# Endotracheal Suctioning of Mechanically Ventilated Patients With Artificial Airways 2010

**An electronic literature search for articles published between January 1990 and October 2009 was conducted by using MEDLINE, CINAHL, and Cochrane Library databases. The update of this clinical practice guideline is the result of reviewing a total of 114 clinical trials, 62 reviews and 6 meta-analyses on endotracheal suctioning. The following recommendations are made following the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) criteria: (1) It is recommended that endotracheal suctioning should be performed only when secretions are present, and not routinely; (2) It is suggested that pre-oxygenation be considered if the patient has a clinically important reduction in oxygen saturation with suctioning; (3) Performing suctioning without disconnecting the patient from the ventilator is suggested; (4) Use of shallow suction is suggested instead of deep suction, based on evidence from infant and pediatric studies; (5) It is suggested that routine use of normal saline instillation prior to endotracheal suction should *not* be performed; (6) The use of closed suction is suggested for adults with high $F_{I}O_{2}$, or PEEP, or at risk for lung derecruitment, and for neonates; (7) Endotracheal suctioning without disconnection (closed system) is suggested in neonates; (8) Avoidance of disconnection and use of lung recruitment maneuvers are suggested if suctioning-induced lung derecruitment occurs in patients with *acute lung injury*; (9) It is suggested that a suction catheter is used that occludes less than 50% the lumen of the endotracheal tube in children and adults, and less than 70% in infants; (10) It is suggested that the duration of the suctioning event be limited to less than 15 seconds.** *Key words: closed suction; endotracheal suction; saline instillation; intratracheal suction; open suction; saline lavage; suction catheter; tracheal suction; clinical practice guideline.* [Respir Care 2010;55(6):758–764. © 2010 Daedalus Enterprises]

## ETS 1.0 DESCRIPTION

Endotracheal suctioning (ETS) is one of the most common procedures performed in patients with artificial airways. It is a component of bronchial hygiene therapy and mechanical ventilation that involves the mechanical aspiration of pulmonary secretions from a patient's artificial airway to prevent its obstruction.[1] The procedure includes patient preparation, the suctioning event, and follow-up care.

There are 2 methods of endotracheal suctioning based on the selection of catheter: open and closed. The ***open*** suctioning technique requires disconnecting the patient from the ventilator, while the ***closed*** suctioning technique involves attachment of a sterile, closed, in-line suction catheter to the ventilator circuit, which allows passage of a suction catheter through the artificial airway without disconnecting the patient from the ventilator. There are also 2 methods of suctioning based on the catheter suction depth selected during the procedure: deep and shallow. ***Deep suctioning*** is defined as the insertion of a suction catheter until resistance is met, followed by withdrawal of the catheter by 1 cm before application of negative pressure, and ***shallow suctioning*** as the insertion of a suction catheter to a predetermined depth, usually the length of the artificial airway plus the adapter.[2]

## ETS 2.0 PATIENT PREPARATION

It is recommended to use smaller catheters whenever possible, since suction pressure seems to have less influence on lung volume loss than catheter size.[3] For a given diameter of the endotracheal tube (ETT), the level of negative pressure transmitted to the airway is determined by the combination of the catheter size and the suction pressure. The larger the diameter of the catheter size, the less attenuation of the suction pressure through the airways.[4]

**2.1** Diameter of the suction catheter should not exceed one half the inner diameter of the artificial airway in adults, providing an internal-to-external diameter ratio of 0.5 in adults,[5,6] and 0.5–0.66 in infants and small children.[7]

**2.2** In preparation for the suctioning event, delivery of 100% oxygen in pediatric[8] and adult patients[9] and 10% increase of baseline in neonates[10-12] for 30–60 seconds prior to the suctioning event is suggested, especially in patients who are hypoxemic before suctioning.[13,14] This may be accomplished either:

**2.2.1** by adjusting the $F_{IO_2}$ setting on the mechanical ventilator, or

**2.2.2** by use of a temporary oxygen-enrichment program available on many microprocessor ventilators.[15]

**2.2.3** Manual ventilation of the patient is not recommended, as it has been shown to be ineffective for providing delivered $F_{IO_2}$ of 1.0.[16,17] Practitioners should ensure that PEEP is maintained if no other alternative is available to hyper-oxygenate.

**2.3** The negative pressure of the unit must be checked by occluding the end of the suction tubing before attaching it to the suction catheter, and prior to each suctioning event. Suction pressure should be set as low as possible and yet effectively clear secretions. Experimental data to support an appropriate maximum suction level are lacking. Negative pressure of 80–100 mm Hg in neonates[18] and less than 150 mm Hg in adults have been recommended.[19]

**2.4** The ***closed suctioning technique*** facilitates continuous mechanical ventilation and oxygenation during the suctioning event.[20,21]

**2.4.1** It may prevent lung derecruitment associated with the use of open-suction system in patients at higher risk of desaturation (eg, premature newborns).[22-29]

**2.4.2** It should be considered in patients requiring high $F_{IO_2}$ and PEEP (eg, acute lung injury).[30-36]

**2.4.3** It neither increases nor decreases the risk of ventilator-associated pneumonia.[37-39]

**2.4.4** Daily changes of in-line suction catheters do not decrease the risk of ventilator-associated pneumonia and is not cost-effective.[40,41]

**2.5** A patient should be placed on a pulse oximeter to assess oxygenation during and following the procedure.

## ETS 3.0 PROCEDURE

The suctioning event consists of the placement of a suction catheter through the artificial airway into the trachea and the application of negative pressure as the catheter is being withdrawn. Each pass of the suction catheter into the artificial airway is considered a suctioning event.[42]

**3.1** Shallow suctioning is recommended to prevent trauma to the tracheal mucosa.

**3.2** Deep suctioning has not shown superior benefit over shallow suction[43] and may be associated with more adverse events.[44-46]

**3.3** The duration of each suctioning event should be no more than 15 seconds.[8,47,48]

**3.4** Sterile technique is encouraged during open suctioning technique.[2]

**3.5 Normal saline instillation**. Instillation refers to the administration of aliquots of saline directly into the trachea via an artificial airway. It is hypothesized that normal saline instillation may loosen secretions, increase the amount of secretions removed, and aid in the removal of tenacious secretions. However, there is insufficient evidence to support this hypothesis. Normal saline instillation appears to enhance secretion clearance through cough stimulation in adults,[49] and a recent report suggests that normal saline instillation prior to suctioning is associated with decreased incidence of ventilator-associated pneumonia in ventilated adult patients.[50] The great majority of the references used to update this guideline indicate that normal saline instillation is unlikely to be beneficial, and may in fact be harmful.[17,48,51-53] Therefore, it should not be routinely performed prior to performing endotracheal suctioning.

## ETS 4.0 FOLLOW-UP CARE

Following the suctioning event:

**4.1** Hyper-oxygenation for at least 1 min by following the same technique(s) used to pre-oxygenate the patient may be used, especially in patients who are hypoxemic before and/or during suctioning.[10]

**4.2** Hyperventilation should not be routinely used.

**4.2.1** Lung-recruitment maneuvers may be attempted in patients with clear evidence of derecruitment.[30,54,55]

**4.3** The patient ***should be*** monitored for adverse reactions.

## ETS 5.0 SETTING

Endotracheal suctioning may be performed by properly trained persons in a wide variety of settings that include (but are not limited to):

**5.1** Hospital
**5.2** Extended care facility
**5.3** Home
**5.4** Out-patient clinic
**5.5** Physician's office
**5.6** Transport vehicle

## ETS 6.0 INDICATIONS

**6.1** The need to maintain the patency and integrity of the artificial airway
**6.2** The need to remove accumulated pulmonary secretions as evidenced by one of:
**6.2.1** sawtooth pattern on the flow-volume loop on the monitor screen of the ventilator and/or the presence of coarse crackles over the trachea are strong indicators of retained pulmonary secretions.[56,57]
**6.2.2** increased peak inspiratory pressure during volume-controlled mechanical ventilation or decreased tidal volume during pressure-controlled ventilation[58]
**6.2.3** deterioration of oxygen saturation and/or arterial blood gas values[58]
**6.2.4** visible secretions in the airway[58]
**6.2.5** patient's inability to generate an effective spontaneous cough
**6.2.6** acute respiratory distress[58]
**6.2.7** suspected aspiration of gastric or upper-airway secretions
**6.3** The need to obtain a sputum specimen to rule out or identify pneumonia or other pulmonary infection or for sputum cytology

## ETS 7.0 CONTRAINDICATIONS

Endotracheal suctioning is a necessary procedure for patients with artificial airways. Most contraindications are relative to the patient's risk of developing adverse reactions or worsening clinical condition as result of the procedure. When indicated, there is no absolute contraindication to endotracheal suctioning, because the decision to withhold suctioning in order to avoid a possible adverse reaction may, in fact, be lethal.

## ETS 8.0 HAZARDS/COMPLICATIONS

**8.1** Decrease in dynamic lung compliance[59] and functional residual capacity[60]
**8.2** Atelectasis[32,37]
**8.3** Hypoxia/hypoxemia[61,62]
**8.4** Tissue trauma to the tracheal and/or bronchial mucosa[63]
**8.5** Bronchoconstriction/bronchospasm[1,60]
**8.6** Increased microbial colonization of lower airway[5,64]
**8.7** Changes in cerebral blood flow[65,66] and increased intracranial pressure[67-69]
**8.8** Hypertension[70]
**8.9** Hypotension[17]
**8.10** Cardiac dysrhythmias[17]
**8.11** Routine use of normal saline instillation may be associated with the following adverse events:
**8.11.1** excessive coughing[49]
**8.11.2** decreased oxygen saturation[53,71-75]
**8.11.3** bronchospasm
**8.11.4** dislodgement of the bacterial biofilm that colonizes the ETT into the lower airway[50,76-78]
**8.11.5** pain, anxiety, dyspnea[79,80]
**8.11.6** tachycardia[53]
**8.11.7** increased intracranial pressure[70,81]

## ETS 9.0 LIMITATIONS OF METHOD

Endotracheal suctioning is not a benign procedure, and operators should remain sensitive to possible hazards and complications and take all necessary precautions to ensure patient safety. Secretions in peripheral airways are not and should not be directly removed by endotracheal suctioning.

## ETS 10.0 ASSESSMENT OF NEED

Qualified personnel should assess the need for endotracheal suctioning as a routine part of the patient/ventilator system assessment as detailed in section 6.0 Indications.

## ETS 11.0 ASSESSMENT OF OUTCOME

**11.1** Improvement in appearance of ventilator graphics and breath sounds[57,58]
**11.2** Decreased peak inspiratory pressure with narrowing of peak inspiratory pressure-plateau pressure; decreased airway resistance or increased dynamic compliance; increased tidal volume delivery during pressure-limited ventilation
**11.3** Improvement in arterial blood gas values or saturation, as reflected by pulse oximetry ($S_{pO_2}$)
**11.4** Removal of pulmonary secretions

## ETS 12.0 RESOURCES

**12.1** Necessary Equipment
**12.1.1** Vacuum source
**12.1.2** Calibrated, adjustable regulator
**12.1.3** Collection bottle and connecting tubing
**12.1.4** Disposable gloves
**12.1.4.1** Sterile (open suction)
**12.1.4.2** Clean (closed suction)
**12.1.5** Sterile suction catheter
**12.1.5.1** For selective main-bronchus suctioning, a curved-tip catheter may be helpful.[82] The information related to the effectiveness of head turning for selective suctioning is inconclusive.

**12.1.6** Sterile water and cup (open suction)
**12.1.7** Goggles, mask, and other appropriate equipment for standard precautions[83]
**12.1.8** Oxygen source with a calibrated metering device
**12.1.9** Pulse oximeter
**12.1.10** Manual resuscitation bag equipped with an oxygen-enrichment device for emergency backup use
**12.1.11** Stethoscope

**12.2** Optional Equipment
**12.2.1** Electrocardiograph
**12.2.2** Sterile sputum trap for culture specimen

**12.3** Personnel. Licensed or credentialed respiratory therapists or individuals with similar credentials (eg, MD, RN) who have the necessary training and demonstrated skills to correctly assess need for suctioning, perform the procedure, and adequately evaluate the patient after the procedure.

## ETS 13.0 MONITORING

The following should be monitored prior to, during, and after the procedure:

**13.1** Breath sounds
**13.2** Oxygen saturation
**13.2.1** Skin color
**13.2.2** Pulse oximeter
**13.3** Respiratory rate and pattern
**13.4** Hemodynamic parameters
**13.4.1** Pulse rate
**13.4.2** Blood pressure, if indicated and available
**13.4.3** Electrocardiogram, if indicated and available
**13.5** Sputum characteristics
**13.5.1** Color
**13.5.2** Volume
**13.5.3** Consistency
**13.5.4** Odor
**13.6** Cough characteristics
**13.7** Intracranial pressure, if indicated and available
**13.8** Ventilator parameters
**13.8.1** Peak inspiratory pressure and plateau pressure
**13.8.2** Tidal volume
**13.8.3** Pressure, flow, and volume graphics, if available
**13.8.4** $F_{IO_2}$

## ETS 14.0 FREQUENCY

Although the internal lumen of an ETT decreases substantially after a few days of intubation, due to formation of biofilm,[84] suctioning should be performed ***only*** when clinically indicated in order to maintain the patency of the artificial airway used.[85-87] Special consideration should be given to the potential complications associated with the procedure.

## ETS 15.0 INFECTION CONTROL

**15.1** Centers for Disease Control guidelines for standard precautions should be followed.[83]
**15.1.1** If manual ventilation is used, care must be taken not to contaminate the airway.
**15.1.2** Sterile technique is encouraged during the entire suctioning event.

**15.2** All equipment and supplies should be appropriately disposed of or disinfected.

## ETS 16.0 RECOMMENDATIONS

The following recommendations are made following the Grading of Recommendations Assessment, Development, and Evaluation (GRADE)[88,89] criteria:

**16.1** It is recommended that endotracheal suctioning should be performed only when secretions are present, and not routinely. (1C)

**16.2** It is suggested that pre-oxygenation be considered if the patient has a clinically important reduction in oxygen saturation with suctioning. (2B)

**16.3** Performing suctioning without disconnecting the patient from the ventilator is suggested. (2B)

**16.4** Use of shallow suction is suggested instead of deep suction, based on evidence from infant and pediatric studies. (2B)

**16.5** It is suggested that routine use of normal saline instillation prior to endotracheal suction should *not* be performed. (2C)

**16.6** The use of closed suction is suggested for adults with high $F_{IO_2}$, or PEEP, or at risk for lung derecruitment (2B), and for neonates (2C).

**16.7** Endotracheal suctioning without disconnection (closed system) is suggested in neonates. (2B)

**16.8** Avoidance of disconnection and use of lung-recruitment maneuvers are suggested if suctioning-induced lung derecruitment occurs in patients with *acute lung injury.* (2B)

**16.9** It is suggested that a suction catheter is used that occludes less than 50% of the lumen of the ETT in children and adults, and less than 70% in infants. (2C)

**16.10** It is suggested that the duration of the suctioning event be limited to less than 15 seconds. (2C)

## 17.0 ETS CPG IDENTIFYING INFORMATION AND AVAILABILITY

**17.1** Adaptation
Original Publication: Respir Care 1993;38(5):500-504.

**17.2** Guideline Developers

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None

**17.4** Financial disclosures/conflicts of interest

No conflicts of interest.

**17.5** Availability

Interested persons may photocopy these clinical practice guidelines (CPGs) for noncommercial purposes of scientific or educational advancement. Please credit the American Association for Respiratory Care (AARC) and Respiratory Care. All of the AARC CPGs can be downloaded at no charge at http://www.rcjournal.com/cpgs.

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