Methods to Appropriately Size Pediatric Endotracheal Tubes

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Structured Abstract

Background

Incorrect sizing of pediatric endotracheal tubes (ETTs) can result in serious complications and significantly increase morbidity and mortality. Problematically, there is no consensus on a standardized formula or method to assist providers in the selection of appropriate pediatric ETT size. Historically, providers have used age-based formulas (ABFs), height-based formulas, and other methods to predict appropriate ETT size. However, these formulas and methods are frequently inaccurate and can't be extrapolated to all pediatric patients.

A 5-year old, 22 kilogram patient presented for a dental rehabilitation. The anesthetic plan was general anesthesia (GA) with a cuffed nasotracheal tube to aid the surgeon's visualization. Cole's ABF [(age in years+16)/4], was used to select the tube size. Because the patient was nearing age 6, age 6 was used in the formula. The predicted ETT size was 5.5 mm internal diameter (ID). A mask inhalation induction was performed and propofol was administered after IV access was obtained. The nasotracheal tube easily advanced through the nasal passages. However, the ETT would not advance past the vocal cords because the tube was oversized. The 5.5 mm ID tube was exchanged for a 5.0 mm ID tube without complication.

Due to the significant complications that can result from inappropriately sized pediatric ETTs, the accuracy of traditional formulas and methods should be evaluated, and new methods should be considered. Ultrasound (US) has emerged as a method to assess the subglottic area to indirectly measure and predict pediatric ETT size.

Clinical Question

In pediatric patients undergoing GA with an ETT, how does the utilization of US compare to the use of traditional formulas, in correctly predicting ETT size?

Evidence Based Discussion

Commonly used ABFs such as Cole's, modified Cole's, Khine's, and Penlington's formulas have variable rates of success. Age-based formulas were primarily developed in the western world, and the accuracy may not extrapolate to other ethnicities, regions, and populations. Additionally, natural variations among children contribute to the unreliable success. Height-based methods, such as the Broselow system, may be helpful in emergencies. However, studies reveal inconsistent results. Also, measurement of the diameter of the little finger method exhibits a poor correlation with appropriate ETT size.

Alternatively, US can be utilized to indirectly measure the subglottic diameter. The diameter is used to select the ETT by outer diameter (OD), instead of ID as with traditional methods. This is advantageous because the OD of ETTs can differ by manufacturer and among specialty tubes.

Many studies reveal US measurement of the subglottic diameter is more accurate than traditional formulas. Ultrasound measurement is a safe and accurate alternative to ABFs, height-based formulas, and the diameter of the little finger method. The learning curve for subglottic airway assessment is short. Thus, it's a skill that can be easily learned by anesthesia providers.

Regarding the case above, US measurement of the subglottic area was an appropriate alternative to using an ABF. The calculated ETT size according to Cole's formula was 5.5 mm ID; however, the ETT should have been downsized to 5.0 mm ID before initial placement because cuffed tubes should be downsized from uncuffed tubes.

Translation to Practice

Utilization of US to predict pediatric ETT size is safe and accurate. Measurement of the subglottic area is likely more accurate than estimation with ABFs, height-based formulas, and the diameter of little finger method. If a provider possesses the skill to perform US assessment of the subglottic area, it is a reasonable alternative to traditional formulas/methods. Regardless of the method used to select the ETT, the auscultated leak test should be performed to confirm the appropriate size.

To implement US measurement of the subglottic diameter for pediatric ETT sizing, a protocol needs to be developed for the facility. A collaborative team of anesthesia providers should be formed to promote the protocol, determine a start date, educate providers of appropriate techniques, and ensure the availability of resources (supplies, equipment, US machines). Post-pilot data should be collected, specifically regarding appropriate ETT placement as verified by the auscultated leak test. Outcomes, processes, and feedback should be routinely evaluated.

Additional research is necessary regarding US subglottic assessment for sizing pediatric ETTs. Most studies are prospective and observational without randomization; systematic reviews and meta-analyses should be completed. Additionally, there is limited research on the use of US subglottic measurement in high-acuity pediatric populations. Future research is needed on the role of US in predicting pediatric ETT size in difficult airways and patients with known subglottic stenosis.

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