

Title: Noninvasive Determination of Tracheal Tube Position in Infants and Children

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Introduction: A variety of techniques are available for the clinical assessment of the proper position of a tracheal tube. Cuffed tubes have the advantage that the cuff is readily palpable in the sternal notch, virtually assuring adequate position. Uncuffed tubes have ring markers that are intended to be aligned with the vocal cords to provide a guideline for proper placement. In the operating room tracheal tube position is rarely confirmed by chest roentgenograph, whereas in the intensive care unit this is a routine procedure. Infants and children who require tracheal intubation for acute respiratory failure frequently require multiple roentgenographs because of repositioning of the tracheal tube. A new non-invasive device, Trach Mate™ (McCormick Laboratories, Inc.), claims to accurately locate the position of an uncuffed tracheal tube with a metallic ring marker imbedded in the wall of the tube using a magnetic detector. We have studied 51 pediatric patients to determine whether this device accurately positions the tracheal tube.

Methods: All children less than six years of age requiring tracheal intubation in the pediatric intensive care unit were candidates for study. The tracheas of fifty-one children between the age of 4 days and 66 months were intubated using the special tracheal tubes with the imbedded metallic rings. Their weight ranged from 2.7 - 19 kg. Tracheal tube size was estimated by the formula: $Size = (Age \text{ in years} + 16) / 4$. The tube was judged to be the appropriate size if a leak was detected at an inflating pressure of less than 40 cm H₂O. The tracheas of ten patients were intubated orally and the remaining 41 nasally. After successful intubation and confirmation of air entry bilaterally, the position of the tracheal tube was confirmed by placing the detector over the patient's sternal notch with the head midline and in a neutral position. The device emits a high pitched noise and a red light glows when the metal band is in proximity to the detector. The tube position is adjusted to maximize the intensity of these two signals. A chest roentgenograph was obtained to confirm proper tracheal tube position after the tube was securely taped. The distance of the tube above the carina was measured and the thoracic vertebrae at the tip of the tube was noted.

Results: The tracheal tube was satisfactorily positioned in all 51 patients judging by the chest roentgenograph. The tip of the tube was positioned between 1.0 and 3.5 cm above the carina with the average distance being 1.7 ± 0.5 cm (SD). The distribution of tracheal tube tip positions is

presented in Figure 1. The following tracheal tube sizes were used: 3.0 (5), 3.5(17), 4.0(18), 4.5(5), and 5.0(6) tracheal tubes.

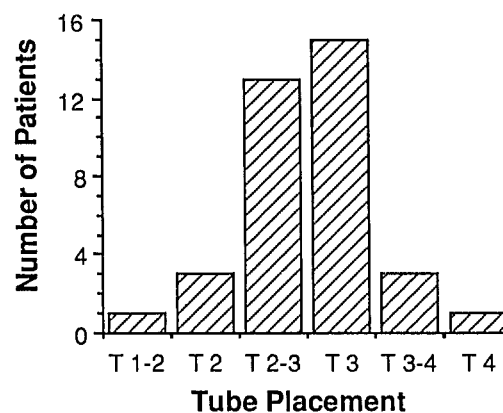


Figure 1. The position of the tip of the tracheal tube was judged versus the thoracic vertebrae or disk space. In all patients the tube was at least 1 cm above the carina and below the clavicles on the chest roentgenograph.

Discussion: Chest roentgenographs for the assessment of tracheal tube placement are expensive, create a delay, are not routinely available in the operating room, and are a source of ionizing radiation. Non-invasive confirmation is therefore often preferable. Our results demonstrate that in infants and children the Trach Mate™ intubation system is effective in properly positioning the tracheal tube in the trachea. None of the patients required the tube to be repositioned after the chest roentgenograph was obtained.

With a cost of approximately \$6.50 compared to \$1.00 for a standard uncuffed tube as well as the one-time cost of approximately \$485 for the detector, the Trach Mate™ system may appear substantially more expensive. However, if one less portable A-P roentgenograph (\$163 patient charge at our institution) is taken for every 30 ICU admissions, then no net increase in cost will occur (except for the initial cost of the locator device). It is reasonable that the number of roentgenographs may be further reduced and a very large potential cost savings could be realized. This system has potential use for patients in the intensive care unit who might be expected to need repeated verification of the tracheal tube position, and for occasional patients in the operating room.