

Update on paediatric tracheostomy tubes

M. E. WYATT, M.A., F.R.C.S., C. M. BAILEY, B.Sc., F.R.C.S., J. C. WHITESIDE, R.N.DIP.

Abstract

In the recent past there has been a significant expansion in the range of paediatric tracheostomy tubes available. This has mainly been in response to clinicians' requests. This article reviews those now available and the situations in which they are useful. A sizing chart is included for easy reference.

Key words: Tracheostomy; Prosthesis design; Paediatrics

Introduction

This article updates the paper written by Irving *et al.* from our department in 1991. Since that time there has been a major re-sizing initiative by Shiley to bring their tubes into line with those made by other manufacturers and a number of new products have been introduced. We have updated the chart published in the original article and expanded it to encompass the wider range of paediatric tubes now used at Great Ormond Street. Age ranges with corresponding sizes for tracheostomy tubes, bronchoscopes and endotracheal tubes are given. Tube descriptions are divided into two sections; plastic tubes and silver tubes.

Plastic tracheostomy tubes

The Great Ormond Street tracheostomy tube

The design of this tube is unchanged, being made of soft, clear plastic with flexible flanges and a bevelled tip. The size range has been expanded to include a 3.0 and an extended type is available, which is of use in children with 'double chins' who block off the standard version.

Shiley tracheostomy tubes

Shiley have now resized their range of tubes to bring them into line with other manufacturers, using the internal diameter in mm instead of their old numbering scheme. The standard paediatric tube is available in sizes 3 to 5.5. The shorter neonatal tube is made in sizes 3 to 4.5 (Figure 1). A longer paediatric tube is manufactured in sizes 5 to 6.5. Cuffed versions are made of the standard and long paediatric tubes as indicated on the chart, and can be useful for preventing aspiration and aiding ventilation (Figure 2).

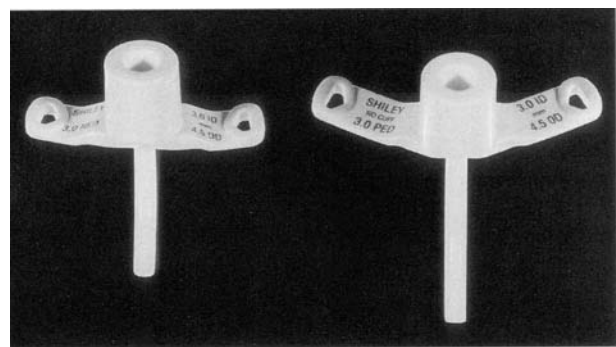


FIG. 1

Shiley tracheostomy tubes size 3.0 in standard paediatric length (39 mm) and in the shorter neonatal length (30 mm)

The Shiley range has now replaced the GOS pattern as our preferred standard tube, because of the greater variety of sizes available, the built-in 15 mm connector and the introducer.

Portex tracheostomy tubes

The Blue Line Portex tube described in Irving's paper is still manufactured for the paediatric population in sizes 3 to 7. One style of tube comes with a 15 mm connector and this type can either be unfenestrated or have a single or double fenestration. There is also a tube manufactured without a connector which can either be unfenestrated or have a single fenestration.

In addition Portex make another range of tubes specifically for children called the '555' series (Figure 3). These are made of blue, radio-opaque PVC which is thermosensitive, so that at body temperature the tube conforms to the shape of the trachea minimizing potential damage to the mucosa. The flanges are contoured to sit comfortably on the neck and minimize tube movement in the trachea. These

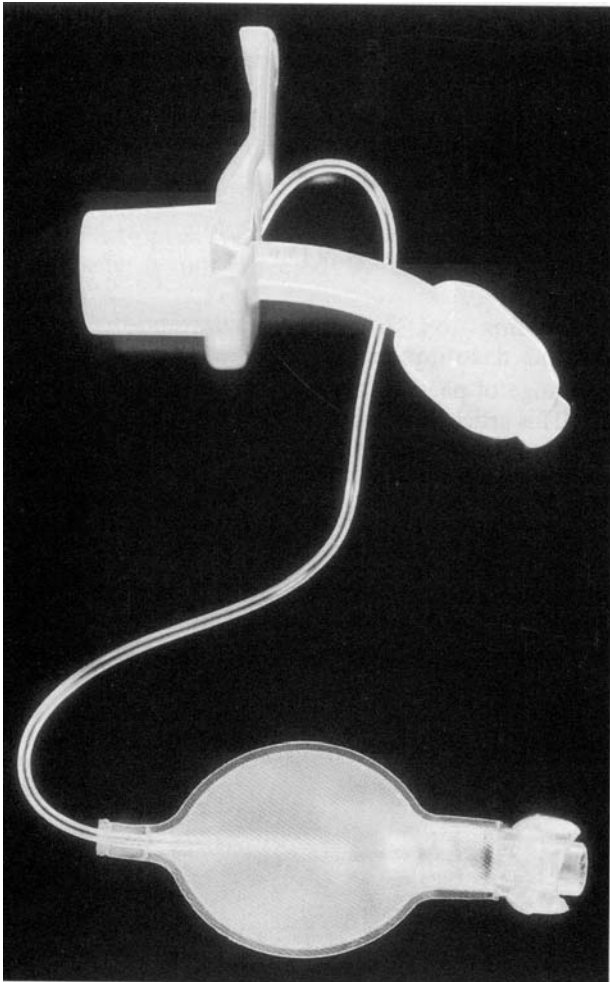


FIG. 2
Shiley cuffed tracheostomy tube size 5.0

tubes have an anti-disconnect strap and a clear 15 mm angled connector to reduce the risk of occlusion by the chin while allowing visualization of any accumulated secretions. A flexible obturator is supplied to aid introduction. A double swivel connector for a ventilator circuit and a tracheostomy wedge to facilitate disconnection from this are also

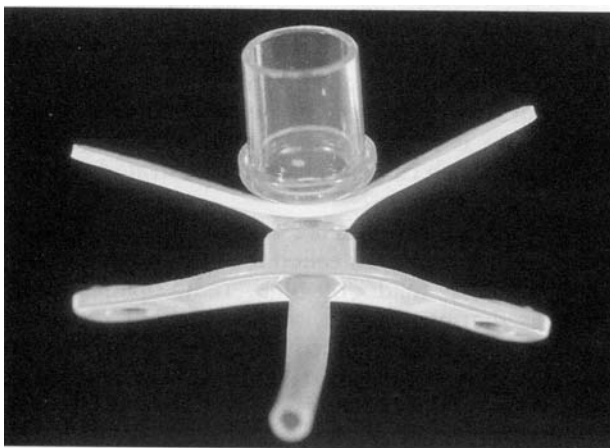


FIG. 3
Portex tracheostomy tube '555' series size 3.0

provided. The two latter items can be supplied separately if required. These tubes are recommended by the manufacturer for single use only.

Care must be taken when considering the sizing of the '555' tubes as there is a disparity compared with other types. The age-appropriate size is dictated by the outside diameter of the tube (to fit correctly in the trachea) but with this type the corresponding internal diameter and hence sizing of the tubes is 0.5 mm smaller than that used by other companies. For example a child of one to six months of age has a tracheal transverse diameter of 5–6 mm. The correct tube in the '555' series has an internal diameter of 3.0 mm and is called a size 3.0. However, the corresponding Shiley tube with the same external diameter has an internal diameter of 3.5 mm and so is called a size 3.5.

Portex are also able to manufacture customized tubes to meet special needs. The length, curvature and position of any fenestration can be altered as necessary. There is also a choice of a plain or 15 mm termination, cuffed or uncuffed tube.

Bivona tracheostomy tubes

The standard Bivona tube is made of opaque, white, reinforced silicone which is flexible and yet resists kinking. The flanges are contoured and the tip is tapered to reduce the risk of tracheal erosion. There is an integrated 15 mm swivelling adaptor to reduce torque on the tube. A neonatal series of shorter length is made as well as a standard paediatric series (Figure 4). These tubes can be cleaned and reused if necessary.

In the paediatric sizes a 'Hyperflex' tube is also made. This has an embedded metallic coil to prevent closure by external pressures but is still flexible and has a sliding flange which can be altered in position to vary the intra-tracheal tube length (Figures 5a and 5b). These tubes have proved useful in patients with unusual anatomy or pathology or in those with thick, 'bull' necks. They are not recommended for home use and should be replaced with a fixed neck flange product as soon as possible. It should be noted that as the coil is made of stainless steel it is not magnetic resonance imaging (MRI) compatible.

The 'Flexextend' tube has the same embedded metallic coil but has a fixed flange placed part way along the shaft. This allows the proximal and distal

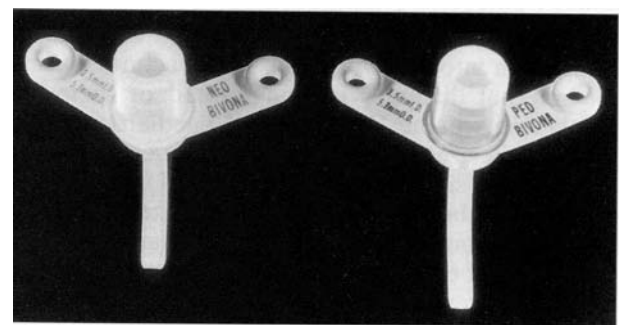
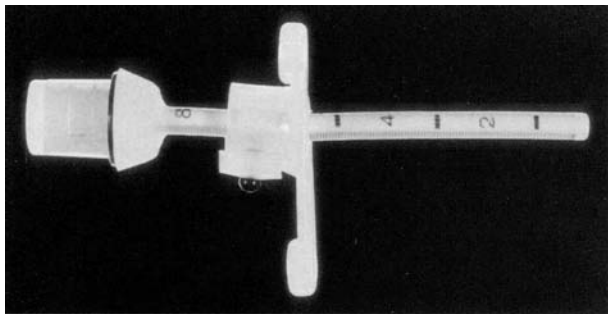
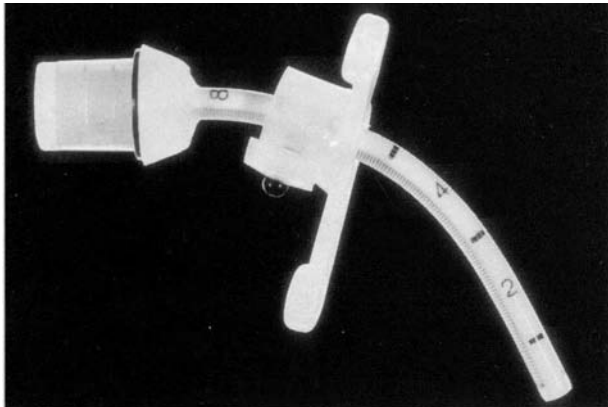


FIG. 4
Bivona tracheostomy tubes size 3.5 in standard paediatric length (40 mm) and the shorter neonatal length (34 mm)



(a)



(b)

Fig. 5a and 5b

Bivona 'Hyperflex' tracheostomy tube size 3.5.

shafts to flex independently (Figure 6). This tube comes with an all-metal obturator. We have found this useful in babies with short necks and poor head control who easily block off a standard tube with their chins and in those for whom attachment to a ventilator circuit has been difficult for the same anatomical reasons.

Cuffed tubes are available in the neonatal and paediatric ranges. There is the traditional air-filled design, known as the 'Aire-cuff'. This has been modified to create the TTS design ('tight to shaft'). Here, the cuff can be partially or totally inflated as required when it is totally deflated, the tube has the same external profile as a cuffless tube (Figure 7). This allows flexibility in airway management, providing the protection of a cuff only when it is needed. There is also the 'Fome-Cuff' tube (Figure 8), which contains auto-expanding foam to conform to the shape of the patient's trachea once the controlling port is opened. The cuff can automatically adjust to changes in the tracheal wall pressure and so during the ventilatory cycle aims to maintain a low cuff-to-tracheal-wall sealing pressure but still protect against aspiration. The cuff volume can also be directly measured with a specially designed syringe which is provided with each tube.

A customizing service is available to deal with specific problems. The patient's individual requirements are entered on a special order form and the company aims to dispatch the assembled non-sterile tube within seven days of receiving the order. The tube can be autoclaved before use. The features

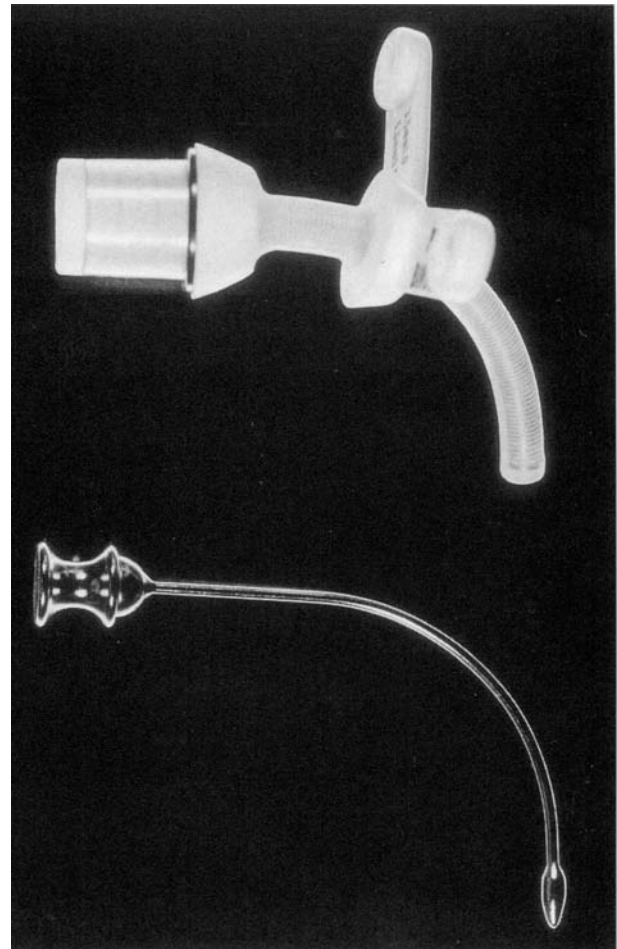


FIG. 6

Bivona 'Flextend' tracheostomy tube size 3.5, with metal obturator.

which can be varied are: tube shaft style, curvature, length, internal and external diameter, cuff design and position and neck flange type. Fenestrated tubes are also manufactured as requested.

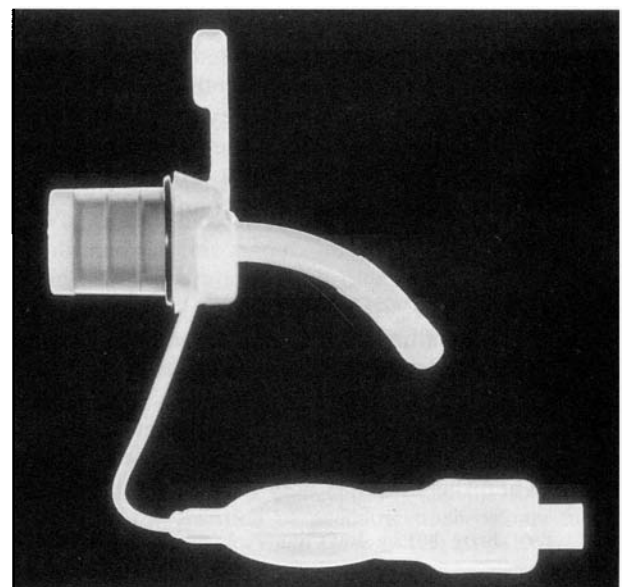


FIG. 7

Bivona 'tight to shaft' cuffed tracheostomy tube size 3.5, with cuff deflated.

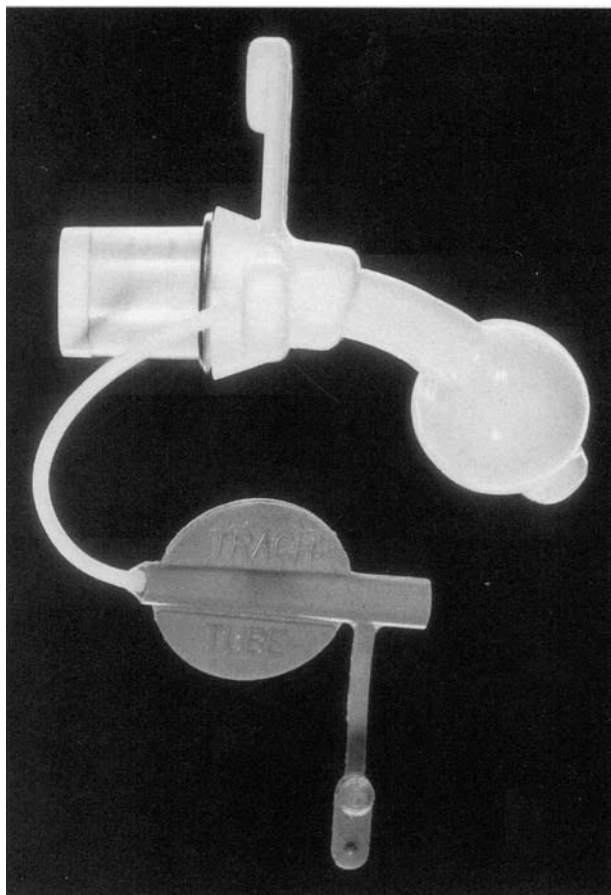


FIG. 8

Bivona 'Fome-Cuff' tracheostomy tube size 5.5.

Silver tracheostomy tubes

A number of silver tracheostomy tubes have been manufactured over the years: the basic designs are unchanged and are fully described in Irving's paper (Irving *et al.*, 1991), but for completeness they are also included here. The main advantage of these tubes is that they can be manufactured with thin walls and so have room for an inner tube which can be removed and cleaned without the need to take out the whole tube. Therefore they are favoured by some for long-term use because they are easy to care for. However, they are obviously inflexible and so some patients find them quite uncomfortable.

The Negus tracheostomy tube

This tube has four parts, a plain outer tube, valved and plain inner tubes and an introducer. It is not ideal for a child who cannot tolerate a tube with a speaking valve as only one unvalved inner tube is provided, so while this is being cleaned there will be a time when the child has only the outer tube *in situ*.

The Chevalier Jackson tracheostomy tube

This silver tube has three parts with a similar design to the Negus tube but it is longer and has a catch to secure the single inner tube which is

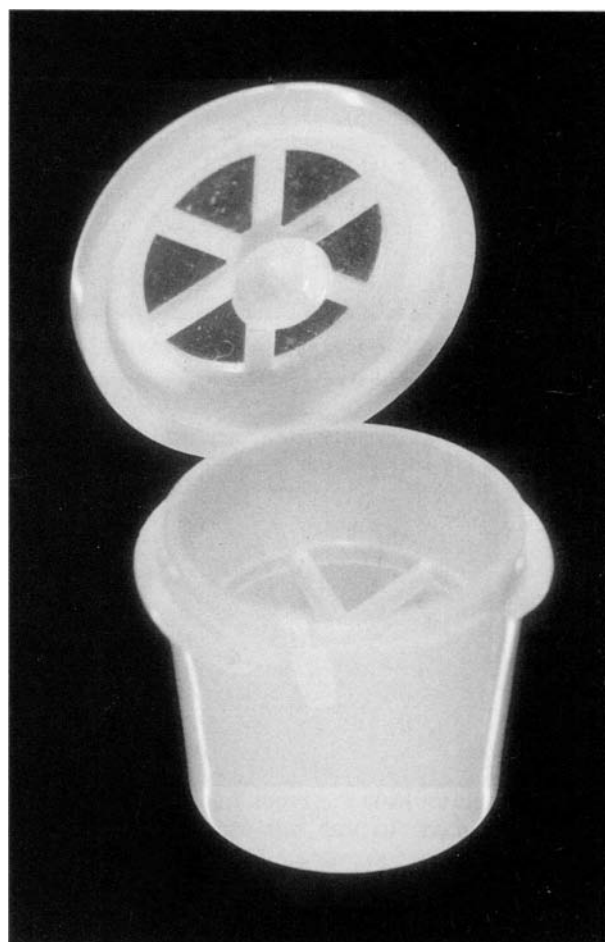


FIG. 9

Shiley speaking valve with flip can open.

unvalved. It is useful for children with tracheomalacia and tracheal stenosis but does not have the option of a valve if required.

The Alder-Hey tracheostomy tube

The Alder-Hey tube has five parts; a fenestrated outer tube, fenestrated valved and plain unvalved inner tubes, an introducer and obturator. The neck plate is adjustable to allow alteration in position of the fenestration. Since Irving's paper this tube is no longer manufactured in size 26.

A problem with this tube is that tissue can become trapped in the fenestration which is painful and can cause obstruction. Also during decannulation, when the proximal part of the tube is occluded with the obturator's crusting can form in the distal tube causing obstruction. The neck plate is rather large and so the Alder-Hey tube is not really suitable for infants.

The Sheffield tracheostomy tube

This is the newest design in the range of silver tubes. It has six parts; a fenestrated outer tube with a retaining clip, one fenestrated valved and two plain unvalved inner tubes, an introducer and a full length obturator. This tube is available in sizes French gauge 14, 16, 18, 20, 22, 24 and 26 and the appropriate internal diameters are shown on the chart.

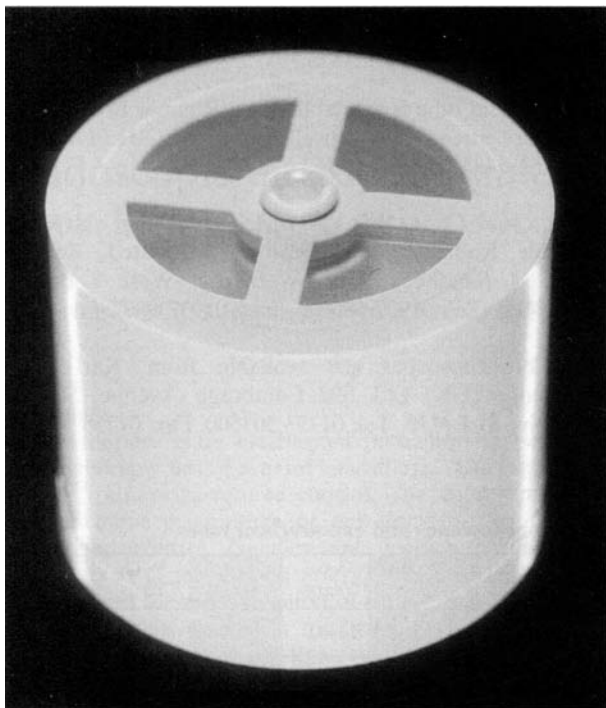


FIG. 10
Passy-Muir speaking valve.

Its advantages include the two unvalved inner tubes as one can always be left in place while the other is cleaned and there is the option of a valved tube to allow phonation in a child who has less severe airway obstruction. When decannulation is undertaken the obturator allows occlusion of the full length of the outer tube so that crusts cannot form there. The neck flanges are slim and well shaped to fit the neck of a young child.

Speaking valves

Other speaking valves are now used at GOS in addition to the De Santi and Rusch. The Shiley valve is made of white plastic with a flip cap to allow easy access for cleaning (Figure 9). The flap for vocalization is clear and made of silicone with a low resistance to facilitate respiration. It is popular for children as it is lightweight, the flap makes minimal noise during breathing and it fits any tube with a 15 mm connector, i.e. the Shiley, Portex and Bivona tubes. It should be cleaned daily in saline or a mild detergent solution and should be replaced after approximately 45 days.

The Passy-Muir valve (PMV) was designed by David Muir, a quadriplegic with muscular dystrophy, who needed a tracheostomy and became ventilator-dependent following a respiratory arrest. The basic design is made of white plastic with a clear one-way speaking valve that has positive closure (Figure 10). This valve therefore allows air to enter easily on inspiration but closes automatically at the end of this part of the cycle and remains closed throughout expiration directing air up to the larynx. There is no leak around the valve and thus a column of air is created in the tube which prevents secretions from entering the tube and occluding the valve. This

'closed system' is more like the normal physiological situation and allows a positive subglottic pressure to develop which aids swallowing, provides a greater volume of air for speech production and facilitates a stronger cough.

The PMV can be fitted directly onto tubes with a 15 mm end or onto the appropriate connector. It is not necessary to have a fenestrated tube but there must be sufficient space around a plain tube to allow air to pass around it. It may be necessary to downsize the tube to achieve this. This valve must only be used with a cuffless tube or a deflated cuffed tube as otherwise the patient will be unable to breathe and so it is essential to ensure that the patient is not at risk of aspiration. It is also not recommended for those patients with severe airway obstruction above the level of the tracheostomy who may not be able to exhale sufficiently, or for those with thick and copious secretions. This standard valve can be used as part of the ventilator circuit although a larger valve which is easier to handle is available. A low-profile valve is also made, supplied with a security attachment which helps to prevent inadvertent loss.

The PMV should be cleaned daily with soap and water and is guaranteed to last two months although it often lasts much longer.

At Great Ormond Street an initial assessment of the possible use of a speaking valve is made with a Rusch valve which is readily available and inexpensive. A PMV is preferred in the longer-term due to the features of low resistance and positive closure which maximize oral airflow.

Conclusions

In general plastic tubes are preferred to metal types as they are more flexible and comfortable and less traumatic for patients in whom the tracheostomy is not intended to be permanent. The Shiley range has replaced the GOS type as the preferred standard tube in our unit. It causes minimal damage to the trachea, is easy to use and maintain and is reasonably priced. The Bivona range has proved particularly useful for children with unusual and difficult airway problems.

Acknowledgements

We would like to thank all the manufacturers mentioned in this paper for their help and advice during its preparation. Particular thanks to Mallinckrodt Medical (UK) Ltd., SIMS Portex Ltd., and Kapitex Healthcare Ltd. for kindly donating tracheostomy tubes and speaking valves for photography.

References

- Irving, R. M., Jones, N. S., Bailey, C. M., Melville, J. (1991) A guide to the selection of paediatric tracheostomy tubes. *Journal of Laryngology and Otology* **105**: 1046–1051.

Address for correspondence:
Miss M. E. Wyatt, F.R.C.S.,
44 Broomwood Road,
London SW11 6HT.

Appendix I

Great Ormond Street tubes are made by Rusch and are available from: Rusch (UK) Ltd. PO Box 138, Halifax Road, Cressex Business Park, High Wycombe, Bucks HP12 3NB. Tel: 01494 532761, Fax: 01494 524 650

Portex tubes are available from: SIMS Portex Limited, Hythe, Kent CT21 6JL. Tel: 01303 260551, Fax: 01303 266761

Shiley tubes and speaking valves are available from: Mallinckrodt Medical (UK) Ltd. 11 North Portway Close, Round Spinney, Northampton NN3 8RQ. Tel: 01604 646132, Fax: 01604 646884

The Alder-Hey, Negus and Chevalier Jackson tubes are made by Downs Surgical which is part of Aesculap at:

Aesculap Ltd. Parkway Close, Parkway Industrial Estate, Sheffield S9 4WJ. Tel: 01142 730346, Fax: 01142 701840

The Sheffield tube is available from: Rimmer Brothers, 18 Aylesbury Street, Clerkenwell, London EC1R 0DD. Tel: 0171 251 6494, Fax: 0171 253 7585

Bivona tubes and the Passy-Muir speaking valve are available from: Kapitex Healthcare Limited, Kapitex House, 1 Sandbeck Way, Wetherby, West Yorkshire LS22 7GH. Tel: 01937 580211, Fax: 01937 580796

Storz bronchoscopes are available from: Karl Storz Endoscopy (UK) Ltd. 392 Edinburgh Avenue, Slough, Berkshire SL1 4UF. Tel: 01753 503500, Fax: 01753 578124

Appendix II
A guide to the size of paediatric tracheostomy tubes, bronchoscopes and endotracheal tubes

		Preterm-1 Month	1-6 Months	6-18 Months	18 Months 3 Years	3-6 Years	6-9 Years	9-12 Years	12-14 Years	
Trachea (Transverse Diameter mm)		5	5.0-6.0	6.0-7.0	7.0-8.0	8.0-9.0	9.0-10	10-13	13	
P L A S T I C	Great Ormond Street	ID (mm) OD (mm)	3.0 4.5	3.5 5.0	4.0 6.0	4.5 6.7	5.0 7.5	5.5 8.0	6.0 8.7	7.0 10.7
	Shiley	Size	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
		ID (mm) OD (mm) Length (mm)	3.0 4.5 30	3.5 5.2 32	4.0 5.9 34	4.5 6.5 36	5.0 7.1	5.5 7.7	6.0 8.3	6.5 9.0
	Cuffed Tube Available	Neonatal	39	40	41	42*	44*	46*	54*	56*
		Paediatric Long Paediatric					50*	52*	54*	56*
	Portex (Blue Line)	ID (mm)	3.0	3.5	4.0	4.5	5.0	5.0	6.0	7.0
		OD (mm)	4.2	4.9	5.5	6.2	6.9	6.9	8.3	9.7
	Portex (555)	Size	2.5	3.0	3.5	4.0	4.5	5.0	5.5	
		ID (mm)	2.5	3.0	3.5	4.0	4.5	5.0	5.5	
		OD (mm)	4.5	5.2	5.8	6.5	7.1	7.7	8.3	
		Length Neonatal Paediatric	30 30	32 36	34 40		44 48	50	52	
	Bivona	Size	2.5	3.0	3.5	4.0	4.5	5.0	5.5	
		ID (mm)	2.5	3.0	3.5	4.0	4.5	5.0	5.5	
		OD (mm)	4.0	4.7	5.3	6.0	6.7	7.3	8.0	
		Length Neonatal Paediatric	30 38	32 39	34 40	36 41	42 44	44 46		
All sizes available with Fome Cuff, Aire Cuff, & TTS Cuff.	Length Neonatal	30	32	34	36					
	Paediatric	38	39	40	41	42	44	46		
Bivone Hyperflex	ID (mm)	2.5	3.0	3.5	4.0	4.5	5.0	5.5		
	Usable Length (mm)	55	60	65	70	75	80	85		
Bivona Flextend	ID (mm)	2.5	3.0	3.5	4.0	4.5	5.0	5.5		
	Shaft Length (mm)	38	39	40	41	42	44	46		
	Flextend Length (mm)	10	10	15	15	17.5	20	20		
S I L V E R	Alder Hey	FG	12-14	16	18	20	22	24		
	Negus	FG		16	18	20	22	24	26	
	Chevalier Jackson	FG	14	16	18	20	22	24	26	
	Sheffield	FG ID (mm)	12-14 2.9-3.6	16 4.2	18 4.9	20 6.0	22 6.3	24 7.0	26 7.6	
Cricoid (AP Diameter)	ID (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)	Size	2.5	3.0	3.5	4.0	4.5	5.0	6.0	6.0	
	ID (mm)	3.5	4.3	5.0	6.0	6.6	7.1	7.5	7.5	
	OD (mm)	4.2	5.0	5.7	6.7	7.3	7.8	8.2	8.2	
Endotracheal Tube (Portex)	ID (mm)	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	
	OD (mm)	3.4	4.2	4.8	5.4	6.2	6.8	8.2	9.6	