A new tracheostomy unit and its evolutional rationale

G. O. M. Jones, M.A., B.M., B.Ch.,* and
Carl E. Wasmuth, M.D., LL.B.

Department of Anesthesiology

ESSENTIALLY, the maintenance of an adequate airway before, during, and after a surgical operation is vital. If continuity of the patient's airway is lost at some critical stage, the consequences might well be fatal. For this reason, tracheostomy is performed to insure patency of the airway in selected cases. However, tracheostomy itself might well be a hazardous procedure due, in many instances, to poor design and construction of the tracheostomy tubes currently available.

The new tracheostomy set that we are reporting has been designed to avoid unnecessary complications due to annoying and dangerous deficiencies in design and structure of the available tracheostomy tubes. Standardization of connectors makes it possible for the patient to pass from the preoperative situation, through anesthesia and surgery, into the postoperative phase without prolonged interference with the integrity of his airway.

Our particular model is a modification of a tube manufactured by the Dittmar and Penn Corporation. The tube† has been modified according to clinical needs in our intensive care and recovery units, as well as in the private patients' rooms, and it now meets most of the requirements of what we consider the ideal tracheostomy tube. These criteria include: ease of cleaning and of sterilization; composition and construction to assure airtight connections at reasonable positive pressure; a thin wall to permit maximal diameter of lumen; a smooth inner surface to offer minimal resistance to passage of suction catheters; light in weight for the comfort of the patient; adjustable to the size of the patient; capable of being connected to any standard anesthesia apparatus; and is relatively inexpensive.

The complete, prepackaged, sterilized unit (*Fig. 1 and 2*), which includes inner and outer cannulas, introducing trocar, and swiveling right-angled connector, can be handed under sterile conditions to the surgical team in the operating room, or wherever needed.

The plastic of the tube is sufficiently rigid to accommodate stretch-fit,

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* *Fellow, Department of Anesthesiology.*

† *Supplied through the courtesy of Mr. Paul W. Girard, Dittmar and Penn Corporation, 5155 Belfield Avenue, Philadelphia, Pennslyvania 19144.*

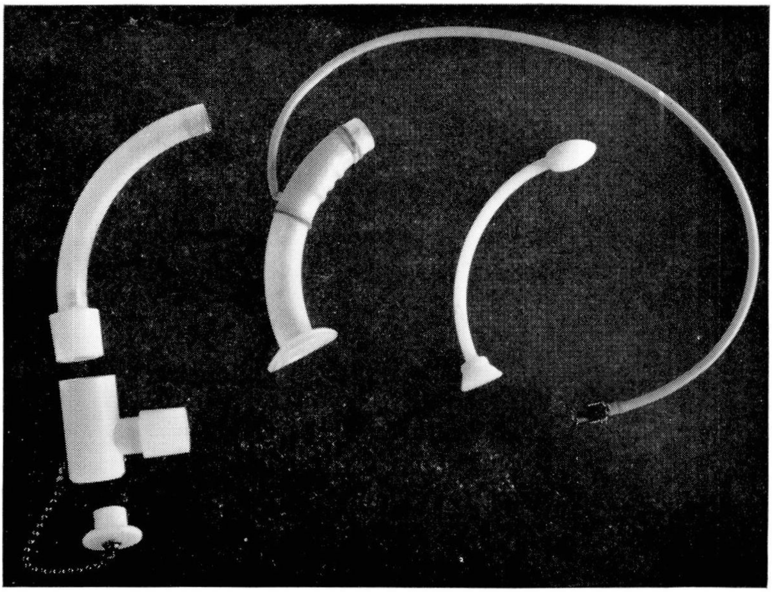

Fig. 1. Photograph of the components of the new tracheostomy set, showing trocar, outer cannula, inner cannula, and right-angled connector with cap.

streamlined, integrally ballooned cuffs that are probably less traumatic than other types. No ligatures are needed to secure the cuff on the tracheostomy tube. Both high- and low-pressure cuffs are fitted, the cuff dimensions not exceeding 1⅛ inches in length for a size 10 tracheostomy tube, with progressively shorter cuff lengths for smaller sizes of tubes. The tracheostomy tube may be used cuffed or uncuffed.

The physical characteristics of the plastic used in construction of the tracheostomy tube enable the contact surface between the inner and outer cannulas to be airtight at any reasonable positive pressure. The cohesion between cannulas is such that should the tracheostomy tube be subjected to severe strain, as that which occurs when the patient moves inadvertently in relation to a bulky ventilator, then the inner tube is pulled out. This is considered preferable to traumatization of the trachea itself, and is the reason that the male 15-mm fitting is on the inner cannula rather than on the outer one. Particular attention was directed to this cohesive factor, and a nice balance has been achieved so that it has been rare for an inner cannula to come out except by direct intent.

The nature of the plastic enables a thin wall to be used, giving a lumen relatively larger for a specific size of tracheostomy tube than that of other types of tube. It is recommended that a minimum tube size of 7 be used in the average woman, and a minimum size of 8 be used in the average man.

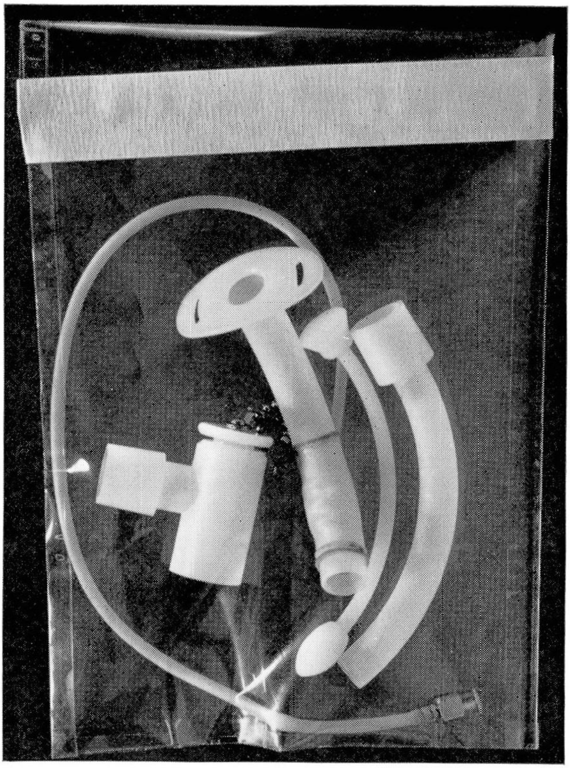

Fig. 2. Photograph of the complete tracheostomy unit in a plastic container, ready to be sterilized.

These minimum sizes are used in those cases in which intermittent positive-pressure ventilation is intended to follow tracheostomy. When spontaneous ventilation is to ensue, then a smaller sized tracheostomy tube without a cuff is permissible. For intermittent positive-pressure ventilation of patients, the larger sizes of 7 and 8 are recommended, because when suction is performed through a tracheostomy tube with an inflated cuff and the tube sizes are smaller than those stated, a large negative pressure can be generated in the system. This is particularly true if the diameter of the suction catheter exceeds one half the diameter of the tracheostomy tube. Should the standard plastic tracheostomy tube prove too long in a short patient, as much as 1.0 cm can be cut from the distal ends of both inner and outer cannulas, and the cuff can be simply moved along the appropriate distance proximally. Any rough ends can be easily rounded off with suitable abrasive material such as a small file or an emery board.

The plastic tubes are considerably lighter than the metal tracheostomy tubes of similar dimensions. This lightness makes for greater patient comfort. In addition, the nonwetting surface of the plastic makes cleansing simple and easy, a feature greatly appreciated by the nursing staff.

The right-angled connector facilitates not only continuity of anesthesia but also immediate transition to intermittent positive-pressure ventilation. This connector permits 360° rotation, and will, by virtue of the 11-mm male fitting, join to any standard anesthetic apparatus or to any of the equipment used by inhalation therapy. The right-angled connector has a minimum ventilatory dead space and can be used with all tracheostomy tube sizes from 5 to 10. This is a significant advantage when intermittent positive-pressure ventilation is performed by means of a size 5 tube in a child.

The cap of the right-angled connector may be removed, and the opening provides an entry port for suction. Being in line with the lumen of the tube, tracheal toilet may be carried out with minimal discontinuity in ventilation. In addition, oxygen may be administered continuously through the tube while suctioning is being performed. The removable cap is permanently chained to the connector.

The cost of this plastic tube compares favorably with the standard metal tracheostomy tubes. Because of the relatively inexpensive cost of the raw material, and the ease with which plastic materials can be precisely machined and molded, it is well within the realm of probability that the complete unit may someday be disposable. In our series, we have frequently used a unit more than once, with no noticeable deterioration.

CLINICAL USE

The prepackaged tracheostomy unit has been used at the Cleveland Clinic Hospital for eight months and on more than 75 occasions. Twenty patients underwent elective tracheosotmy in the operating room, and the new plastic tube and accessories were used (*Fig. 3*) from the time of operation until the tube was no longer needed. The tube was in place in patients from five days to more than six weeks.

On 22 occasions the plastic tracheostomy tube was used as a replacement for a preexisting metal tube. On no occasion was difficulty experienced in inserting a larger sized tube into either a recent or an old tracheostomy site.

The new tracheostomy tube has also been employed in a number of patients with pulmonary disease who are being treated in the medical constant care unit.

When properly installed, the tube and its right-angled connector have not leaked at gas pressures of 70 cm of water, the highest pressure at which the system was assessed. The cuff in the dimensions used provided an airtight seal without causing the tracheostomy tube to change position within the trachea. The ballooned cuff was never seen in the tracheostomy site,

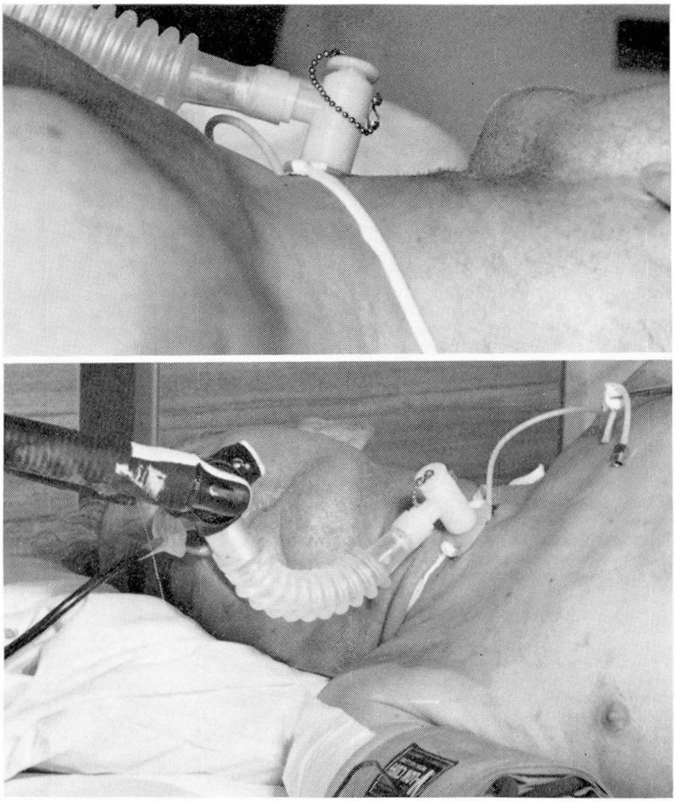

Fig. 3. Photograph of the new tracheostomy tube and connector in use in a patient in the constant care unit.

which cannot be said of the longer ligatured cuff on the metal tubes. Deflation of the cuffs permitted the passage of gases around the tube and the cuff. Occlusion of the tube for speech communication was discouraged, because the larger sizes of tube within the trachea permit sufficient respiratory exchange only with wide pressure fluctuation within the chest and with the expenditure of considerable energy by the patient. This perhaps constitutes a valid criticism of the use of the larger sizes of tracheostomy tube.

Complications

One patient who had received intermittent positive-pressure ventilation for seven weeks via a metal tracheostomy tube, and who had a ballooned trachea due to the presence of this cuffed metal tube, hemorrhaged profusely via the replacement plastic tube two days after its insertion, and died almost instantly. Autopsy was not performed, but death was considered to be due to the previous thinning of the tracheal wall and erosion of the aorta or pulmonary artery in the long-term management.

On two occasions the inner tube was seen to be half out of its outer cannula when the controlling ventilator was moved accidentally in relation to the patient. In both of these patients ventilation was continuing, though there was some leak around the inner cannula.

The cap on the right-angled connector several times was more difficult to remove than had been anticipated, but it always could be removed with effort.

In its initial use, in four instances the connector became disconnected from the male fitting on the end of the inner cannula. Subsequently, when the connector was put on it was given a half-turn twist under pressure and then rotated to its final position, completely overcoming the difficulty.

Before the inner cannula was modified to give a tighter fit, in five patients, while they were reacting to tracheal suction, the inner cannula loosened within the outer cannula. After the modification this did not occur.

CONCLUSION

A new plastic tracheostomy tube has given satisfactory results in most of the 75 instances in which it has been used. By standardizing the tracheostomy equipment, and its connections, we expect to preclude some of the unfortunate mishaps that can occur.

ACKNOWLEDGMENTS

The authors herewith thank John Homi, M.D., for originally evoking interest in the new tracheostomy tube, and John Viljoen, M.D., for using and criticizing it; and the nurses in the constant care and recovery units and throughout the hospital for their support and frank appraisal of the new equipment.