A comparison of three methods for determining proper endotracheal tube depth in children

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Background: Methods for estimating the appropriate depth of endotracheal tube (ETT) placement in children differ among anesthesia practitioners. While chest radiography remains the gold standard for confirming ETT placement, this is not routinely performed in the operating room. Instead, many anesthesia practitioners predict appropriate depth using clinical methods such as deliberate endobronchial intubation followed by withdrawal 2 cm above the carina[1], alignment of marks on the endotracheal tube at the level of the vocal cords[2], and inserting the tracheal tube at a predetermined depth in cm that is 3 times the internal diameter of the tube in mm[3]. We designed this study to compare these three methods and determine which method most reliably places the ETT at the appropriate depth in pediatric patients.

Methods: After obtaining IRB approval and parental consent, 23 patients between 3 months and 7 years of age undergoing general endotracheal anesthesia were enrolled in this prospective study. Enrollment criteria included the planned use of fluoroscopy during the surgical procedure and the placement of an uncuffed ETT. Demographic data were collected for all patients. Patients were randomly assigned to one of three methods. Following induction of anesthesia, patients were intubated using Hudson RCI® Sheridan™ uncuffed ETTs. Appropriate internal diameter of the ETT was determined using the formula Age (yrs) / 4 + 4 for children over the age of 2 years. A 3.5-4.0 mmID ETT was used for infants under 6 months of age, and a 4.0-4.5 mmID ETT was used for patients between 6 and 24 months of age. Tracheal intubation was confirmed by the presence of end-tidal CO2 (ETCO2) and bilateral breath sounds by auscultation. In Group 1 (mainstem method), the ETT was advanced until breath sounds were no longer heard over the left axilla. The ETT was slowly retracted until bilateral breath sounds returned then withdrawn an additional 2 cm before being secured. In Group 2 (marker method), the double black line marker on the ETT was placed at the level of the vocal cords during direct laryngoscopy. In Group 3 (formula method), the depth of ETT placement was predetermined by multiplying the internal diameter of the ETT in mm by 3. Following intubation, the ETT was secured with the depth marker at the alveolar ridge. During the first intraoperative fluoroscopy, the distances from the sternoclavicular junction (SCJ) to the ETT tip and from the ETT tip to the carina were measured with the head midline and neck in neutral position. ETT placement for each patient was determined to be "High" (above the SCJ), "Appropriate" (between the SCJ and 0.5 cm above the carina), or "Low" (less than 0.5 cm above the carina or below the carina). Data for all 3 methods were calculated and recorded for each study patient.

Results: Age of the patients ranged from 3 to 84 months with a mean of 31+/-26.16 months. Mean weight (kg) was 11.45+/-5 and mean length (cm) was 84.76+/-19.81 with 55% males and 45% females representing 4 ethnic groups. There was no difference in demographics between groups. Based on our preliminary data, use of the mainstem method was most likely to result in appropriate ETT placement (65%) followed by the formula method (60%). The marker method had the lowest incidence of appropriate ETT placement (35%) and was most likely to result in high placement (65%). Use of the formula method most frequently resulted in low ETT placement (30%).

Discussion: Use of both the mainstem and formula methods result in an acceptable rate of appropriate ETT depth following intubation. Preliminary data suggest that deliberate mainstem intubation may be the preferred method due to the high likelihood of appropriate placement and decreased risk of high or low positioning compared to the other two clinical methods studied. Whenever ETT depth is in question, confirmation of ETT positioning by intraoperative chest radiography or fluoroscopy is recommended.

References:

1. Bloch EC, et al. Anesth Analg 67(6): 590-2.
2. Freeman JA, et al. Anaesthesia 50(12): 1050-2.
3. Gregory GA. *Pediatric Anesthesia*. 4th ed: 224.