procedure
- Color, volume, consistency, and odor of secretions
- Comfort assessment and specific interventions provided
- Additional interventions necessary before, during, and after suctioning
- Child's tolerance of and response to suctioning and care
- Unexpected outcomes and related nursing interventions
- Child and family education

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Endotracheal Tube: Closed Suctioning (Pediatric) - CE

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AACN Levels of Evidence

- Level A - Meta-analysis of quantitative studies or metanalysis of qualitative studies with results that consistently support a specific action, intervention, or treatment
- 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 D - Peer-reviewed professional organizational standards with clinical studies to support recommendations
- Level E - Multiple case reports, theory-based evidence from expert opinions, or peer-reviewed professional organizational standards without clinical studies to support recommendations
- Level M - Manufacturer's recommendations only

SUPPLIES

- Gloves and PPE, as indicated
- Closed suction system with an appropriate-size catheter
- Suction source (wall regulator or portable machine)
- Collection container
- Connecting tube (large-bore noncollapsible)
- Ventilation bag (self-inflating or flow-inflating) connected to an oxygen flowmeter
- Appropriate-size mask
- Individual catheters for oral and nasal suctioning (wide-bore pliable plastic suction catheter and rigid pharyngeal tonsil tip catheter)
- Stethoscope
- Premedications as indicated

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