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Endotracheal Suctioning in Critically Ill Child

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Abstract

Endotracheal suctioning is one of the most common advanced procedure carried out in pediatric intensive care. Despite this, there are not many evidences to support different techniques for endotracheal suctioning in pediatric patients as compared to preterm infants and adults. This paper enlightens different techniques used for endotracheal suctioning in pediatric intensive care unit and also its impact on pediatric patients.

Keywords: Endotracheal Suctioning; Neonates; Children; Pediatric Intensive care units.

Introduction

Endotracheal and tracheostomy tubes are used to maintain airway and facilitate mechanical ventilation. The presence of theses tubes, especially endotracheal tube prevents coughing and effective removal of secretion, therefore periodic suctioning is required. Endotracheal-suctioning (ETS) is one of the most common invasive procedures carried out in patients with mechanical ventilation[1] It is a procedure that aids in removal of pulmonary secretions from the patient's airway who are on mechanical ventilation. This procedure is an essential part of airway hygiene therapy in patients undergoing mechanical ventilation in the intensive care unit (ICU), because these patients often show impaired cough reflex and mucociliary clearance, and increased mucus production.[2]

This paper will enlighten different techniques used for endotracheal suctioning in pediatric intensive care unit and also its impact on pediatric patients.

Impact of Endotracheal Suctioning in Pediatric Patients

Endotracheal suctioning when performed causes changes in lung compliance and airway resistance. It causes stimulation of tracheal wall, thereby producing sympathetic nervous system effects and resulting in increased intracranial pressure.

1. Patients with hypoxemic acute respiratory failure, in particular those with acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) who are ventilated with high fractions of inspired oxygen (FiO_2) and high levels of positive end-expiratory pressure (PEEP), are at greater risk for ES-related complications, especially severe hypoxemia and atelectasis. Different techniques have been developed in order to prevent or decrease ES-induced hypoxemia, such as hyperoxygenation, hyperinflation, and lung recruiting maneuvers.[3,4]

2. Children with Traumatic Brain Injury and Raised Intracranial Pressure: Fisher et al reported in their study ETS causes increases increased intracranial pressure (ICP) elevation as a result of tracheal stimulation (by the suction catheter) rather than increase in partial pressure of carbon dioxide caused by apnea alone.[5] Yano M et al conducted a study to reduce ICP related to endotracheal suctioning by giving both intravenous and endotracheally administered lidocaine to nine adolescent (and some adult) patients with severe TBI. They found that both methods decreased ICP with suctioning, with endotracheal administration being more effective[6]. It supported Fisher's[6] findings that increase in ICP is primarily due to tracheal stimulation during suctioning. Tume LN also reported in their study that ICP was increased with suctioning both clinically and statistically. The results of the study also showed that majority of children recovered to their baseline ICP within 5 minutes after suctioning, with a median time of 3 minutes (range: 0–90 minutes)[7].
3. Children with Congenital Heart Disease: Reactive pulmonary hypertension is a common problem in the cardiac PICU. Endotracheal suctioning is a known noxious trigger in this group of children, albeit one that is necessary. Hickey has conducted a study to assess the effect of an opiate (fentanyl) on pulmonary vascular response during suctioning. The results showed that there was marked reduction in pulmonary vascular response among children who received opiate before suctioning.[8]
4. Respiratory complications: Hypoxia, pneumothorax, mucosal trauma because of deep ET suctioning in neonates and atelectasis.[9, 10]
5. ET suctioning has been associated with increased nosocomial bacteremia because of entry of pathogens into the airway through suction catheter.[11]
6. Behavioral pain: Pokela ML showed in their study that administration of opioids before ET suctioning significantly reduced the duration of hypoxemia and the level of distress [12].

Evidences in Endotracheal Suctioning Techniques

1. Frequency of suctioning: ES should be performed whenever clinically required, with potential complications associated with the procedure in consideration. In clinical scenerio, suctioning should be performed every 1–2 hours in order to maintain the patency of the artificial airway used[3] while some studies suggested that atleast 12–24 suctioning procedures should be done per day. Cordero et al. conducted a study to compare frequencies of suctioning, every 4 hours and every 8 hours plus as needed, and found that decreasing ES frequency had no clinically important effect on incidence of nosocomial infections, frequency of reintubation, duration of mechanical ventilation, duration of hospitalization, and neonatal mortality, suggesting that a low-frequency suction regimen can be safely implemented.[13] Based on all these data, the updated clinical practice guidelines of the American Association for Respiratory Care recommend ES to be performed only when clinically indicated to maintain the patency of the artificial airway. Other clinical parameters in suctioning should be performed are visible secretions in the endotracheal tubes, increased peak inspiratory pressure during volume-controlled mechanical ventilation or decreased tidal volume during pressure-limited ventilation, marked reduction in oxygen saturation. At present, a sawtooth pattern on the flow-volume loop and/or the presence of coarse crackles over the trachea are likely to be the best parameters to assess the need for suctioning on an individual basis[3].
2. Depth of Suctioning: Deep ES may promote mucosal trauma and airway bleeding, and can also cause major alveolar collapse and hypoxemia. Maggiore SM recommended that suction should be inserted until resistance is met (usually at the carina), followed by withdrawal of the catheter by 1 cm before application of negative pressure.[14]
3. Size of Suction Catheter: The size of suction catheter along with the amount of negative pressure applied and duration of suctioning has impact on severity of potential complications of ES procedure. For this reason, it has been suggested that the diameter of the suction catheter should not exceed one half the inner diameter of the endotracheal and tracheosotmy tubes[15]. Morrow B recommended that the catheter size should be selected in consideration with both ETT size and consistency of secretion,

as small diameter catheters will not effectively clear thick secretions[16].

4. Level of Negative Pressure: The suction pressure should be high enough to remove secretions, but not so high that it can cause mucosal damage or lung volume loss. Evidences are limited regarding the ideal amount of negative pressure to be applied during suctioning. Negative pressures between 100 and 250 cmH_2O have been recommended[3,5]. Young CS suggested that suction pressures may be increased up to 200 mm Hg to aspirate thick secretions[15]. Kohlhauser C used suction pressures between 200 and 300 mm Hg in their neonatal study[17].

5. Duration of Suctioning: Increase in duration of suctioning concurrently increases the amount of negative pressure within a lung and causes variable degree of hypoxia clinically. Presently there is not enough evidences regarding duration of suctioning but some authors recommend between 10 and 15 seconds[17]. Runton recommended from their study that duration of suctioning should be limited to 5 seconds in children [18].

6. Hyperoxygenation: Hyperoxygenation is reuired during suctioning in order to prevent ET suction-induced hypoxia but there are limited evidences that depicts the exact amount and duration of preoxygenation[19]. Evans JC showed in their study that providing 10% fiO_2 above baseline for 2 minutes before suctioning and manually ventilating with 100% O_2 in between suctioning reduced the incidence of hypoxemia, bradycardia, and apnea associated with suctioning[20]. Kerem et al. also concluded based on results of their study that delivering 100% inspired O_2 for 1 min before the procedure reduces the chances of decrease in oxygen saturation during suctioning[21]. Branson et al. suggested that adults and children should receive 100% inspired O_2 for 30 seconds before suctioning[18]. On the contrary, delivering 100% oxygen is associated with absorption atelectasis which may enhance the ES-related alveolar collapse.

7. Use of Saline: Isotonic saline (sodium chloride) is being used from a long time during suctioning in PICU with the impression that the fluid aides in removal of pulmonary secretions by either diluting thick secretions or by eliciting cough reflex. This method was introduced before development of humidifying systems and is still in practice. However, mucus and water when present in large amount do not mix with each other thereby making separate phases even after vigorous shaking. Thus, the use of saline in dilution secretion is still questionable. It may also cause additional dispersion of contaminated adherent material in the lower respiratory tract when used during endotracheal suctioning thereby increasing the risk for nosocomial infection[22]. The use of normal saline is effective only in infants with ETT size 2.5 mm for maintaining artificial airway patency.[23]

8. Open vs Closed-System Suctioning. Suctioning is performed with one of two basic methods. In open suctioning technique, a single use suction catheter of appropriate size is introduced into the open end of endotracheal tube after disconnecting the tube from ventilatory circuit. In closed suctioning technique, also called as in-line suctioning, a multiple use suction catheter wrapped inside a plastic sleeve is inserted through a special diaphragm attached to endotracheal tubes. Closed suctioning should be done in patients with moderate to severe pulmonary insufficiency, those requiring high positive end expiratory pressure and high inspired oxygen (>80%) or in whom airborne transmission is suspected like active pulmonary tuberculosis. It also decreases the risk for aerolization of tracheal secretion during suction induced coughing[24]. Mosca FA et al reported in their study that CSS in neonates led to decrease in degree and duration of desaturation and bradycardia[25]. Choong K suggested that use of CSS may prevent ET suction induced hypoxia and decreases in lung volume in pediatric patients[26]. The major disadvantage of CSS use is ineffective clearance of thick secretions from the airways. Practically, if suction catheter is not removed completely after suctioning then it may cause partial occlusion of endotracheal tube and may further increase airway resistance. Cordero L et al showed in their study that CSS as compared to OES did not affect the rate of bacterial airway colonization, frequency of ET suctioning and reintubation, duration of mechanical ventilation, length of hospitalization, incidence of nosocomial pneumonia or mortality among low birth infants. However, CSS was most preferred by nurses because it decreases their time, improved their effi-

ciency and also was easy to use as compared to OES. The nurses also perceived that it was better tolerated by the patients as compared to OES[27]. Choong et al. found that OES led to increase in loss of total lung volume as compared to CSS in pediatric patients aged 6 days to 13 yrs. It was also found that patient with OES experienced more periods of desaturaton as compared to CSS. Thus authors recommend that CSS is preferable to the open technique, especially in patients requiring high levels of positive end-expiratory pressure, to avoid alveolar derecruitment and hypoxia during ET suctioning.

9. Recruitment Maneuvers: Duff et al conducted a study to assess the safety and efficacy of sustained inflations (SIs) as a lung Recruitment Maneuver (RM) in PICU children the results of the study found a significant sustained decrease in oxygen requirements (by 6.1%) lasting up to 6 hours post-RM; thus, they concluded that RMs are safe and may improve oxygen requirements[27]. With conflicting results regarding the efficacy of RMs and some safety issues raised, this practice cannot be recommended.

Conclusion

Endotracheal suctioning is the most common procedure carried out in pediatric intensive care unit. The above review support different practices carried out for suctioning in children as well as neonates in intensive care units.

Conflict of Interest : No conflict of interest

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References

1 American Association for Respiratory Care (AARC). Clinical Practice Guidelines. Endotracheal suctioning of mechanically ventilated patients with artificial airways. Respiratory Care. 2010; 55: 758-64. PMid:20507660

2 Maggiore SM, Iacobone E, Zito G, et al (2002) Closed versus open suctioning techniques. Minerva Anestesiol 68:360–4

3 American Association for Respiratory Care (1993) AARC clinical practice guideline. Endotracheal suctioning of mechanically ventilated adults and children with artificial airways. Respir Care 38:500–4

4 AARC Clinical Practice Guidelines (2010) Endotracheal suctioning of mechanically ventilated patients with artificial airways 2010. Respir Care 55:758–64.

5 Fisher DM, Frewen T, Swedlow DB. Increase in intracranial pressure during suctioning—stimulation vs. rise in $PaCO_2$. Anesthesiology 1982;57(5):416–417.

6 Yano M, Nishiyama H, Yokota H, Kato K, Yamamoto Y, Otsuka T. Effect of lidocaine on ICP response to endotracheal suctioning. Anesthesiology 1986;64(5):651–653

7 Tume LN, Baines PB, Lisboa PJ. The effect of nursing interventions on the intracranial pressure in paediatric traumatic brain injury. Nurs Crit Care 2011;16(2):77–84

8 Hickey PR, Hansen DD, Wessel DL, Lang P, Jonas RA, Elixson EM. Blunting of stress responses in the pulmonary circulation of infants by fentanyl. Anesth Analg 1985;64(12):1137–1142

9 Singh NC, Kissoon N, Frewen T, et al: Physiological responses to endotracheal and oral suctioning in pediatric patients: The influence of endotracheal tube sizes and suction pressures. Clin Intensive Care 1991; 2:345–350

10 Loubser MD, Mahoney PJ, Milligan DW: Hazards of routine endotracheal suction in the neonatal unit. Lancet 1989; 24: 1444 –1445 65.

11 Bailey C, Kattwinkel J, Teja K, et al: Shallow versus deep endotracheal suctioning in young rabbits: Pathological effects on the tracheobronchial wall. Pediatrics 1988; 82: 746 –751.

12 Pokela ML: Pain relief can reduce hypoxemia in distressed neonates during routine treatment procedures. Pediatrics 1994; 93: 379 – 383.

13 Cordero L, Sananes M, Ayers LW (2001) A comparison of two airway suctioning frequencies in mechanically ventilated, verylow-birthweight infants. Respir Care 46:783–8.

14 Maggiore SM, Lellouche F, Girou E, et al (2002). Implementation of ICU practice guidelines to reduce complications of endotracheal suctioning [abstract]. Am J Respir Crit Care Med 165:A786.

15 Young CS: Recommended guidelines for suction. Physiotherapy 1984; 70:106 –108].

16 Morrow B, Futter M, Argent A: Endotracheal suctioning: From principles to practice. In-

tensive Care Med 2004; 30:1167–1174.

17 Kohlhauser C, Bernert G, Hermon M, et al: Effects of endotracheal suctioning in highfrequency oscillatory and conventionally ventilated low birth weight neonates on cerebral hemodynamics observed by Near Infrared Spectroscopy (NIRS). Pediatr Pulmonol 2000; 29:270 –275.

18 Runton N: Suctioning artificial airways in children: Appropriate technique. Paediatr Nurs 1992; 18:115–118.

19 Oh H, Seo W: A meta-analysis of the effects of various interventions in preventing endotracheal suction- induced hypoxemia. J Clin Nurs 2003; 12:912–924).

20 Evans JC: Reducing the hypoxemia, bradycardia, and apnea associated with suctioning in low birthweight infants. J Perinatol 1992; 12:137–142.

21 Kerem E, Yatsiv I, Goitein KJ: Effect of endotracheal suctioning on arterial blood gases in children. Intensive Care Med 1990; 16:95–99.

22 Freytag CC, Thies FL, Ko¨nig W, et al: Prolonged application of closed in-line suction catheters increases microbial colonization of the lower respiratory tract and bacterial growth on catheter surface. Infection 2003; 31:31–37.

23 Drew JH, Padoms K, Clabburn SL: Endotracheal tube management in newborn infants with hyaline membrane disease. Aust J Physiother 1986; 32:3–5.

23 Wiegand D. AACN Procedure Manual for Critical Care.2011; 6th Edition. Elsevier Saunders, Missouri, USA:79-81.

24 Mosca FA, Colnaghi M, Lattanzio M, et al: Closed versus open endotracheal suctioning in preterm infants: Effects on cerebral oxygenation and blood volume. Biol Neonate 1997; 72:9 –14).

25 Choong K, Chatrkaw P, Frndova H, et al: Comparison of loss in lung volume with open versus in-line catheter endotracheal suctioning. Pediatr Crit Care Med 2003; 4:69 –73.

26 Cordero L, Sananes M, Ayers LW: Comparison of a closed (Trach Care MAC) with an open endotracheal suction system in small premature infants. J Perinatol 2000; 3:151–156.

27 Duff JP, Rosychuk RJ, Joffe AR. The safety and efficacy of sustained inflations as a lung recruitment maneuver in pediatric intensive care unit patients. Intensive Care Med 2007;33(10): 1778–1786.