Tam D. Pediatric Endotracheal Tube (ETT) Size. *MDCalc Journal*. 2026;022026(01).
doi:10.65357/001c.160323

Clinical Decision Tool Reviews

Pediatric Endotracheal Tube (ETT) Size

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Evidence to Action: Official Journal of MDCalc
Vol. 022026, Issue 01, 2026

Article Information

Keywords: anesthesia, pediatric airway management, intubation, airway management, pediatric anesthesia, endotracheal tube, respiratory failure

https://doi.org/10.65357/001c.160323

Submitted: November 13, 2025 EDT

Accepted: March 17, 2026 EDT

Published: April 17, 2026 EDT

Abstract

Pediatric airways grow along with the patient, so selection of tube size must be tailored to the patient's age and size. Broselow tape or other weight-based pediatric resuscitation tools also have estimated ETT sizes but may not always be available. Multiple formulae have been proposed for pediatric ETT size selection, with (age/4) + 3.5 being the most widely used for cuffed tubes.

I. HOW TO USE

When to Use

Use these formulae to calculate cuffed & uncuffed tube sizes for pediatric patients undergoing endotracheal intubation.

Pearls / Pitfalls

Sizes are estimates for what size tube will fit an average airway for a given age. It is recommended to have adjacent sizes available (0.5mm larger and 0.5mm smaller) when preparing for intubation of a pediatric patient.

Certain clinical scenarios may require the use of a smaller-than-predicted tube, particularly in the setting of airway edema (including but not limited to burns, epiglottitis, croup, history of subglottic stenosis, etc.

These formulae are generally most applicable to patients older than 12 months of age; for infants less than 12 months, full term newborns will generally be able to accommodate a 3.5mm inner diameter (ID) cuffed tube. Infants closer to 12 months will often accommodate a 4.0mm tube.

Why Use

Pediatric airways grow along with the patient, so selection of tube size must be tailored to the patient's age and size. Broselow tape or other length-based pediatric resuscitation tools also have estimated ETT sizes but may not always be available.

II. NEXT STEPS

Advice

The largest tube size expected to pass easily into the glottic opening should be used to facilitate easier suctioning and ventilation, but the endotracheal tube should never be forcefully inserted through the vocal cords.

Video laryngoscopy improves first pass success and should be used when available.

If an endotracheal tube cannot be placed, rescue with bag-mask ventilation or supraglottic airway placement is often successful.

Management

Prior to intubation, ensure that extra tube sizes, airway adjuncts, supraglottic airways, and alternative laryngoscope blade sizes are available

Children have a shorter safe apneic time (i.e. desaturate more rapidly when apneic) as compared to adults; adequate preoxygenation (at any age) is critical to maximizing safe apneic time.

Have post-intubation sedation readied as part of the pre-intubation preparation. Sedation / induction agents will often wear off before neuromuscular blockers do, which can lead to awareness under paralysis.

Waveform end-tidal capnography is the most reliable way to verify successful intubation of the trachea, though this should always be done in conjunction with other methods (auscultation, X-ray, visualization of tube misting, direct or video visualization of the tube entering the glottic opening).

Critical Actions

Cuffed tubes are almost always preferred. In some circumstances, particularly in neonates, an uncuffed tube may be more appropriate. The presence of an inflatable cuff increases the outer diameter of the endotracheal tube, even when the cuff is deflated, which may necessitate placement of an uncuffed tube where the glottic opening does not allow for the passage of an available cuffed tube.

Consultation with a pediatric airway expert is recommended in cases of a predicted anatomically difficult airway (airway malformations, tumors).

III. EVIDENCE

Evidence Appraisal

The original formula ((age (y) / 4) + 4) for determining pediatric endotracheal tube (ETT) size was published by Cole in 1957. This was in an era in which uncuffed tubes were used.

With anatomical studies showing that the pediatric airway is more elliptical than round, cuffed tubes came into favor. While inner diameter measurements remained as the way in which tubes were sized, cuffed tubes have a greater outer diameter than corresponding uncuffed tubes, even with the cuff deflated, necessitating a new formula for size selection.

Initially a formula of (age/4)+3.0 was suggested by Khine et al. in 1997. Duracher refined the formula to be (age/4)+3.5, since the Khine formula appeared to underestimate ETT size by ~0.5mm (Duracher et al., 2008).

Manimelathu et al. conducted a randomized trial among 135 patients under 8 years of age undergoing endotracheal intubation comparing the Cole, Khine, and Duracher formulae. Sizes were rounded to the nearest 0.5mm. Children were intubated by anesthesiologists, and cuff inflation pressure necessary to eliminate an audible air leak at a continuous airway pressure of 20 cmH2O was the criterion used to determine whether tube size was appropriate or too small. Tubes were deemed too small if the cuff pressure required to eliminate an air leak was 30cmH2O or higher. Tubes were deemed too large if there was no air leak with the cuff fully deflated. The primary outcome was the need to exchange the tube for a larger or smaller size. The authors also measured secondary outcomes of cuff pressure, cuff inflation volume required to seal the airway, and postoperative adverse effects (stridor, hoarseness, throat pain/soreness) assessed 0-2h, 2-4h, and 24h postoperatively.

The authors findings were that the Duracher group required no tube changes, whereas 4 patients in the Khine group and 6 in the Cole group required tube size changes. Postoperative adverse effects were lower in the Duracher group than both the Cole and the Khine groups. These differences were not statistically significant when comparing the Duracher and Khine groups, and it should be noted that the Cole formula was applied to cuffed tubes in this study, even though the Cole formula was designed to calculate uncuffed tube size. Because of these findings, the Duracher formula is generally recommended for clinical use.

Endotracheal tubes of the same inner diameter may have different outer diameters between different manufacturers. There are also variations in airway size between individuals, meaning that no ETT size formula will be 100% accurate. Airway managers should have available one 0.5mm size up and one size down from the calculated ETT size to avoid damage to the larynx and trachea due to a too-large tube as well as inadequate / difficulty with ventilation with a too-small tube.

Formula

Cole formula (uncuffed tube size): (age (y) / 4) + 4.0
Duracher formula (cuffed tube size): (age (y) / 4) + 3.5
Round to the nearest 0.5mm (eg a 1 year old cuffed tube size would be calculated as (1/4) + 3.5 = 0.25 + 3.5 = 3.75, which would round to 4.0mm.

Facts & Figures

This formula typically is applicable to children ages 1-12. Below that, consider an endotracheal tube reference card(http://www.smiths-medical.com/userfiles/tracheal-tubechart.pdf); above 12, typically most adult sizes (6.5-8.0) can be used.

Literature

Original/Primary

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Validation

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