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Internal vs. External Diameter of Pediatric Endotracheal Tubes

To the Editor:—Recently, pediatric endotracheal tubes have been marked according to their internal diameter in mm. While this measurement largely determines the resistance of the artificial airway once it is inserted, the ability to insert it safely and with facility is determined by its external diameter. For many years external diameter was used to determine the correct size of pediatric endotracheal tubes, as it formed the basis of the French catheter gauge:

F.c.g. (circumference) = $\pi \times$ external diameter in mm

By a happy coincidence, the correct size of tube for a given child, when more than 1 year old, could be found by adding 18 to its age in years. The F.c.g. for a 1-year-old is 18, and that for newborns, 14. Thus, a 16 F.c.g. should fit a 6-month-old and a 12 F.c.g., the smaller premature infant. Although this guide should provide the appropriate tube, it is prudent to have a slightly smaller and a slightly larger tube handy. It was customary, and satisfactory, to manufacture an

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In reply:—Dr. Morley's letter regarding substitution of the traditional French catheter gauge for internal diameter as an indication of tube size, and the suggestion that tracheal tubes for use in children be marked with an age range, is appropriate and fundamentally correct. I have always objected to the use of the internal diameter as the major reference for tracheal tube size. It stems from the 1950's, when anesthetized infants were usually allowed to breathe spontaneously, and thereby the resistance of the tubing connector to gas flow was a major consideration; anesthesiologists tended to put in tubes that were entirely too small. In modern pediatric anesthesia, newborns and small infants usually undergo anesthesia with controlled ventilation and tubes of appropriate sizes are inserted. Thus, internal diameter is a minor consideration, and external diameter becomes the important determinant of size.

The American National Standards Institute Standard Z-79.1 (Tracheal Tubes and Cuffs) states that tube size shall be indicated in internal diameter in millimeters rather than any other system. The reason for this is more historical than practical, as stated above. There is no standard for wall thickness, because various users desire different characteristics. A tube with a thin wall permits the largest internal diameter to be inserted into the patient's trachea, but is more prone to kinking or collapse from external pressure. A thicker wall decreases the internal diameter, increases resistance to gas flow, but resists kinking and external

endotracheal tube size for even numbers only on the F.c.g.

The use of the internal diameter has another drawback. I recently compared two 5.0-mm-ID tubes from two leading manufacturers: one had an external diameter of 6.8 mm and would have been most suited for a 3- or 4-year-old; the other, however, had an external diameter of 7.3 mm and would have best fitted a 5- or 6-year-old. The F.c.g. values for these two tubes are 21.4 and 22.9, respectively.

May I make a plea that in the future manufacturers of children's endotracheal tubes simply label each tube with the range of ages for which the tube is most suitable, based on the F.c.g., not the internal diameters. Marks on the tube indicating the usual position of the glottis and lips would also be helpful.

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compression. For these reasons, the majority of the committee devising the standards chose to use internal diameter as the unit of reference.

Dr. Morley makes the plea that manufacturers label the tubes with the ranges of ages for which they are most suitable and place markings indicating the usual positions of the glottis and lips. Because of the wide variation in the anatomy of the airways of infants and children, this would be unwise. Anesthesiologists might incur liability for malpractice if they chose to use endotracheal tubes of a size not indicated for the age of their patients or placed the tubes at variance to the anatomic markings. Manufacturers are generally reluctant to mark their devices in such a restrictive manner, for similar reasons. However, a package insert could include guidelines for appropriate sizes of the tubes. The guideline we use at The Children's Hospital of Philadelphia has been published in several articles and textbooks, including: Vaughan VC, McKay RJ: *Nelson's Textbook of Pediatrics*, tenth edition. Philadelphia, W. B. Saunders, 1975, p. 274.

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