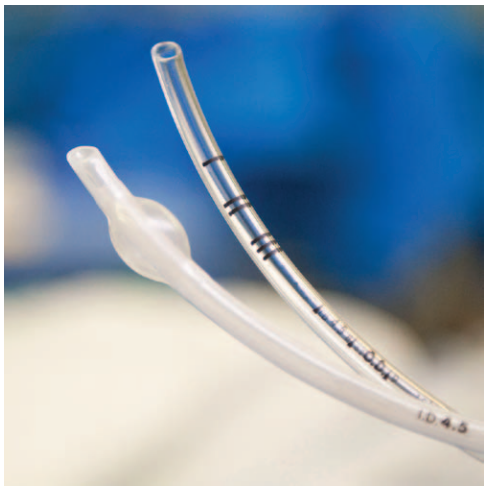
Cuffed *versus* Uncuffed Endotracheal Tubes in Pediatric Anesthesia

The Debate Should Finally End

IN this issue of ANESTHESIOLOGY, Sathyamoorthy *et al.*[1] describe three cases of postextubation airway swelling in young infants. The cases are noteworthy because the endotracheal tube used in all three infants was a recently developed cuffed endotracheal tube called the Microcuff® (Kimberly-Clark, Roswell, GA), which has been specifically designed for use in pediatric anesthesia. It differs from a traditional cuffed endotracheal tube in two major modifications: first, the cuff is made of ultrathin (10 microns) polyurethane, which allows a more effective tracheal seal at pressures below those known to cause tracheal mucosa pressure necrosis; and second, the cuff is physically located more distally on the endotracheal tube shaft, facilitated by the omission of the Murphy eye. This latter feature more reliably places the cuff below the nondistensible cricoid ring and theoretically reduces the chance of an accidental main bronchus intubation.



"Except for unique clinical circumstances … there is no longer a feasible role for the use of the uncuffed tube in pediatric anesthesia...."

As Sathyamoorthy *et al.* demonstrate,[1] these innovations do not guarantee that tracheal injury will not occur. In fact, the report is important because it reminds us that postextubation stridor (*i.e.*, airway injury and swelling) can occur after tracheal intubation with any type of endotracheal tube; however, it does not implicate the Microcuff® as a unique offender. The infants in cases 1 and 2, who were born preterm and weighed less than 3 kg, were intubated with a size 3.0 Microcuff® tube, but the manufacturer recommends this size only for full-term infants weighing more than 3 kg. The 3-week-old infant presented in case 3 was born at term and weighed 4 kg at the time of intubation with a size 3.5 Microcuff® tube, but the manufacturer recommends this size tube only for infants from 8 months to less than 2 yr of age.* In the three described infants, the use of Microcuff® tube sizes greater than that recommended by the manufacturer was likely more responsible for the airway swelling than the tube and cuff design.

Careful examination of the literature leads us to believe that the most important cause of endotracheal tube related airway damage is actually the *lack* of a cuff. In the 1960s, when neonatal care was improving at an exponential pace, oral or nasal tracheal intubation began to replace tracheostomy.[2,3] Uncuffed endotracheal tubes were preferred because the absence of a cuff allowed for a relatively larger internal diameter endotracheal tube. This allowed easier suctioning of secretions and a lower resistance to spontaneous ventilation. Since that time, many authors have promulgated, without evidence, the notion that uncuffed tubes are required until the pediatric larynx goes through a transformation from cone-shaped to cylindrical at 8 yr of age. To this day, authoritative textbooks on pediatric anesthesia still claim that this occurs at or around the age of 8 yr and is responsible for the ability of the pediatric larynx to safely accommodate a cuffed endotracheal tube. Even if this were true (it is not),[4] it simply does not matter.

To be clear, we need to distinguish between two distinct populations under consideration. The largest population of children that requires tracheal intubation most often comprises those children of any age who undergo general anesthesia for medical or surgical procedures. The use of an uncuffed tube is generally safe, and associated with a low incidence of postextubation stridor, but there are drawbacks to having a ventilation leak around the tube. These include an inaccurate capnographic tracing,[5] inaccurate spirometric tidal volume measurement, inaccurate end-tidal anesthetic level measurement, waste and increased cost of inhaled

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*http://kchealthcare.com/media/74430/microcuff%20brochure_pediatric_h8346_final.pdf. Accessed November 13, 2012.

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anesthetics,[6,7] increased pollution of the operating room environment, increased airway fire risk, possible need to change the endotracheal tube to a different size[5] (often only recognized after the surgical procedure has begun), lack of ability to regulate the tracheal seal with change in respiratory system compliance, and an increased risk of microaspiration.[8] On the other hand, all types of cuffed endotracheal tubes have been shown to be safe in pediatric patients.[5,7,9–11] Claims that cuffed endotracheal tubes predispose to glottic injury or an increased chance of bronchial intubation based on mathematical analyses of tracheal lengths[12,13] have not been substantiated clinically.

The smaller but probably more important population of interest is those children (especially neonates) who are intubated for prolonged periods. Although the incidence of intubation-related subglottic stenosis has steadily declined over the past several decades, it continues to be a significant clinical problem. Studies of freshly extubated neonatal larynges demonstrate damage to all areas of the glottic and subglottic regions.[14–17] The rigid cricoid ring and the vocal folds are particularly susceptible to damage from mucosal shear because of the lack of any substantial submucosal layer in these areas. This is most likely what happens when an uncuffed endotracheal tube is used, which has a large enough external diameter to provide adequate ventilation without an excessive leak, especially with movement of the infants' head and neck. But evidence of the clinical efficacy of cuffed endotracheal tubes in the neonatal setting is absent; thus, neonatologists have not been as eager as pediatric anesthesiologists to transition to cuffed endotracheal tubes in their practice.

Sathyamoorthy's report has provided us with the opportunity to emphasize that all types of endotracheal tubes have the potential to cause damage, and there are likely many other factors (previous intubations, patient movement, coexisting morbidity, *etc.*) that play a significant role in the generation of airway edema and scarring. Nevertheless, all children requiring tracheal intubation should benefit from a standard type of endotracheal tube that is associated with the best evidenced-based outcomes. This endotracheal tube should contain a high-volume, low-pressure cuff, with a standard ratio of internal to external diameter,[12] and clear length markers along the tube. Anesthesia and intensive care practitioners should establish a standard routine for the measurement of endotracheal tube cuff pressures at regular and frequent intervals in patients ventilated for prolonged periods.

Once considered mandatory for the young pediatric airway, the uncuffed endotracheal tube has now been reduced to a pessimistic meta-induction from the history of anesthesiology. Except for unique clinical circumstances (*e.g.,* purposeful bronchial intubation for neonatal thoracic surgery and lung isolation), there is no longer a feasible role for the use of the uncuffed tube in pediatric anesthesia, or in chronically ventilated children beyond the neonatal period. Further research should be directed toward optimizing endotracheal tube standards in the neonatal unit, where the greatest incidence of airway damage occurs.

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