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A guide to the selection of paediatric tracheostomy tubes

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Abstract
A large range of tracheostomy tube types and sizes are available for use in children. Regional preference, rather than individual patient assessment, tends to determine selection. We present a table designed to assist with appropriate size selection, and discuss the relative merits and shortcomings of the tubes currently available.

Introduction

The table (Table I) demonstrates the lack of size uniformity of currently available paediatric tracheostomy tubes. Various age ranges are shown, and for each, the most appropriate tube size, bronchoscope and endotracheal tube are suggested. Tracheostomy tube selection is further confused by the wide range of alternative design features (Pracy, 1976). Two main types of tracheostomy tube are used in children, plastic tubes usually without inner tubes, and silver tubes with removable inner tubes. In young children, cuffed tubes are unnecessary, a snug fitting tube being sufficient for ventilation or to reduce

TABLE I
A GUIDE TO THE SIZE SELECTION OF PAEDIATRIC TRACHEOSTOMY TUBES, BRONCHOSCOPES AND ENDOTRACHEAL TUBES

		Age							
		Preterm–1/12	1–6/12	6–18/12	18/12–3	3–6	6–9	9–12	12–14
Trachea (transverse diameter)	I.D. (mm)	5.0	5.0–6.0	6.0–7.0	7.0–8.0	8.0–9.0	9.0–10.0	10–13	13
Great Ormond Street	I.D. (mm)	N/A	3.5	4.0	4.5	5.0	5.5	6.0	7.0
	O.D. (mm)	N/A	5.0	5.7	6.7	7.3	8.0	8.7	10.7
Shilley (paediatric)	Size	00	0	1	2	3	4	4	6 (adult)
	I.D. (mm)	3.1	3.4	3.7	4.1	4.8	5.5	5.5	7.0
	O.D. (mm)	4.5	5.0	5.5	6.0	7.0	8.0	8.0	10.0
Portex	I.D. (mm)	3.0	3.5	4.0	4.5	5.0	5.0	6.0	7.0
	O.D. (mm)	4.5	4.9	5.5	6.2	6.9	6.9	8.3	9.7
Alder-Hey	FG	12–14	16	18	20	22	24	26	N/A
Negus	FG	N/A	16	18	20	22	24	26	28
Chevalier-Jackson	FG	14	16	18	20	22	24	26	28
Sheffield	I.D. (mm)	2.9–3.6	4.2	4.9	N/A	N/A	N/A	N/A	N/A
	FG	12–14	16	18	N/A	N/A	N/A	N/A	N/A
Cricoid (AP Diameter)	I.D. (mm)	3.6–4.8	4.8–5.8	5.8–6.5	6.5–7.4	7.4–8.2	8.2–9.0	9.0–10.7	10.7
Bronchoscope (Storz)	I.D. (mm)	2.5	3.0	3.5	4.0	5.0	5.0	6.0	6.0
	O.D. (mm)	4.0	5.0	5.7	7.0	7.8	7.8	8.2	8.2
Endotracheal Tube (Portex)	I.D. (mm)	2.5–3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
	O.D. (mm,)	3.4–4.2	4.8	5.4	6.2	6.8	8.2	9.6	10.8

Tracheal diameters adapted from CT measurements (Griscom and Wohl, 1986). Cricoid mesurements derived from cadaver dissection (Tucker, 1932; Sellars and Keen, 1990), and the external diameter of accepted bronchoscopes in various age ranges (Johnson *et al.*, 1985; Stankiewicz and Hollinger, 1986).

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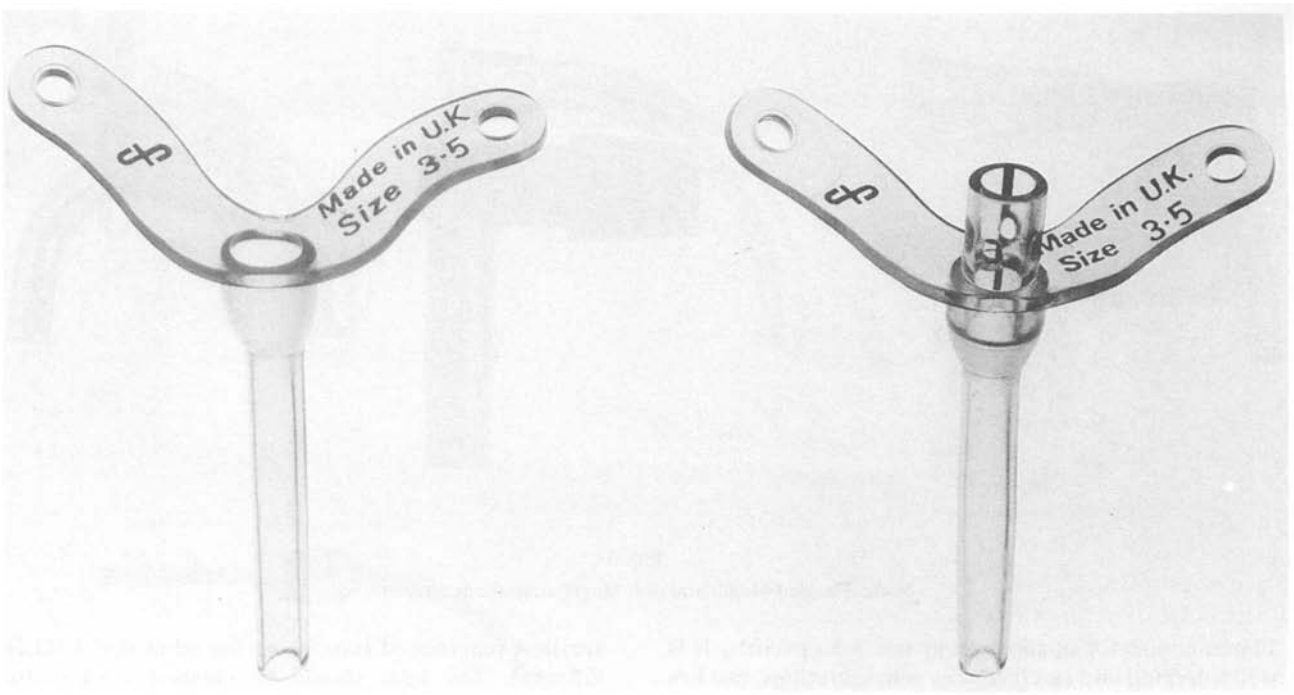

FIG. 1
Flat-ended and extended type Great Ormond Street tracheostomy tubes.

aspiration (Stool and Eavey, 1990). In general, silver tubes are easy to maintain and allow for good vocalisation; being made of metal the walls can be kept very thin with a correspondingly larger inner diameter (Lindholm, 1985). They are, however, conspicuous, and the rigidity of these tubes may result in discomfort, skin damage, and cause, tube tip, suprastomal, and posterior tracheal wall granulations; in some children an allergy to the metal may also develop. Fatal innominate artery haemorrhage and tracheo-oesophageal fistula rarely occur.

Plastic tubes, with the exception of the Shiley, are designed for single use; they do allow limited vocalisation, and rarely cause necrosis such as that seen with silver tubes.

The Great Ormond Street tracheostomy tube (Fig. 1)

The Great Ormond Street tube is simple, soft, comfortable, excites minimal tissue reaction, and, being of clear plastic, cosmetically acceptable. It becomes more pliable with body temperature, has soft atraumatic flanges, and a bevelled tip to aid introduction. It should be used only once and then discarded as the plastic hardens with sterilization. Tube changing should be performed at least weekly, is straightforward, and an introducer is not required (Stool *et al.*, 1968). An extended version with sideholes is available and is especially useful in infants whose 'double chins' tend to occlude a flat-ended tube.

A silver De Santi speaking valve (Fig. 2) can be fitted, but these are poorly tolerated, stretch the soft plastic, easily block with secretions, and are frequently coughed out. Younger children learn to achieve satisfactory speech by occluding the opening of the flat-ended tube with their chin, thereby avoiding the problems associated with speaking valves. As the child grows, this becomes increasingly difficult, and an alternative type of tube may be necessary.

For ventilation, an oral Magill adaptor will fit the extended version, while an angled Magill adaptor or Portex endortracheal adaptor is appropriate for the flat-ended type (Fig. 3).

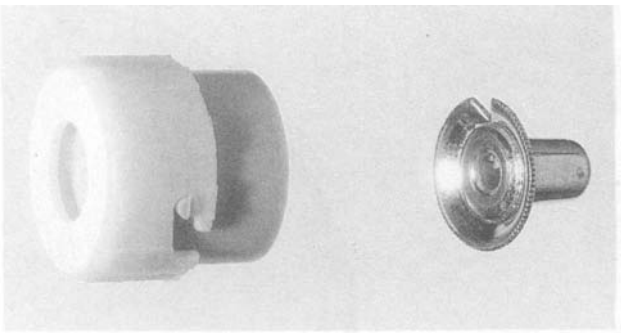

FIG. 2
Rusch and De Santi speaking valves.

The Portex tracheostomy tube (Fig. 4)

The Portex tube is made of firm, opaque, blue plastic, has large horizontal flanges and is available with or without a protruding 15 mm diameter connector/extension. The large firm flanges provide excellent stabilisation, especially in children with significant neck asymmetry or bulky tumours (e.g. cystic hygromas), but owing to this rigidity, trauma to the underlying skin can occur. The tube should be changed weekly and discarded after a single use. The smallest size (3.0 mm I.D.) is of a different design in clear plastic, being very similar to the Great Ormond Street tube. While being useful in premature infants and for downsizing prior to decannulation, it does not allow for easy suction in a child with copious secretions and is consequently difficult to manage.

A Rusch speaking valve (Fig. 2) can be fitted to the

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FIG. 3
Portex, angled Magill and oral Magill anaesthetic adaptors.

15 mm connector of tubes from size 3.5 upwards. It is well tolerated and rarely blocks with secretions, but has the disadvantage of giving an audible 'click' on closure. It should be cleaned daily, with Milton or equivalent, and (like all speaking valves and valved inner tubes) be removed at night in case it should stick shut.

Auto-humidifiers (artificial noses) can be fitted; these are bulky, impair the child's ability to cough and may mask the need for suction. We do not, for these reasons, recommend their use in the immediate post-operative period, however, they can be useful for long-term tracheostomy, where there are crusting problems.

The extended Portex tube readily connects to most ventilator circuits.

The Shiley tracheostomy tube (Fig. 4)

Shiley paediatric tubes are made of opaque, white, firm plastic, and come with an introducer. The tube, unlike its adult counterpart, has no fenestration, the smallest fenestrated tube being the adult size 4 (O.D. 8.5 mm). The tube should be cleaned weekly, and although expensive is re-usable.

Rusch valves, and auto-humidifiers fit satisfactorily. Connection to ventilators is straightforward.

A neonatal series (sizes 00–1) is available, with both shortened length and smaller external flanges. These we have found useful in premature and extremely small infants, when standard length tubes have occluded either a main bronchus, or a right upper lobe bronchus with an abnormally proximal origin.

The Alder-Hey tracheostomy tube (Fig. 5)

The Alder-Hey tube is a silver tube with five constituent parts, a fenestated outer tube, fenestrated valved and plain unvalved inner tubes, an introducer and occluder. An adjustable neck plate allows accurate positioning of the fenestration under radiologic or bronchoscopic control, and has a lock to secure the inner tube

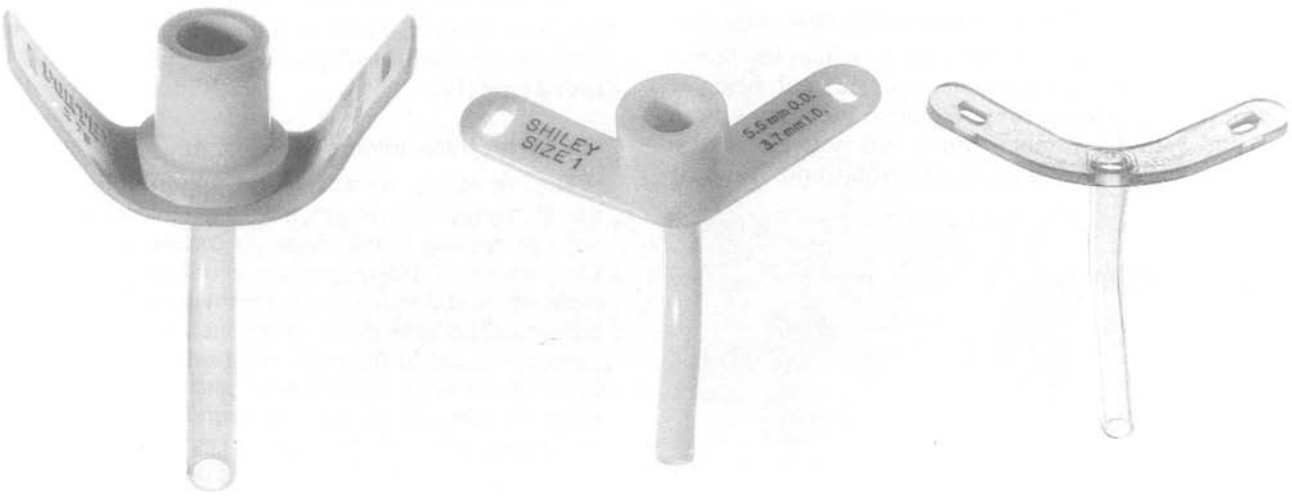

FIG. 4
Portex, Shiley and Portex size 3 mm tracheostomy tubes.

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FIG. 5
Alder-Hey tracheostomy tube.

FIG. 6
Negus tracheostomy tube.

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FIG. 7
Chevalier-Jackson tracheostomy tube.

and prevent the speaking tube from becoming dislodged. The knurled screw can only be altered with a screwdriver, thus preventing unskilled interference with the neck plate. However, maintaining the fenestra site has proved difficult and the opening may impinge on the suprastomal trachea or posterior tracheal wall. A blocker is available for use during decannulation: being short, it allows air through the fenestration but the distal tube may become obstructed by crust formation. The tube is expensive, bulky, stands proud, and in several of our patients we have had to reduce the size of the flange to reverse skin damage; for these reasons it is not very suitable for infants and small children. Being compatible with anaesthetic connectors it is useful for laser surgery to the larynx and subglottis when the patient has a tracheostomy.

The Negus tracheostomy tube (Fig. 6)

The Negus tube is simply a smaller version of the adult type and comes in four parts, a plain outer tube, valved and plain inner tubes, and pilot. The inner tubes are a 'jam fit' in the outer tube, and can be coughed out by older children. The flange is small and flat and thus relatively atraumatic and cosmetically acceptable.

The Chevalier Jackson trcheostomy tube (Fig. 7)

The Chevalier Jackson tube, a three-part tube similar to the Negus, but longer and with a retaining catch to secure the inner tube, has proved useful for several children with tracheomalacia and tracheal stenosis. A speaking valve is only aviailable by special request from the manufacturers.

The Sheffield tracheostomy tube (Fig. 8)

The recently introduced Sheffield tube has yet to prove itself, but has some interesting design features. It is a six-part silver tube consisting of a fenestrated outer tube with retaining clip, one fenestrated valved and two plain unvalved inner tubes, an introducer and a full length obturator. We have no experience with this tube, but the 'Y' shaped flange may be less traumatic to the skin, the full length obturator should prevent crusting within the outer tube during decannulation, and a second inner tube will be of use during cleaning.

The Great Ormond Street tube remains the workhorse of our department, being soft, inconspicuous, easy to change, relatively atraumatic and inexpensive; it is

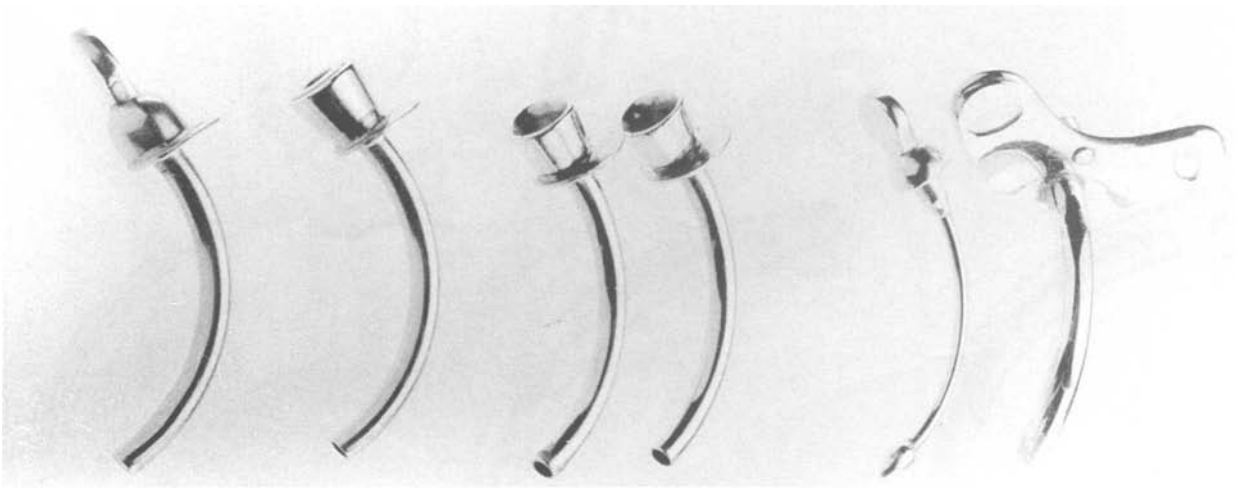

FIG. 8
Sheffield tracheostomy tube.

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preferred by the majority of parents. Its major drawback is the poor tolerance of the speaking valve, and if speech is unsatisfactory then either the Shiley with a Rusch valve, or a silver tube, can be substituted.

Appendix

Great Ormond Street tubes are available from: Warne Franklin, PO Box 138, Cressex Industrial Estate, High Wycombe HP12 3NB.

Portex tubes are available from: Portex Ltd, Hythe, Kent CT21 6JL.

Shiley tubes, and Rusch valves, are available from: Shiley Ltd, Shiley House, 42 Thames Street, Windsor, Berks Sl4 1PR.

The Alder-Hey, Negus and Chevalier Jackson tubes, and the De Santi valve are available from: Downs Surgical Ltd, 32–34 New Cavendish Street, London W1M 8BU.

The Sheffield tube is available from: Rimmer Brothers, 18 Aylesbury Street, Clerkenwell, London EC1.

The Magill anaesthetic adaptors are available from: Magill, Medical and Industrial Equipment Ltd, Falcon Road, Sowton Industrial Estate, Exeter EX2 7NA.

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