

## Tracheostomy From A to Z: Historical Context and Current Challenges

The following special articles address 8 different aspects of tracheostomy, a core topic for respiratory care, regardless of its site of practice and patient population. The authors, participants in the 2004 New Horizons symposium at the 50th Annual International Respiratory Congress of the American Association for Respiratory Care, focus on optimal patient management, although their approach is based on evidence wherever possible. To place the various facets of tracheostomy as addressed in these articles into perspective, I will briefly review its history, mention some of its present controversies, and list a number of related challenges.

### A Brief History of Tracheostomy

The word tracheostomy is derived from 2 Greek words meaning "I cut the trachea."<sup>1</sup> Among current surgical procedures it has a surprisingly long history.<sup>1,2</sup> It is referred to in 2 of the 3 oldest known medical works. The *Rig Veda*, sacred book of Hindu medicine, written between 2000 and 1000 BC, and the *Ebers Papyrus*, dating from about 1550 BC, both mention cutting into the neck to access the windpipe; the ancient Chinese text *Huang Ti Nei Ching Su Wen* contains no reference to any surgical procedure.

Several ancient Western references to tracheostomy have been cited, although all have been questioned in the face of varying translations and interpretations. In the 8th century BC, Homer is said to have described the relief of choking persons on cutting into the trachea. Hippocrates (4th century BC) may have referred to tracheal cannulation as a treatment for quinsy (peritonsillar abscess). A more familiar citation is an account of how Alexander the Great, in the 4th century BC, "punctured the trachea of a soldier with the point of his sword when he saw the man choking from a bone lodged in his throat."<sup>3</sup> Both Aretaeus and Galen, in the 2nd Century AD, wrote that Asclepiades of Bithynia performed elective tracheostomy in around 100 BC.<sup>2</sup>

Antyllus of Rome told in AD 340 of making a transverse incision between the 3rd and 4th tracheal rings, drawing the cartilages apart with hooks, and subsequently sewing the edges of the wound together once the patient could breathe more freely.<sup>1</sup> Tracheostomy is also described in

Arabian texts from the 4th century AD, although whether the procedure was actually performed or just discussed as a theoretical possibility is unclear.<sup>1</sup> Following these references, however, an entire millennium passed in which tracheostomy was either not mentioned or disparaged as a barbaric act that no responsible medical person would consider actually committing.

Only in the 16th century did reference to the performance of tracheostomy reappear. The first account of the procedure to be written by the surgeon who performed it was by Brasavola in 1546, who used it to relieve airway obstruction from enlarged tonsils.<sup>2</sup> At about the same time, Fabricius ab Aquapendente is said to have performed a tracheostomy on a patient with a foreign body in the larynx, as well as on several other occasions.<sup>1</sup> Others reported experience with the procedure during the next several decades. Sanatorius, in 1590, first used a trocar for tracheostomy, and reported leaving a cannula in place for 3 days.<sup>1</sup>

The word *tracheostomy* was first used by Heister in 1739.<sup>1</sup> George Washington, who died in 1799, developed progressive upper-airway obstruction, the cause of which is thought most likely to have been acute epiglottitis.<sup>4,5</sup> The prominent physician Elisha C Dick, who examined the former president, recommended tracheostomy, but was overruled by the other physicians in attendance.<sup>1,5</sup> In the early 19th century, performance of the procedure became more widespread and there were multiple reports in the medical literature. Trousseau reported in 1869 on 215 patients in whom tracheostomy was performed in the treatment of diphtheria (with 47 survivors), his series having begun during the 1830s.<sup>1</sup> The 1860 yearbook of the New Sydenham Society contained some 38 papers devoted to indications and techniques of tracheostomy.<sup>1</sup> In this country, the famous surgeon Chevalier Jackson refined the technical aspects of the procedure and described them in detail in 1909.<sup>6</sup>

The history of tracheostomy during the last 50 years is notable for 3 additional major developments. The first of these was the emergence of intermittent positive-pressure ventilation, along with the evolution of intensive care units, which followed a series of devastating poliomyelitis epidemics in the 1950s.<sup>7,8</sup> Prior to this time, tracheostomy had been used as an emergency treatment for upper-airway

obstruction. With paralytic polio, what was needed was a means for assisting ventilation for patients whose respiratory muscles were weak. Negative-pressure ventilation, in the form of the iron lung, had been introduced in 1929 and was widely available by mid-century.<sup>7</sup> Although tracheostomy had first been suggested as an aid to ventilatory support in acute poliomyelitis in 1932,<sup>9</sup> this application did not see wide use in this condition until the Copenhagen epidemic of 1952.<sup>10</sup> Among thousands of cases during that epidemic, 27 of the first 31 patients admitted with respiratory paralysis died. However, the 32nd patient, a 12-year-old girl, was successfully ventilated with manually-delivered positive pressure via a tracheostomy and survived.<sup>8,10</sup>

Reliable mechanical ventilators were not yet available during the epidemic, and, at the Communicable Disease Hospital in Copenhagen, as many as 70 patients at a time were hand-ventilated around the clock by nurses and medical students.<sup>8</sup> As better positive-pressure ventilators were introduced in the next few years, long-term ventilatory support by means of tracheostomy became more practical and was successfully applied in thousands of patients.<sup>7,8</sup> Effective life support by means of mechanical ventilation was greatly facilitated by the emergence of intensive care units, the first of which opened in 1958 in Baltimore, Oxford, and Toronto.<sup>8</sup>

Second among the last half-century's developments was the introduction of less injurious, low-pressure cuffs for endotracheal and tracheostomy tubes. These have permitted safer and more widespread use of tracheostomy for long-term ventilatory support. Although mucosal erosion and other cuff-related problems remain a concern for clinicians managing patients with tracheostomies, the incidence of these complications has been dramatically reduced over the last 30 years through the use of improved materials.

Finally, the most recent major step in the history of tracheostomy has been the development of the percutaneous dilational technique. First reported by Toye and Weinstein in 1969,<sup>11</sup> and used by these investigators in the first large patient series,<sup>12</sup> the introduction of this technique has brought a revolution of sorts with respect to tracheostomy and its use in critical care. Use of the Seldinger technique and preassembled kits, such as those that had previously been available for percutaneous nephrostomy,<sup>13</sup> has made tracheostomy simpler, more readily available to clinicians, and probably safer as well. Previously the exclusive province of surgeons in the operating room, tracheostomy is now widely performed at the bedside, using the percutaneous dilational technique, by anesthesiologists and internist intensivists, as well as by general, head and neck, thoracic, and other surgical specialists.

### Is It Tracheostomy or Tracheotomy—or Both?

By analogy to words such as laparotomy that refer to surgical procedures, it would make sense to call the act of creating an opening in the trachea *tracheotomy*. Similarly, by analogy to colostomy, the opening so created would be termed a *tracheostomy*, and the appliance inserted into it a *tracheostomy* tube. However, despite the logic of such a distinction, the terms tracheotomy and tracheostomy are inconsistently applied and most often used interchangeably.

Reference to “definitive” sources does not help. For example, 3 authoritative dictionaries define the 2 terms as follows:

*Merriam-Webster Online Dictionary*:<sup>14</sup>

- Tracheostomy: the surgical formation of an opening into the trachea through the neck especially to allow the passage of air
- Tracheotomy: the surgical operation of cutting into the trachea especially through the skin

*Stedman's Medical Dictionary*:<sup>15</sup>

- Tracheostomy: An operation to make an opening into the trachea.
- Tracheotomy: The operation of incising the trachea, usually intended to be temporary

*Oxford English Dictionary*:<sup>16</sup>

- Tracheostomy: The operation of making an opening in the trachea near its upper end, so that the patient can breathe through it; also, the opening so made
- Tracheotomy: = tracheostomy

At RESPIRATORY CARE's conference on artificial airways,<sup>17</sup> Reibel, speaking from the perspective of an otorhinolaryngologist, made this distinction between the 2 terms: “*Tracheotomy* refers to an opening made in the trachea *without* connection to the skin surface. *Tracheostomy* refers to a tracheal opening with a surgical attachment to the skin.”<sup>18</sup> At that conference, no consensus on the proper use of the terms tracheostomy and tracheotomy could be reached among the diverse clinicians present, despite vigorous discussion.<sup>18</sup> The “bottom line” of the argument may have been stated best by John Heffner: “A review of the topic I read within the last year (but have been unable to locate since) stated that only pedagogues worry about the difference.” (discussion, Page 826)<sup>18</sup>

I think the prognosis for consistency and clarity here is not good. PubMed searches on February 18, 2005, yielded 6,661 citations for *tracheostomy* and 7,945 for *tracheotomy*. Accepting either term (“tracheostomy OR tracheotomy”) produced 13,126 citations, whereas 1,480 citations

were retrieved that were indexed under both terms. These findings show that both terms are widely used, and deliberate distinction between intended meanings is inconsistent at best. Heffner may be right.<sup>18</sup> In the 8 articles in this issue, while attempting to maintain consistency within a given paper, I have allowed the authors to use whichever term they prefer.

### Current Clinical Issues and Unresolved Questions

The subjects of the 8 articles that follow are important in all the venues in which respiratory care is practiced. Clinicians everywhere—in the intensive care unit, on acute-care wards, at the rehabilitation or long-term weaning center, in the out-patient clinic, and in the home—encounter patients with tracheostomies. Many important, practical questions confront those clinicians, including:

- What are the indications for tracheostomy in patients requiring ventilatory support for respiratory failure, and when should it be done?
- Under what circumstances should tracheostomy be performed to facilitate secretion management?
- Which patients are appropriate candidates for percutaneous dilational tracheostomy? When is this approach contraindicated?
- What are the most important complications of the tracheostomy procedure and its early postoperative period? How can they be avoided?
- When should the tracheostomy tube first be changed after initial placement?
- Does the technique of tracheostomy management in the acute-care setting affect the incidence of pneumonia and other complications?
- From the bewildering array of available tracheostomy tube designs and sizes, how can the clinician choose the right one for a particular patient?
- In which tracheostomized patients should speech be attempted, and how should this be done?
- What are the main long-term complications of tracheostomy and how can they be avoided?
- Does tracheostomy facilitate weaning from ventilatory support? If so, how?
- How can readiness for decannulation be determined? How should it be carried out?

The papers in this issue of *RESPIRATORY CARE* do not answer all of these questions, but they address many issues important to clinicians managing patients who have tracheostomies or might be considered for this procedure.

Their purpose is to provide a review of the available evidence in this field, as well as to offer synthesis and practical recommendations based on personal experience and consultation when that evidence base is imperfect. These articles do not address permanent tracheostomy in the setting of laryngeal carcinoma, or the “mini-trach” as performed in some centers to facilitate cough and secretion clearance. Little is said about cricothyroidotomy or other procedures for emergency airway access. The focus is primarily on the care of adult patients, and not everything discussed in these articles may be applicable to the management of infants and children.

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