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Original Research Paper

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TO STUDY THE DIFFERENT METHODS OF PREDICTING ETT SIZE IN INDIAN CHILDREN

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ABSTRACT **Background:** This study compares three methods for determining the size of cuffed endotracheal tubes (ETT) for pediatric intubation: age-based formula, weight-based formula, and the width of the fifth fingernail. Selecting the correct ETT size is crucial for effective ventilation, as an undersized ETT can cause air leaks and aspiration risk, while an oversized ETT may lead to postoperative complications such as stridor, croup, and dysphonia. **Material and Method:** In this cross-sectional study, 75 pediatric patients of ASA grade I and II undergoing elective intubation under general anesthesia were randomized into three groups: Group A (age-based formula), Group B (weight-based formula), and Group C (fingernail width technique). **Result:** The age-based formula was found to be the most accurate predictor of ETT size. Conclusion: The age-based formula is recommended as the most reliable method for predicting ETT size, while the finger width technique is the least effective.

KEYWORDS : Endotracheal Tube (ETT), Pediatric Intubation, Age-Based Formula, Airway Management

INTRODUCTION-

Accurate selection of cuffed endotracheal tubes (ETTs) is essential for effective ventilation during endotracheal intubation, particularly in pediatric patients. Proper ETT sizing is crucial to ensure optimal ventilation while minimizing postoperative complications. An undersized ETT can lead to air leaks, inadequate tidal volume (TV), and increased risk of aspiration. Conversely, an oversized ETT may cause postoperative pharyngolaryngeal complications, including stridor, croup, and dysphonia, due to excessive cuff pressure and trauma to the airway.

Several methods are employed to predict the appropriate ETT size, including the age-based formula, weight-based formula, and the width of the fifth fingernail. The age-based formula [1] provides an estimation based on the patient's age, with two variations: for children 6 years and younger, the formula is (Age/3) + 3.5; for children 7 years and older, it is (Age/4) + 4.5. The weight-based formula [2] estimates ETT size as (Weight in kg/10) + 3.5. Additionally, the width of the fifth fingernail [3] technique offers a more direct measurement but lacks the empirical support of the other methods.

This study aims to compare the effectiveness of these three methods in predicting ETT size in pediatric patients. By evaluating the accuracy and reliability of each method, this research seeks to identify the optimal approach for enhancing ventilation efficacy and reducing the risk of complications associated with improper ETT sizing.

METHODS-

Study Design: Prospective Comparative Study
Duration: September 2022 – September 2023
Location: Sri Aurobindo Medical College & Post Graduate Institute, Indore, M.P.

Sample Size: 75

Inclusion Criteria:

- Patients classified as ASA I and II
- Children aged 1 to 12 years undergoing elective surgery under general anesthesia
- Requirement for endotracheal intubation

Exclusion Criteria:

- Children older than 12 years
- Children not requiring intubation

Selection of Cases and Grouping:

1. Patients scheduled for elective intubation under general anesthesia were selected.
2. Informed written consent was obtained from the guardians of all participants.
3. Patients were assigned to one of three groups in an alternating sequence:

- **Group A:** ETT size prediction using the age-based formula
- **Group B:** ETT size prediction using the weight-based formula
- **Group C:** ETT size prediction using the finger width technique

Patients were randomly assigned to one of three groups, with each group receiving a different method for predicting the appropriate endotracheal tube (ETT) size. Group A used the age-based formula, Group B used the weight-based formula, and Group C used the finger width technique. Informed written consent was obtained from the guardians of all participants.

A detailed airway assessment was performed prior to intubation, with ETT size selected according to the assigned method. Intubation was conducted after muscle relaxation with cisatracurium (0.5 mg/kg). Correct ETT placement was confirmed through capnography and bilateral breath sound auscultation. ETT placement was considered satisfactory if the tube passed smoothly through the glottis and demonstrated minimal air leakage at 20 cm H_2O during the leak test. The ventilator was set with a peak inspiratory pressure of 20 cm H_2O, zero positive end-expiratory pressure, a gas flow of 3 L/min, and an age-appropriate respiratory rate. Acceptable ventilation was indicated by minimal air leak, an expired tidal volume greater than 7 ml/kg, and a square wave capnogram.

Anesthesia was maintained with isoflurane in an oxygen/nitrous oxide mixture. Ventilation was managed using either pressure or volume control modes, with peak inspiratory pressures of 10-15 cm H_2O, tidal volumes of 7-10 ml/kg, and a breathing frequency adjusted to maintain an end-tidal CO_2 of 35-40 mm Hg. Upon completion of the surgery, inhalation agents and nitrous oxide were discontinued, and neuromuscular blockade was reversed with neostigmine (50 μg/kg) and glycopyrrolate (10 μg/kg). Extubation was performed when the patient was awake and breathing adequately. Patients were then moved to the post-anesthesia

care unit for recovery.

Data analysis was carried out using SPSS version 25 software. Categorical data were expressed as numbers and percentages, while quantitative data were presented as means and standard deviations. The association between categorical variables was analyzed using the Chi-Square test, and comparisons of means were conducted using One-Way ANOVA. A p-value of less than 0.05 was considered statistically significant.

RESULTS:

Table 1: Endotracheal tube used versus age (all sample)

Age group (years)	Group		
	A	B	C
1-5	13 (52)	14 (56)	21 (84)
6-10	10 (40)	7 28)	4 (16)
>10	2 (8)	4 (16)	0 ()

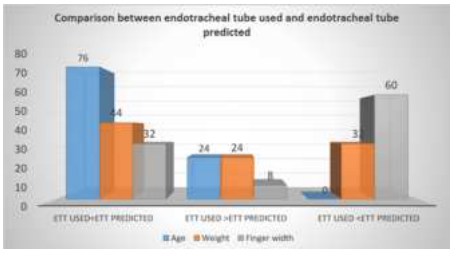
Table 2: Mean ETT predicted size by different methods

Method	Mean	SD	P value
ABF	5.34	0.965	<0.001 (ANOVA)
WBF	5.04	0.705	
FWT	4.06	0.845	

Table 3: Comparison between endotracheal tube used and endotracheal tube predicted

Parameter used for ETT size prediction	ETT Used=ETT predicted	ETT Used >ETT predicted	ETT Used <ETT predicted	P value*
Age (n=25); ABF	19 (76)	6 (24)	0 (0)	<0.001
Weight (n=25); WBF	11 (44)	6 (24)	8 (32)	
Finger width (n=25); FWT	8 (32)	2 (8)	15 (60)	

- Data is expressed as number of patients (percentage). Chi Square test was used to compare the proportions.
- P value of <0.05 is considered as significance



- The ABF underestimated ETT size in 0% of cases while the WBF underestimated ETT size in 32% of patients and FWT underestimated 60% of cases.
- The ETT size was overestimated in 24%, 24% and 8% of children by ABF, WBF and FWT respectively

DISCUSSION:

Study	Findings
Kim et al 2007 [4]	ABF was able to predict appropriate ETT size in less than one-third of the patients (Korean children)
King et al 1993 [5]	ABF was superior to fifth fingernail dimensions
Turkistani et al 2009 [6]	ABF and fifth fingernail width predicted the best fit ETT more accurately than length and multivariate formula
Park et al 2023 [7]	Penlington formula had a better success rate than the Cole formula (43% vs. 32%), but both ABF were inferior to a radiograph-based formula that calculated ETT size from the tracheal diameter at C7 from a chest X-ray
Shih et al 2008 [8]	Length-based formula had a high accuracy of 82.4% (Chinese children
Present Study	ABF was able to predict the ETT more accurately (76%) than WBF (44%) and FWT (32%

CONCLUSION:

The age-based formula (ABF) demonstrated superior accuracy in predicting endotracheal tube (ETT) size compared to both the weight-based formula (WBF) and the finger width technique (FWT). ABF correctly predicted the appropriate ETT size for all patients, with no cases of underestimation. In contrast, the WBF underestimated the required ETT size in 32% of cases, and the FWT underestimated ETT size in 60% of cases. Additionally, overestimation of ETT size occurred in 24% of patients using ABF, 24% using WBF, and 8% using FWT. These findings indicate that while ABF is more reliable in avoiding underestimation of ETT size, it still presents a notable rate of overestimation, which was comparatively lower than that observed with WBF and FWT.

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