CONTINUING EDUCATION

Evidence Based Use of Cuffed Endotracheal Tubes in Children

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Historically, the use of cuffed endotracheal tubes (ETTs) was reserved for children aged 8 years or older to minimize the risks of postextubation laryngeal edema. However, since publication of a 1997 study, researchers have consistently presented evidence that appropriately used cuffed ETTs are as safe as uncuffed ETTs. Because of the advantages of cuffed ETTs in the perianesthesia setting, the transition to cuffed ETTs in children is now complete. However, risks related to using cuffed ETTs in young children increase when guidelines for safe and appropriate use are not followed. Perianesthesia practitioners caring for children must understand the implications related to ETT type, correct ETT sizing, and the monitoring and control of ETT cuff pressure. The purpose of this educational module is to present evidence-based guidelines for the appropriate use of cuffed ETTs in children less than 8 years of age in the perianesthesia setting.

Keywords: *pediatric anesthesia, cuffed endotracheal tube, laryngeal edema, cuff pressure.*

OBJECTIVES—(1) DESCRIBE THE anatomical differences between the pediatric airway and the adult airway, (2) list factors related to appropriately choosing an endotracheal tube (ETT) and controlling ETT cuff pressure (CP) in children; and (3) discuss the nursing implications related to recognition and treatment of children with postextubation laryngeal edema.

Historically, the use of cuffed ETTs was reserved for children aged 8 years or older, with the intent of minimizing the risk of postextubation laryngeal edema. However, in 1997, Khine et al compared the intraoperative use of cuffed ETTs with uncuffed ETTs in 488 children aged less than 8 years and found no significant difference in outcomes.[1] The findings from this landmark study began the controversy related to the use of cuffed ETTs in young children.

Since that time, other researchers have presented supporting evidence that appropriately used cuffed ETTs are as equally safe as uncuffed ETTs.[2-5] There is also evidence that repeated laryngoscopies with reintubation due to uncuffed ETTs that are too small or too large,[2,6,7] and poorly fitting uncuffed ETTs[5,8,9] are more problematic than cuffed ETTs.

There are significant disadvantages to the use of uncuffed ETTs. Manageable, expected leaks during the perianesthesia period can become problematic with changes in anesthetic depth, intraoperative insufflation, levels of muscle relaxation, and position changes.[8,10-12] Repeated laryngoscopies and reintubations due to poorly fitted uncuffed ETTs can be significantly reduced when cuffed ETTs are used.[2,13,14] In a recent meta-analysis of two randomized clinical trials and two prospective cohort studies comparing the use of cuffed ETTs with uncuffed ETTs in almost 3,800 children

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aged less than 8 years, the ETT exchange rate and incidence of postextubation stridor were actually higher in the uncuffed ETT group.[2] Children intubated with uncuffed ETTs are more likely to have postoperative sore throats.[6]

Measurements of physiologic parameters such as end-tidal carbon dioxide and peak inspiratory pressure are more accurate when a significant air leak around the ETT is avoided.[2,15] Sealing the airway with a cuffed ETT decreases operating room (OR) contamination, higher peak inspiratory pressures can be delivered, lower fresh gas flows with associated less volatile gas usage contribute to cost savings,[1,2,16-18] and aspiration[2,15,19] and airway fire risks[10] are reduced. The current American Heart Association guidelines for pediatric advanced life support recommend using cuffed ETTs as a safe alternative to uncuffed ETTs.[20]

As a result of these findings, many perianesthesia practitioners are now using cuffed ETTs almost exclusively in children weighing at least 3 kg.[10,21] However, balancing the risk of potentially severe and sometimes irreversible tracheal damage from cuffed ETTs with the advantages of the cuff carries important patient safety implications. Because nurses in the OR and the postanesthesia care unit (PACU) are often called on to assist with intubation or reintubation, their understanding of the related nursing implications is important. The purpose of this educational module is to present evidence-based guidelines for the safe and appropriate use of cuffed ETTs in children aged less than 8 years in the perianesthesia setting.

Anatomy of the Pediatric Airway

An understanding of pediatric airway anatomy and how it differs from that of the adult airway is foundational for appreciating the risks related to laryngoscopy, ETTs and postextubation laryngeal edema in young children. The most significant differences are related to the larynx, tongue, epiglottis, vocal cords, and cricoid ring.

The larynx of an infant is more cephalad in the neck than that of an adult. The infant larynx is at the level of C3-4, the adult larynx at C4-5. The hyoid bone, which functions as the anchor for the tongue, is also proportionately higher in an infant. The proximity of the tongue to the more cephalad larynx creates a more acute angle between the planes of the tongue and glottis and can make intubation more difficult. For this reason, the use of a straight blade in infants more effectively lifts the tongue during laryngoscopy than a curved blade and thus increases the likelihood of a successful intubation.[22]

A child's epiglottis is more narrow and stiff with a more acute angle to the trachea when compared with the broad, flat adult epiglottis, making lifting of the child's epiglottis more difficult. The angle of a child's vocal cords also differs from the near perpendicular angle of the adult epiglottis with the anterior insertion sitting lower than the posterior insertion.[10] These factors contribute to making intubation of children relatively more difficult than intubation of adults and increases the risk of laryngeal trauma and the need for repeated laryngoscopies.

The most clinically significant differences when discussing the use of cuffed ETTs in children relate to the shape and dimensions of the area around the vocal cords, the cricoid ring, and the region just below. Historical studies include evidence that the airway is conical in shape and that the cricoid ring and the subglottic area just below is the narrowest. But researchers presenting recent evidence from magnetic resonance imaging, computed tomography, and bronchoscopic examinations report that the airway is elliptical in shape with the transverse diameter of the vocal cords or just below being the narrowest. But they caution that because of the rigid cricoid ring, the area around the ring may continue to be of most concern.[10,21]

In the adult airway, the area between the vocal cords is consistently the narrowest part. So, during intubation, visualization of the ETT passing easily through the vocal cords should insure that the ETT is not too large. Unfortunately, when intubating an infant or young child, the vulnerable area beyond the vocal cords at and just below the level of the cricoid ring is not visualized during laryngoscopy. So, the ETT can be inaccurately assumed to appropriately fit when it could actually cause damage by putting excessive pressure on the lateral wall mucosa of the cricoid ring. When pressure on the tracheal mucosa exceeds tracheal perfusion pressure, inflammation and tissue damage can