CHOICE OF ENDOTRACHEAL TUBE IN THE MALAYSIAN PAEDIATRIC PATIENT—A GUIDE

By A. E. Delilkan

SYNOPSIS

The literature on choice of endotracheal tube in paediatric anaesthesia is reviewed.

643 Malaysian patients were studied regarding size of tube required for endotracheal intubation in a 4-year period. In the 2-10 year age group (500 cases) it was found that the size required is 0·5 mm. (internal diameter) less than that currently recommended by a formula based on experience with Western patients. A new formula is proposed for the Malaysian patient as a guide for anaesthetists under training in this part of the world.

INTRODUCTION

Endotracheal intubation in paediatric anaesthesia is an accepted routine procedure today.

Not many years ago endotracheal intubation in the paediatric patient for anaesthesia was frowned upon and the advantages and disadvantages of the procedure were weighed before a decision made (Pender, J. W. 1954).

In the child, certainly before puberty, the narrowest point in the larynx is at the cricoid as opposed to that of the adult which is at the level of the rima glottidis (Eckenhoff, J. F. 1951). The larynx in a child is also more cephalad and anterior in position compared to that of the adult; the epiglottis is folded and hooded compared to the more spade-like epiglottis of the adult. The anatomical peculiarities of the child's larynx plus the possible sequelae of intubation make endotracheal intubation in children a slightly different entity from that in adults. For instance non-cuffed endotracheal tubes are recommended for children below 8 years of age (Kaufman, L. 1971). The choice of the correct-sized (internal diameter) endotracheal tube in paediatric anaesthesia is vital.

Various charts and formulae (McIntyre, J. W. R. 1957; Levin, J. 1958; Slater, H. M. *et al*, 1955; Cole, F. 1957; Leigh, D. M. and Belton, K. 1960; Smith, R. M. 1968; Hallowell, P. 1962) based on experience have been advocated as a guide. These charts and formulae are all based on experiences with Western children using age as the basis for calculation. No known guide based on experience with children in this part of the world has been published.

The purpose of this paper is to investigate whether a recommended formula, based on Western standards and experience, applies to the Malaysian paediatric patient; the final aim being to provide a guide (based on local experience) for anaesthetists-in-training in this part of the world when endotracheal intubation in the local paediatric patient is required.

METHOD AND MATERIAL

643 patients were studied in the period September 1968-September 1972 at the University Hospital, Petaling Jaya; age range was <24 hours - 10 years, weight range was 2·2-33·1 kgms.

All 643 patients (500 in the age range 2-10 years; 143, <2 years) were personally intubated by the author as part of the anaesthetic management for surgery. (See Table I for analysis of cases).

The choice of patient for the study was as follows: Whenever the author anaesthetised a patient up to 10 years of age (for elective or emergency surgery) the internal diameter size (in millimetres) of the endotracheal tube used was noted down together with the age and weight. Before anaesthetising each case 3 endotracheal tubes were selected. In the 2-10 year age group (500 cases) the formula often quoted (Kaufman, L, 1971),

TABLE I

SHOWING ANALYSIS OF 643 CASES ACCORDING TO AGE

Age	Total No. of Cases
>2 <10 years	500
<2 years	143

Associate Professor, Dept. of Anaesthesiology, University of Malaya, Kuala Lumpur. Consultant Anaesthesiologist, University Hospital.

A. E. DELILKAN, A.M. (Malaysia), M.B., B.S., F.F.A.R.C.S.

$\frac{\text{Age (in years)}}{4}$ + 4·5 mm., was used to select the endotracheal tube; one size smaller and one size larger were also prepared as is usual in paediatric anaesthetic practice. The endotracheal tube calculated by the above formula was used as first choice. If any resistance beyond the cords was encountered when attempting intubation with the initially chosen tube the one size smaller (by 0·5 mm.) endotracheal tube was used; if the initial tube was inserted without resistance the one size larger (by 0·5 mm.) tube was used. The largest size endotracheal tube, passed without resistance, was the final choice of tube and its size (internal diameter) was noted.

All endotracheal tubes used were non-cuffed; the tubes were either the red-rubber variety (Magill or Rusch) or the latex, nylon-reinforced type (Rusch). All cases were intubated under the influence of neuro-muscular blocking agents and manual controlled ventilation with $N_20/0_2$ via the T-piece circuit (cases less than 20 kgm. weight) or the adult semi-closed, circle circuit (cases more than 20 kgm. weight) was used for maintenance anaesthesia. Premedication (Syrup trimeprazine tartrate, Pethidine and atropine) and induction (0_2/halothane inhalation) were dose controlled and standardized.

The patients in the less than 2 years age group were intubated with endotracheal tubes chosen according to a regime followed by the author based on personal experience.

RESULTS

The number of times the correct size endotracheal tube was predicted by the recommended formula, was 0·5 mm. more than, and 0·5 mm. less than, the prediction is shown in Table II.

The final choice of the endotracheal tube passed without resistance allowed for clinically adequate controlled ventilation.

The results are statistically significant and show that for the Malaysian paediatric patient (2-10 years of age) a better guide for choice of the correct size endotracheal tube should read $\frac{\text{Age (in years)}}{4}$ + 4·0 mm. (or 0·5 mm. less than that recommended for paediatric patients based on Western experience).

The regime for selection of 3 endotracheal tubes to standby for local patients (<2 years) as used by the author, based on personal experience, is shown in Table III.

DISCUSSION

It is important in paediatric patients that the proper size endotracheal tube is chosen for several reasons (Chodoff, P., Helrich, M. 1967).

TABLE II

SHOWING FINAL CHOICE OF ENDOTRACHEAL TUBE IN RELATION TO PREDICTION OF RECOMMENDED FORMULA ($P<0·01$)

Number of times Endotracheal tube size correct using formula $\frac{\text{Age (years)}}{4}$ + 4·5 mm.	62 (12·4%)
Number of times endotracheal tube size correct using one size (+ 0·5 mm.) larger than formula prediction	40 (8%)
Number of times endotracheal tube size correct using one size (— 0·5 mm.) smaller than formula prediction	398 (79·6%)

TABLE III

SHOWING REGIME FOR SELECTION OF 3 ENDOTRACHEAL TUBES FOR INTUBATION IN PATIENTS IN THE AGE GROUP LESS THAN 2 YEARS AS USED BY AUTHOR

Age	Endotracheal tubes (internal diameter)
Neonates (Newborn - 28 days)	2·5, 3·0, 3·5 mm.
Post-neonate - 3/12	3·0, 3·5, 4·0 mm.
3/12 - 1 year	3·5, 4·0, 4·5 mm.
1 - 2 years	4·0, 4·5, 5·0 mm.

1. There will be no unnecessary reduction in the cross sectional area of the airway.
2. Selection of the proper size endotracheal tube may be made before induction of anaesthesia. It is also vital to have a guide as to the largest tube that should fit without force so that a snug fit with the tracheal wall can be obtained. This will help towards prophylaxis against aspiration of stomach contents and simultaneously provide a better system for controlled or assisted ventilation.

Slater, H. M., Sheridan, C. A. and Ferguson, R. H. (1955) have listed the causative factors for variations in size of endotracheal tubes as:

1. Normal differences in laryngeal diameter.
2. Congenital abnormalities.

3. Pathological conditions involving the larynx and trachea.
4. Degree of laryngeal relaxation, and
5. Technical skill and judgement of the anaesthesiologist.

Another factor which should be considered when attempting to gauge the size of endotracheal tube required is the thickness of the wall of tubes which varies slightly depending on the manufacturer. In this study red rubber (Magill or Rusch) or latex nylon-reinforced (Rusch) non-cuffed tubes were used.

Chodoff and Helrich (1967) investigated for a correlation between tube size and age, weight, height and surface area. They found that the best correlation is with age and surface area to tube size and that age alone turned out to be the most predictive of any of the variables.

In this study all variables such as the anaesthesiologist (same one—the author) premedication, anaesthetic technique, intubation technique and dose of muscle relaxant were controlled by standardization; the only variable could have been the slightly different wall-thickness of the manufactured-type of endotracheal tube (external diameter).

From the available literature it can be seen that previous studies have been conducted and conclusions drawn from experiences based on the Western or European paediatric patient. This study shows that conclusions and suggestions made, based on Western patients, need not apply to Asian patients.

CONCLUSION

The selection of the proper size endotracheal tube for the Malaysian paediatric patient (age group 2-10 years) should be based on the formula

$$\frac{\text{Age (in years)}}{4} + 4{\cdot}0 \text{ mm. (internal diameter)}$$

This formula is easier to remember and results in a tube 0·5 mm. less in internal diameter than the currently quoted $\frac{\text{Age (in years)}}{4} + 4{\cdot}5$ mm. (internal diameter) formula which is based on Western paediatric experience.

For the age group < 2 years, a guide table based on the author's anaesthetic experience in Malaysia (see Table III) is proposed.

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