Facilitating Speech in the Patient With a Tracheostomy

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A tracheostomy tube decreases the ability of the patient to communicate effectively. The ability to speak provides an important improvement in the quality of life for a patient with a tracheostomy. In mechanically ventilated patients, speech can be provided by the use of a talking tracheostomy tube, using a cuff-down technique with a speaking valve, and using a cuff-down technique without a speaking valve. Speech can be facilitated in patients with a tracheostomy tube who are breathing spontaneously by use of a talking tracheostomy tube, by using a cuff-down technique with finger occlusion of the proximal tracheostomy tube, and with the use of a cuff-down technique with a speaking valve. Teamwork between the patient and the patient care team (respiratory therapist, speech-language pathologist, nurse, and physician) can result in effective restoration of speech in many patients with a long-term tracheostomy. *Key words: speaking valve, speech, talking tracheostomy tube, tracheostomy, mechanical ventilation, complications.* [Respir Care 2005;50(4):519–525.

Introduction

Placement of a tracheostomy facilitates long-term mechanical ventilation, minimizes large-volume aspiration, and bypasses upper-airway obstruction. However, it also decreases the ability of the patient to communicate effectively. It is possible to restore voice in many patients with tracheostomy who are cognitively intact and free of laryngeal or pharyngeal dysfunction. The ability to speak provides an improvement in the quality of life for a patient with a tracheostomy. In order to achieve adequate voice, a subglottic (tracheal) pressure of a least 2 cm H_2O is required.[1–3] In normal persons the tracheal pressure is 5–10 cm H_2O during speech. Flow through the upper airway during normal speech is 50–300 mL/s (3–18 L/min).[4,5] There are a variety of techniques to achieve this in tracheostomized patients who are either ventilator-dependent or

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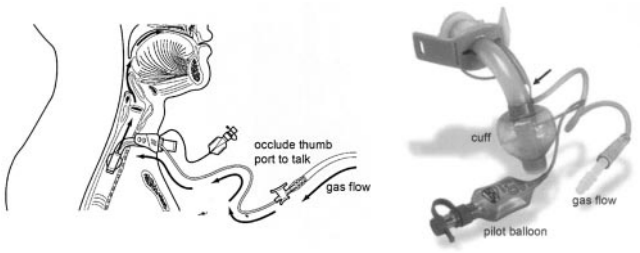

Fig. 1. Talking tracheostomy tube. Note that gas flow exits above the cuff and provides flow through the upper airway to facilitate speech. The arrow indicates the point of gas flow into the trachea above the cuff. (Adapted from illustrations provided courtesy of Smiths Medical, Keene, New Hampshire.)

breathing spontaneously. The purpose of this paper is to describe these methods.

Facilitation of Speech in the Ventilator-Dependent Patient With a Tracheostomy

Talking Tracheostomy Tube

The talking tracheostomy tube (Fig. 1) was designed to assist the patient to speak in a low, whispered voice.[6–13] With the cuff inflated, a gas line with a thumb port is connected to a gas source. The flow is adjusted to 4–6 L/min and the thumb port is occluded by the patient or caregiver. Gas passes through the larynx, allowing the patient to speak in a soft whisper. Note that the talking tracheostomy tube allows the use of voice with the cuff inflated. Thus, this technique decouples speech and breathing. There is no loss of ventilation during speech with this device, and the inflated cuff reduces the risk of aspiration.

There are several limitations to the use of the talking tracheostomy tube, and for these reasons this tube is not commonly used. Unless this tube is inserted at the time of the tracheostomy procedure, the use of this tube requires a tube change. In many cases, the voice quality is not good—a whisper at best. Voice quality may improve with higher flows,[10,11] but this can be associated with a potentially greater risk of airway injury. If the resistance to airflow retrograde through the stoma is less than that through the upper airway, much of the added flow may leak from the stomal site and not be available for speech.[12] One study reported stoma complications associated with a talking tracheostomy tube, but the tube used in that study is no longer commercially available (Communi-Trach I).[13] Upper-airway secretions can interfere with the quality of voice, and secretions above the cuff can lead to a clogged gas flow line.[11,12] An important limitation is the need for an assistant to control gas flow in many patients.[12] It has also been observed that several days of use may be necessary before the patient is able to develop voice with this device.[10,11] Practice and training may be necessary to master the use of this device, and even with such, some patients cannot develop adequate voice.[11]

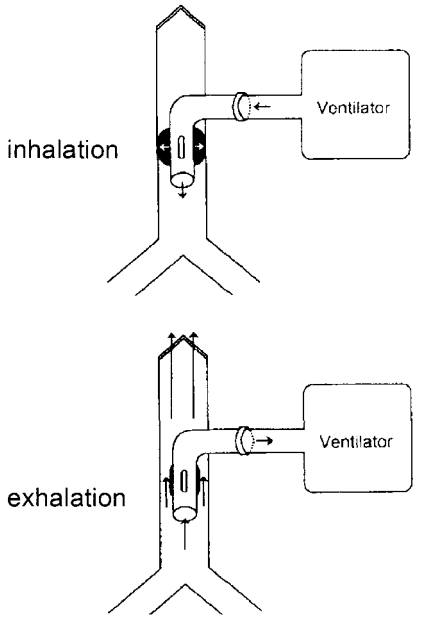

Fig. 2. The voice tracheostomy tube. The cuff expands with positive pressure from the ventilator, which results in inflation of the lungs without a leak through the upper airway. On exhalation, the cuff deflates and some of the exhaled gas exits through the vocal cords, allowing the patient to speak. (From Reference 14, with permission.)

A voice tracheostomy tube, not yet commercially available, has been described.[14] It is specially configured so that the cuff inflates with positive pressure and deflates during the expiratory phase (Fig. 2). This tube was used in 16 patients, and all but one were able to speak with this tube. There were no changes in P_{aO_2} or P_{aCO_2} with the use of this tube.

Cuff Down With Speaking Valve

When using a speaking valve with the cuff deflated or with a cuffless tube, gas flows from the ventilator into the tracheostomy tube during inhalation but exits through the upper airway during exhalation (Fig. 3). In other words, the speaking valve is a one-way valve designed to attach to the proximal opening of the tracheostomy tube. Before placing the speaking valve, the cuff must be completely deflated. It may be necessary to increase the tidal-volume delivery from the ventilator to compensate for volume loss through the upper airway during the inspiratory phase. Some patients are able to control oropharyngeal muscle tone sufficiently to minimize the leak through the upper airway during the inspiratory phase.

The alarms on most critical-care ventilators are intolerant of a speaking valve. This can be addressed by using a

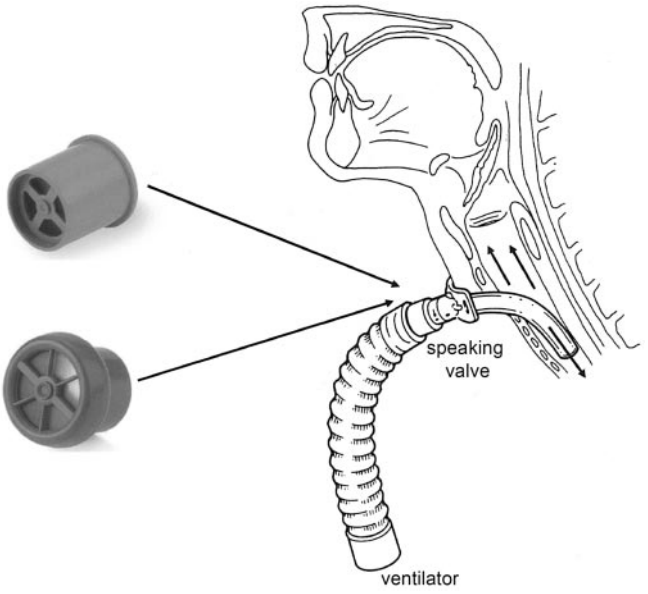

Fig. 3. Placement of a speaking valve between the ventilator and the tracheostomy tube results in the exhaled gas passing through the upper airway (rather than into the ventilator circuit). (Adapted from illustrations courtesy of Passy-Muir, Irvine, California.)

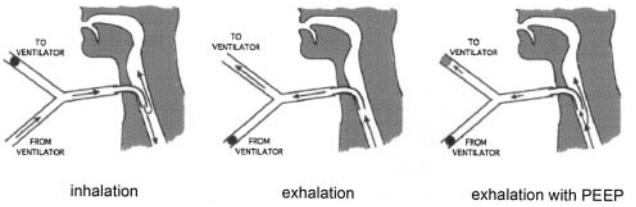

Fig. 4. Airflow during ventilator-supported speech. The black circles represent occlusions and the gray circle represents higher-than-usual impedance. During inhalation (left), air flows both toward the lungs and through the larynx. During usual exhalation (center), most of the air flows toward the ventilator. This is because the impedance of the ventilator circuit is much lower than that of the laryngeal pathway during speech production. With positive end-expiratory pressure (PEEP) (right), the impedance of the ventilator circuit is higher than usual, so that more air flows through the larynx. (From Reference 18, with permission.)

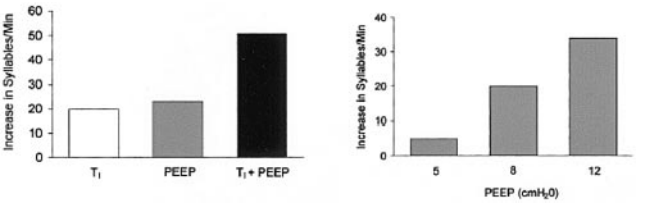

Fig. 5. Left: Changes in speaking rate (syllables per minute) for lengthened inspiratory time (T_I), positive end-expiratory pressure (PEEP), and lengthened T_I plus PEEP. Right: Changes in speaking rate with 5, 8, and 12 cm H_2O PEEP. (From Reference 18, with permission.)

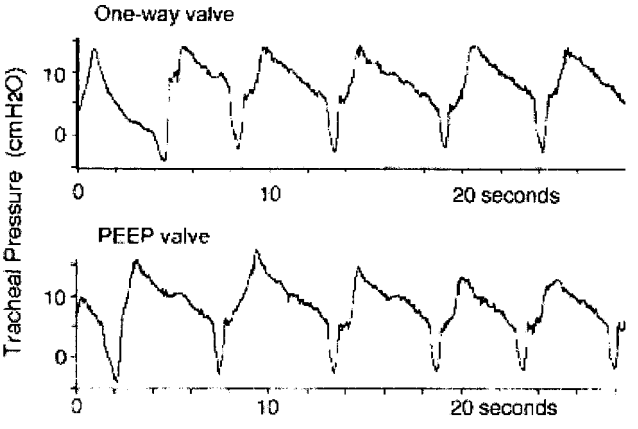

Fig. 6. Tracheal pressure waveforms generated during speech production with a one-way valve and with a positive end-expiratory pressure (PEEP) valve set to 15 cm H_2O. (From Reference 18, with permission.)

ventilator with a speaking valve mode (eg, Puritan Bennett 760) or a portable home-care ventilator. Heated humidifiers can be used with a speaking valve. However, a heat-and-moisture exchanger should not be used, because no exhaled gas passes through it if a speaking valve is in place. If an in-line closed suctioning system is used, the speaking valve should be connected to the side port to allow the catheter to easily pass into the tracheostomy tube. The volume of dead space in the ventilator circuit is unimportant when a speaking valve is used, because there is no potential for rebreathing in the circuit.

Adequate cuff deflation, tracheostomy tube size, tracheostomy tube position, and upper-airway obstruction should be assessed if the patient is unable to exhale adequately through the upper airway. Some patients complain of discomfort due to airflow through the upper airway when the speaking valve is in place. This can result from drying of the pharyngeal membranes, inability to ventilate adequately, and increased noise levels. This may be the result of decreased pharyngeal or laryngeal tone due to weakness or atrophy from lack of flow through the upper airway during prolonged mechanical ventilation. This can be addressed by using a slow cuff deflation over several minutes. Initial placement of the speaking valve may stimulate coughing, which may be the result of secretions pooled above the cuff. This can be minimized by clearance of pharyngeal and tracheal secretions before the cuff is deflated. Some patients can communicate during both the inspiratory and expiratory phase of the ventilator. This is only problematic if it results in inadequate ventilation during speech. A speech-language pathologist can help patients who have difficulty adjusting to the speaking valve.

Passy et al[15] reported their experience in a series of 15 ventilator-dependent patients in whom a speaking valve was used. In all 15 patients there was an improvement in speech intelligibility, speech flow, elimination of speech

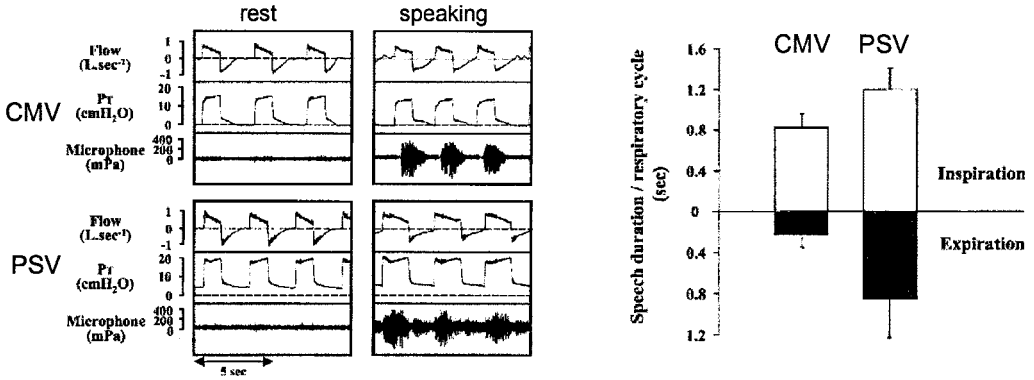

Fig. 7. Left: Recording from a patient during a vowel-holding trial with continuous mandatory ventilation (CMV) and pressure-support ventilation (PSV). Note the increase in inspiratory time during speech and the improvement in speech duration during both inhalation and exhalation with PSV, compared with CMV. P_T = tracheal pressure. Right: Distribution of maximum speech duration over the phases of the respiratory cycle during a reading test with CMV and PSV. (From Reference 21, with permission.)

hesitancy, and speech time. In a series of 10 chronically ventilator-dependent patients, Manzano et al[16] reported that a speaking valve was effective in improving communication in 8 of the 10 patients. In one patient, use of the speaking valve was not possible because adequate ventilation was not possible with the cuff deflated. In a second patient, the speaking valve was not effective because of laryngopharyngeal dysfunction.

Cuff Down Without Speaking Valve

Hoit et al[17–20] have published several papers related to cuff-down techniques to facilitate speech without the use of a speaking valve. They have shown that simple manipulations on the ventilator allow the patient to speak during both the inspiratory phase and expiratory phase. Moreover, the lack of a speaking valve may increase safety should the upper airway become obstructed.

If the cuff is deflated, gas can escape through the upper airway during the inspiratory phase (Fig. 4). During speech, this has been shown to be about 15% of the delivered tidal volume, which may cause a small increase in P_{CO_2} (< 5 mm Hg).[17] This leak results in the ability to speak during the inspiratory phase. It has been shown that increasing the inspiratory time setting on the ventilator increases breathing rate (syllables per minute) (Fig. 5).[18,19] If the positive end-expiratory pressure (PEEP) setting on the ventilator is zero, most of the exhaled gas exits through the ventilator circuit rather than the upper airway. In this situation, there is little ability to speak during the expiratory phase. If PEEP is set on the ventilator, then expiratory flow is more likely to occur through the upper airway, which increases speaking rate. The use of a longer inspiratory time and higher PEEP are additive in their ability to improve speaking rate (see Fig. 5).[18] Tracheal pressure (important for speech) is similar with the use of PEEP and the use of a speaking valve (Fig. 6). By prolonging the inspiratory time and using PEEP, mechanically ventilated patients with a tracheostomy may be able to use 60–80% of the breathing cycle for speaking.[17–20] Anecdotally, I have observed such patients who are able to speak throughout the entire ventilatory cycle without any pauses for breathing. This is unlike normal subjects without tracheostomy tubes, who speak only during the expiratory phase.

The ventilator is normally flow-cycled during pressure-support ventilation. In the presence of a leak through the upper airway, the ventilator may fail to cycle appropriately, and thus result in a prolonged inspiratory phase. Although this would usually be considered undesirable, it might facilitate speech. Prigent et al[21] reported that pressure support with PEEP and the cuff deflated resulted in an increase in inspiratory time during speech, and this improved speech duration during both the inspiratory and expiratory phase (Fig. 7). This occurred with minimal effect on gas-exchange variables.

Patients Not Mechanically Ventilated

Talking Tracheostomy Tube

Although not common practice, a talking tracheostomy tube can be used in a patient with a tracheostomy who is not mechanically ventilated. For example, this may be considered in a patient who is cognitively able to speak but is at risk for aspiration if the cuff is deflated.

Cuff-Down Finger Occlusion

With the cuff down (or with a cuffless tube), the patient (or caregiver) can place a finger over the proximal opening of the tracheostomy tube to direct air through the upper airway and thus produce speech (Fig. 8).[22] Some patients

Fig. 8. Finger occlusion technique to direct exhaled gas through the upper airway rather than through the tracheostomy tube. (From Reference 22, with permission.)

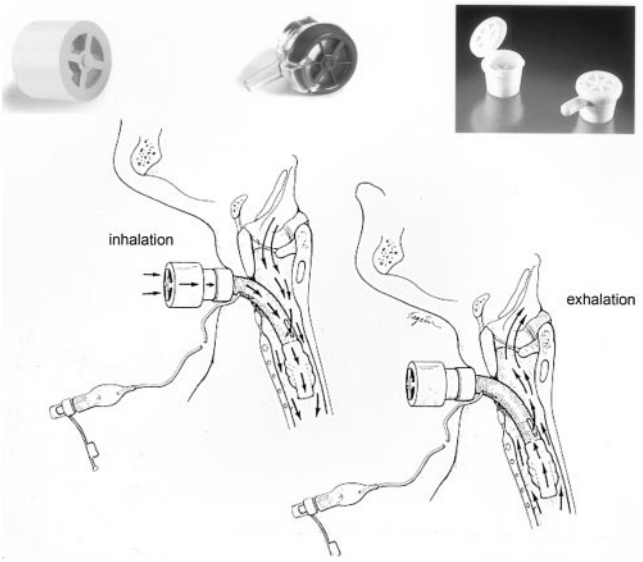

Fig. 9. Speaking valves for use with a tracheostomy tube. Arrows indicate gas flow during inhalation and exhalation. (Adapted from illustrations courtesy of Passy-Muir, Irvine, California and Tyco Healthcare, Pleasanton, California.)

are quite facile with this technique, but many do not have the coordination to master this method.

Cuff Down With Speaking Valve

In the spontaneously breathing patient, a speaking valve directs the exhaled gas through the upper airway, which may allow the patient to speak (Fig. 9). This is probably the most common method used to facilitate speech in spontaneously breathing patients with tracheostomy tubes. Although many patients can use this method effectively, there are several contraindications to the use of a speaking valve (Table 1). The speaking valve should be used only for a patient who is awake, responsive, and attempting to communicate. The patient must be able to exhale around the tracheostomy tube and through the upper airway. The patient should be medically stable and must be able to tolerate cuff deflation. Although the speaking valve may facilitate oral expectoration of secretions, airway clearance issues may occur if the patient has abundant secretions. The patient's risk for aspiration should be evaluated before the speaking valve is placed. The speaking valve is generally considered inappropriate in a patient at risk of gross aspiration. However, silent aspiration may occur even with the cuff inflated.[23] The input of a speech-language pathologist and use of techniques such as fiberoptic endoscopic evaluation of swallowing can be valuable to assess the risk of aspiration with cuff deflation.

Table 1. Speaking Valve Contraindications

Unconscious or comatose patient
Inflated tracheostomy tube cuff
Foam-cuffed tracheostomy tube
Thick and copious secretions
Severe upper-airway obstruction
Abnormal lung mechanics that prevent sufficient exhalation (high resistance, high compliance)
Speaking valves are not intended for use with endotracheal tubes

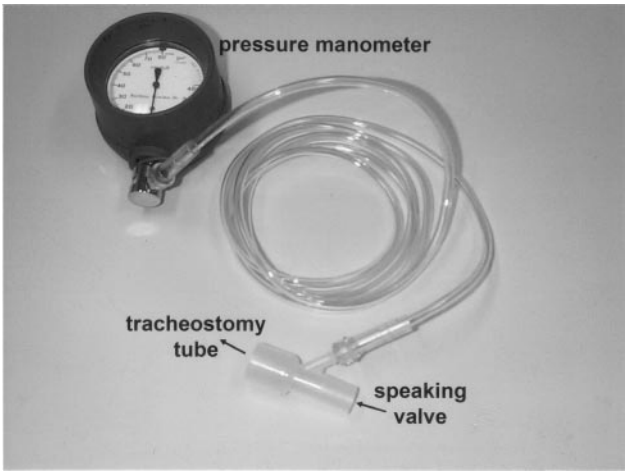

Fig. 10. Equipment used to measure tracheal pressure when a speaking valve is applied.

The patient must be able to exhale effectively around the tracheostomy tube when the speaking valve is placed. This can be assessed by measuring tracheal pressure with the speaking valve in place (Fig. 10). If the tracheal pressure is > 5 cm H_2O during passive exhalation (without speech) with the speaking valve in place, this may indicate excessive expiratory resistance.[24] The upper airway should

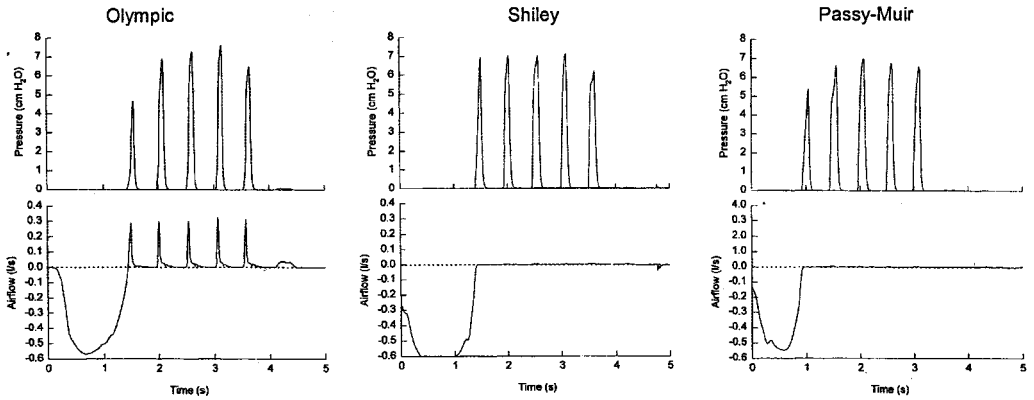

Fig. 11. Pressure and flow through a tracheostomy tube with 3 brands of speaking valve. Note that the bias-open design (Olympic) allows flow through the valve during exhalation, whereas the bias-closed design does not. The bias-closed design thus directs more gas flow through the upper airway to facilitate speech. (From Reference 26, with permission.)

be assessed for the presence of obstruction (eg, tumor, stenosis, granulation tissue, secretions). The size of the tracheostomy tube should be evaluated and consideration given to downsizing the tube. The cuff on a tracheostomy tube can also create an obstruction, even when deflated. Consideration should be given to the use of an uncuffed tube or a tight-to-shaft cuff. The use of a fenestrated tracheostomy tube can also be considered.

Before placing the speaking valve, the cuff must be completely deflated. Before cuff deflation the upper airway should be cleared of secretions. A slow cuff deflation often facilitates a smoother transition for the patient to airflow in the upper airway. The lower respiratory tract may need to be suctioned after cuff deflation because of aspiration of secretions from above the cuff. The ability of the patient to tolerate the speaking valve can be briefly assessed by finger occlusion of the tracheostomy tube after cuff deflation. Once the speaking valve is placed, carefully assess the patient's ability to breathe. Many patients initially tolerate short periods of speaking-valve-placement until they become acclimated. If the patient experiences difficulty with airway clearance when the speaking valve is in place, the valve should be removed to allow the patient to be suctioned. If the patient exhibits signs of respiratory distress, remove the speaking valve immediately and reassess upper-airway patency.

Oxygen can be administered while the speaking valve is in place, using a tracheostomy collar or an oxygen adapter on the speaking valve. The patient may inhale through the upper airway when the speaking valve is in place. This is most likely with a small tracheostomy tube, in which inspiratory resistance through the tube may be greater than the resistance through the upper airway. When this occurs, oxygen administration to the upper airway may be required (eg, nasal cannula). Humidity can be applied using a tracheostomy collar, but a heat-and-moisture exchanger filter should not be used, because the patient will not exhale through the heat-and-moisture exchanger. If inhaled aerosol medications are given, the speaking valve should be removed during this therapy.

There have been several evaluations of the aerodynamic characteristics of speaking valves.[25–27] The inspiratory resistance through speaking valves has been reported at about 2.5 cm H_2O/L/s at a flow of 0.5 L/s, and is similar among valves from several manufacturers.[26] Speaking valves can be either bias open or bias closed. The bias-open design may result in incomplete closure during exhalation, resulting in expiratory flow through the valve (Fig. 11), which limits flow through the upper airway and the ability to speak.[26,27]

In addition to allowing speech, the use of a speaking valve may have other benefits. Some studies have suggested that the speaking valve may improve swallow and decrease the risk of aspiration,[28–33] although this has been debated by others.[34] Because the patients inhales through the tracheostomy tube and exhales through the upper airway, rebreathing (dead space) may be reduced, but this has not been studied. The use of a speaking valve may also allow the patient to control exhalation (eg, pursed lips in the patient with chronic obstructive pulmonary disease), but this also has not been adequately studied. Improvements in olfaction have also been reported with the use of a speaking valve.[35]

Summary

The ability to speak is an important aspect of the quality of life for patients with a tracheostomy. A variety of techniques to achieve this are available for either mechanically ventilated or spontaneously breathing patients. Teamwork between the patient and the patient care team (respiratory therapist, speech-language pathologist, nurse, physician) can result in restoration of speech in many patients with long-term tracheostomies.

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