Tracheostomy Tube Malposition in Patients Admitted to a Respiratory Acute Care Unit Following Prolonged Ventilation*

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Background: **Tracheostomy tube malposition is a barrier to weaning from mechanical ventilation. We determined the incidence of tracheostomy tube malposition, identified the associated risk factors, and examined the effect of malposition on clinical outcomes.**

Methods: **We performed a retrospective study on 403 consecutive patients with a tracheostomy who had been admitted to an acute care unit specializing in weaning from mechanical ventilation between July 1, 2002, and December 31, 2005. Bronchoscopy reports were reviewed for evidence of tracheostomy tube malposition (*ie*, > 50% occlusion of lumen by tissue). The main outcome parameters were the incidence of tracheostomy tube malposition; demographic, clinical, and tracheostomy-related factors associated with malposition; clinical response to correct the malposition; the duration of mechanical ventilation; the length of hospital stay; and mortality.**

Results: **Malpositioned tracheostomy tubes were identified in 40 of 403 patients (10%). The subspecialty of the surgical service physicians who performed the tracheostomy was most strongly associated with malposition. Thoracic and general surgeons were equally likely to have their patients associated with a malpositioned tracheostomy tube, while other subspecialty surgeons were more likely (odds ratio, 6.42; 95% confidence interval, 1.82 to 22.68; p = 0.004). Malpositioned tracheostomy tubes were changed in 80% of cases. Malposition was associated with prolonged mechanical ventilation posttracheostomy (median duration, 25 vs 15 d; p = 0.009), but not with increased hospital length of stay or mortality.**

Conclusion: **Tracheostomy tube malposition appears to be a common and important complication in patients who are being weaned from mechanical ventilation. Surgical expertise may be an important factor that impacts this complication.** ***(CHEST 2008; 134:288–294)***

Key words: airway obstruction; mechanical ventilation; tracheal stenosis; tracheostomy; weaning

Abbreviations: APACHE = acute physiology and chronic health evaluation; CI = confidence interval; RU = respiratory acute care unit

Tracheostomy is one of the most frequently performed procedures in critically ill patients.[1,2] While the precise timing of tracheostomy remains controversial, it is usually performed after a period of mechanical ventilation to facilitate weaning, improve patient comfort, and allow safe discharge from the ICU.[3,4] Although morbidity and mortality rates are low with this procedure,[5] complications ranging from stomal infection to death may occur.[5] Tracheostomy tube malposition has been reported in case reports and small case series[6–10] and can result in life-threatening airway emergencies.[9] To the best of our knowledge, there has been limited description of the epidemiology of tracheostomy tube malposition. We therefore sought to determine the incidence of tracheostomy tube malposition, the factors contributing to tracheostomy tube malposition, and the effect of tracheostomy tube malposition on patient outcomes.

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Materials and Methods

Setting

The study was performed in the Respiratory Acute Care Unit (RU) of the Massachusetts General Hospital. Massachusetts General Hospital is a university-affiliated teaching hospital, a tertiary care referral center, a level-1 trauma center, and a community hospital for Boston. It has > 1.5 million patient visits and 45,000 admissions annually. The RU is a 10-bed unit providing care for mechanically ventilated patients who are hemodynamically and metabolically stable. It uses a transitional model that includes a medical director, staff intensivists from the Departments of Anesthesia and Critical Care Medicine and Pulmonary Medicine, and the participation of primary care physicians in patient care.[11] There is one nurse for every two patients. A respiratory therapist and physician are on site 24 h per day. The focus of the RU is the liberation of patients from mechanical ventilation. Patient care is provided in a multidisciplinary fashion that incorporates protocols and guidelines for weaning from mechanical ventilation, downsizing of tracheostomy tubes for speech and oral feeding, and tracheostomy tube decannulation. At Massachusetts General Hospital, tracheostomies are performed by general surgeons as well as by subspecialty surgeons. The hospital does not have an otolaryngology service. During the study period, the majority of tracheostomies were performed using an open technique.

For this study, we included consecutive mechanically ventilated patients who were > 18 years of age who had been admitted to the RU between July 1, 2002, and December 31, 2005, and had a tracheostomy tube placed during their current hospital admission. The study was approved by the Institutional Review Board of the Massachusetts General Hospital.

Study Objectives

The study objectives were as follows: (1) to determine the incidence of tracheostomy tube malposition; (2) to identify the factors associated with tracheostomy tube malposition; and (3) to examine the effect of tracheostomy tube malposition on the duration of mechanical ventilation and length of hospital stay. *A priori*, we identified the following two categories of factors potentially associated with tracheostomy tube malposition: (1) patient-associated factors, including demographics, body habitus, nutritional status, comorbidities, illness severity, and preexisting respiratory disease; and (2) technical and mechanical tracheostomy factors, including the type of tracheostomy tube and the surgical subspecialty of the surgeon performing the tracheostomy. The identification of tracheostomy tube malposition, tracheostomy-related factors, the duration of mechanical ventilation, the length of stay, and mortality were prespecified outcomes included in a data extraction instrument that was developed prior to the initiation of data collection.

Identification of Tracheostomy Tube Malposition

Bronchoscopies are frequently performed in the RU to identify the reasons for a change in respiratory status, to assist in the diagnosis of pneumonia, or to clear secretions from the lower respiratory tract. All patients with a tracheostomy tube placed during their current hospital admission underwent at least one bronchoscopy. Patients are routinely nursed with a head elevation of > 30°, and bronchoscopy was performed with the patient in this position. Bronchoscopy (Olympus bronchoscope; Tokyo, Japan; or Pentax bronchoscope; Tokyo, Japan) is usually performed with local anesthesia. Written reports of all bronchoscopies performed during the hospital stay subsequent to tracheostomy tube placement were reviewed for evidence of malposition, which was defined as a > 50% occlusion of the distal opening of the tracheostomy tube by tissue on bronchoscopic examination. Bronchoscopies in the RU are performed by four attending intensivists, and they routinely comment on tracheostomy tube position. Figure 1 is an example of tracheostomy tube malposition in one of our patients. Two independent investigators reviewed the bronchoscopy reports of every patient for tracheostomy tube malposition. In the case of a discrepancy between the two reviewers, a third reviewer scrutinized the report, and a consensus was reached. The types of malposition were categorized as the posterior tracheal wall occluding the distal tip of tube, the presence of granulation tissue, tracheostomy tube too short proximally, tracheostomy tube too short distally, and tracheostomy tube cuff in the stoma.

Clinical Response to Malposition

We recorded the clinical indicators that prompted the bronchoscopy that identified the tracheostomy tube malposition. We

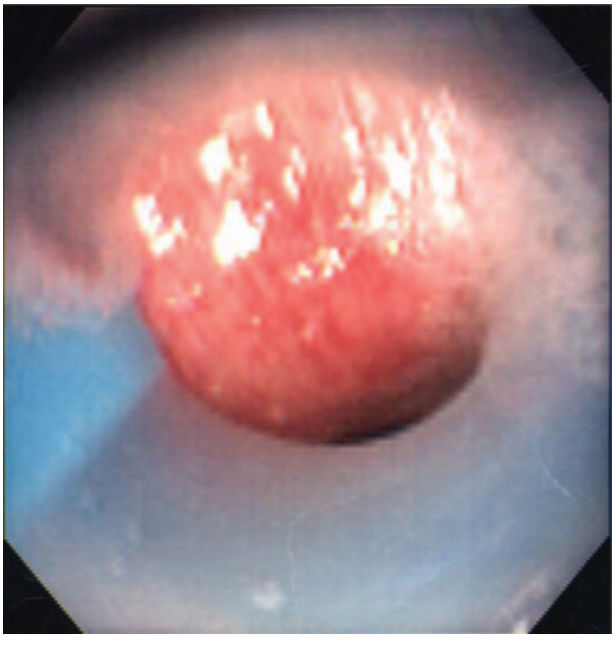

Figure 1. Tracheostomy tube malposition due to posterior tracheal wall occluding the distal tip of the tube, as seen through a bronchoscope.

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also recorded the clinical response to the identification of tracheostomy tube malposition as replacing the tracheostomy tube, surgical consultation, resuming mechanical ventilation, changing ventilator settings (inspiratory pressure and positive end-expiratory pressure), repositioning the existing tracheostomy tube, and initiating or intensifying medical therapy with bronchodilators or corticosteroids.

Demographic and Clinical Factors

Age, gender, duration of mechanical ventilation, hospital admitting service, and the unit in which the tracheostomy was performed were identified from the medical record. The etiology of respiratory failure was categorized as acute lung injury, chronic lung disease with acute respiratory failure, neurologic disease, or congestive heart failure. We identified the following additional clinical data: smoking history; height; weight; albumin level (a surrogate measure of nutrition status); and the administration of steroids prior to tracheostomy. Patient comorbidities were identified (*ie*, coronary artery disease, congestive heart failure, peripheral vascular disease, neurologic disease, history of malignancy, renal insufficiency, diabetes, chronic obstructive lung disease, asthma, connective tissue disease, and GI disease) and were summarized using the Charlson comorbidity index.[12] APACHE (acute physiology and chronic health evaluation) II score on admission to the ICU[13] and body mass index were calculated.

Tracheostomy-Related Factors

Tracheostomy-related factors identified from the medical record included a history of tracheostomy, the time from the first intubation to tracheostomy, the duration of mechanical ventilation prior to tracheostomy, whether the tracheostomy was performed emergently, whether it was performed outside the operating room, and whether the procedure was a percutaneous or open tracheostomy. The service that placed the tracheostomy was categorized as general surgery, thoracic surgery, or other surgical subspecialty (*eg*, otolaryngology, plastic surgery, neurosurgery, transplant surgery, or vascular surgery). The dimensions of the tracheostomy tube (*ie*, inner diameter, outer diameter, and length) were identified as well as whether an inner cannula was present, and the cuff pressure was recorded. The documentation of complications during the initial tracheostomy placement and confirmation by bronchoscopy during the procedure were recorded.

Outcomes

The following outcome data were recorded: length of hospital stay; length of hospital stay following tracheostomy; duration of mechanical ventilation; ICU readmission; hospital mortality; and tracheostomy tube decannulation prior to hospital discharge.

Statistical Analysis

The strategy for the primary analysis was to evaluate each of the three specific study objectives. Patient characteristics were summarized using nominal measures (proportions), ordinal measures (median and interquartile range), and interval measures (mean and SD). Data for the patients with and without tracheostomy tube malpositions were compared using *t* tests, χ^2 tests, and Fisher exact test for outcomes with rare events. Nonparametric comparisons were performed using the Mann-Whitney test. Logistic regression was performed to examine the associations between demographic, hospital, clinical, and tracheostomy factors, and tracheostomy tube malposition. Variables were first examined using univariate analyses. Variables that were significant at a $p \leq 0.1$ were included in the multivariable analyses. Variables were selected by means of backward stepwise regression and comparison of the regression sum of squares. Statistical analyses were performed using a statistical software package (SAS, version 8.2; SAS Institute; Cary, NC) with two-tailed significance levels of 0.05.

Results

Incidence of Malposition and Clinical Response

There were 419 patients admitted to the RU during the study period, of whom 16 were excluded from the study (no tracheostomy placed, n = 12; chronic tracheostomy, n = 3; no mechanical ventilation during RU stay, n = 1). The focus of the article was on the remaining 403 patients. There were 40 cases of tracheostomy tube malposition (10%; 95% confidence interval [CI]; 7 to 13%). The median time from tracheostomy tube placement to the identification of malposition was 12 days (interquartile range, 4 to 20 days). The indication for bronchoscopy was respiratory distress in 23 patients (58%) and changes in respiratory mechanics in 17 patients (42%). Occlusion of the distal end of the tracheostomy tube by the posterior tracheal wall was the most common malposition (Table 1).

The tracheostomy tube was changed in 80% of patients with a malposition. In four patients, the cuff was found in the stoma or the tracheostomy tube was too short proximally, prompting an emergent tracheostomy change. In these patients, a longer tracheostomy tube was placed, and the position was confirmed by bronchoscopy. In 28 patients, malacia affected a short segment of the trachea. A longer tracheostomy tube bypassed the lesion, the tube type depended on the length and flexibility needed, and good tube position was confirmed by bronchoscopy in all cases. Eight patients with malpostion had dynamic airway collapse. In these cases, a combination of altered ventilator settings and medical therapy, including bronchodilators and corticosteroids, were used (Table 2). Seven of these patients were successfully weaned off the ventilator, and one patient died while still receiving ventilatory support.

Table 1—*Type of Malposition

Type of Malposition	No. (%)*
Posterior tracheal wall occluding distal tip of tube	37 (92)
Granulation tissue	6 (15)
Tube too short distally	4 (10)
Cuff in stoma	3 (8)
Tube too short proximally	1 (3)

*Sum is > 100% as some patients had more than one type of tube malposition.

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Table 2—*Clinical Response to Malposition

Clinical Response to Malposition	No. (%)†
Tracheostomy tube replaced	32 (80)
Surgical consultation	19 (48)
Reinstitution of mechanical ventilation in patient liberated from mechanical ventilation	9 (23)
Increase in ventilator driving pressure in patient dependent on mechanical ventilation	4 (10)
Increase in PEEP in patients dependent on mechanical ventilation	14 (35)
Existing tracheostomy tube repositioned	3 (8)
Bronchodilators initiated	5 (13)
Steroids (inhaled or systemic) initiated	2 (5)

*PEEP = positive end-expiratory pressure.
†Sum is > 100% as some patients had more than one intervention.

Risk Factors for Tracheostomy Tube Malposition

There was no significant relationship among tracheostomy tube malposition, age, gender, severity of disease, etiology of respiratory failure, and time on the ventilator prior to tracheostomy (Table 3). The type of tracheostomy tube and the type of tracheostomy procedure (open vs closed) did not influence the risk of malposition (Table 4). Patients with a tracheostomy tube malposition had an increased mean (± SD) albumin level compared to patients without the complication (2.4 ± 0.6 vs 2.1 ± 0.5 mg/dL, respectively). Patients with a tracheostomy tube malposition were shorter in height (mean height, 1.68 ± 0.11 vs 1.72 ± 0.11 m, respectively). The factor most strongly associated with tracheostomy tube malposition was the subspecialty of the surgical service of the surgeon who performed the tracheostomy ($p = 0.006$). Compared to thoracic surgeons, general surgeons were equally likely to be associated with a tracheostomy tube malposition (odds ratio, 1.35; 95% CI, 0.50 to 3.62; $p = 0.551$), while other subspecialty surgeons were more likely associated with a tracheostomy tube malposition (odds ratio, 6.42; 95% CI, 1.82 to 22.68; $p = 0.004$). Forty-one patients underwent tracheostomies performed by nonthoracic subspecialty surgeons. These patients had a 23% risk of tracheostomy malposition. These other subspecialty surgeons were otolaryngologists (n = 1), plastic surgeons (n = 1), neurosurgeons (n = 1), transplant surgeons (n = 2), and vascular surgeons (n = 36).

Outcomes

Patients with a tracheostomy tube malposition had a longer duration of mechanical ventilation (median duration, 25 vs 15 days, respectively; $p = 0.016$), but had similar lengths of hospital stay following trache-

Table 3—*Demographic and Clinical Factors Assessed as Potential Contributors to Tracheostomy Tube Malposition

Characteristics	Patients With Tracheostomy Malposition (n = 40)	Patients Without Tracheostomy Malposition (n = 363)	p Value
Demographics			
Age,† yr	66.8 (17)	61.7 (17.8)	0.08
Female gender	19 (48)	136 (38)	0.29
Hospital			
Admitting service			0.66
Medicine	20 (50)	163 (45)	
Surgery	20 (50)	200 (55)	
ICU			0.44
Medical	14 (35)	97 (27)	
Surgical	17 (43)	156 (43)	
Other	9 (23)	110 (30)	
Clinical			
Height,† m	1.68 (0.11)	1.72 (0.11)	0.060
Weight,† kg	86.8 (41.3)	83.7 (30)	0.653
BMI,† kg/m^2	30.8 (14.3)	28.5 (11.1)	0.341
Charlson comorbidity index score,†‡	2.1 (2.7)	1.5 (1.9)	0.243
Etiology of respiratory failure			0.282
Acute lung injury	26 (65)	232 (64)	
Chronic lung disease with acute lung injury	7 (17.5)	34 (9.4)	
Neurologic disease	4 (10)	68 (19)	
Congestive heart failure	3 (8)	29 (8)	
APACHE II score	20.5 (5.2)	20.4 (6.4)	0.9282
Albumin level,† g/dL	2.4 (0.6)	2.1 (0.5)	0.005
Steroids prior to tracheostomy	18 (45)	124 (34)	0.235

*Values are given as No. (%), unless otherwise indicated.
†Values are given as the mean (SD).
‡None of the comorbidities summarized in the Charlson comorbidity index[12] were significant.

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Table 4—*Technical Factors Assessed as Potential Contributors to Tracheostomy Tube Malposition

Tracheostomy Factors	Patients With Tracheostomy Malposition (n = 40)	Patients Without Tracheostomy Malposition (n = 363)	p Value
Previous tracheostomy	2 (5)	15 (4)	0.99
Time from first intubation to tracheostomy,† d	19.3 (15.5)	18.9 (13.6)	0.872
Duration of mechanical ventilation prior to tracheostomy,† d	16.89 (15.3)	15.1 (9.3)	0.497
Service performing tracheostomy			0.012
General surgery	24 (60)	261 (72)	
Thoracic surgery	7 (18)	70 (19)	
Subspecialty surgery	9 (23)	32 (9)	
Tracheostomy performed emergently	1 (< 1)	3 (< 11)	0.343‡
Tracheostomy performed outside operating room	5 (13)	39 (11)	0.943
Percutaneous tracheostomy technique	3 (8)	31 (9)	0.999‡
Tracheostomy with inner cannula	29 (73)	317 (87)	0.035
Tracheostomy inner diameter,† mm	7.6 (0.8)	7.8 (0.6)	0.131
Tracheostomy outer diameter,† mm	10.7 (1.0)	10.8 (0.8)	0.385
Tracheostomy length,† mm	78.2 (11.4)	75.2 (6.4)	0.1034
Initial tracheostomy cuff pressure,† mm Hg	21.6 (4)	20.9 (3.8)	0.305
Tracheostomy tube position confirmed by bronchoscopy during procedure	10 (25)	56 (15)	0.184
Complication noted during tracheostomy	3 (8)	15 (4)	0.565

*Values are given as No. (%), unless otherwise indicated.
†Values are given as the mean (SD).
‡p Value calculated by Wilcoxon rank sum and Fisher exact test.

ostomy (median stay, 33 vs 26 days, respectively; p = 0.258) compared to patients without malposition (Table 5). There were no differences in ICU readmissions or the number of patients discharged to home, rehabilitation facilities, or other health-care facilities. Tracheostomy tube malposition had no significant effect on hospital mortality.

Discussion

Our major findings were as follows: (1) the incidence of tracheostomy tube malposition was 10% in patients who were admitted to a respiratory acute care unit with prolonged respiratory failure following critical illness; (2) patients with a tracheostomy performed by a nonthoracic subspecialty surgeon were at increased risk of experiencing tracheostomy tube malposition; and (3) tracheostomy tube malposition was associated with prolonged mechanical ventilation.

Table 5—*Tracheostomy Tube Malposition and Patient Outcomes

Measures	Patients With Tracheostomy Malposition (n = 40)	Patients Without Tracheostomy Malposition (n = 363)	p Value†
Duration of mechanical ventilation following tracheostomy, d	25 (13–37)	15 (8–29)	0.016
Ventilator-free days following tracheostomy, d	2 (0–14)	11 (0–19)	0.028
ICU readmission	15 (25)	107 (29)	0.228
Length of stay, d	52 (36–67)	46 (31–64)	0.228
Length of stay following tracheostomy, d	33 (19–46)	26 (16–42)	0.258
Hospital mortality	10 (25)	68 (19)	0.458

*Values are given as the median (interquartile range) or No. (%), unless otherwise indicated.
†Calculated by Wilcoxon rank sum test and Fisher exact test.

Incidence and Etiology of Tracheostomy Tube Malposition

The 10% incidence of tracheostomy tube malposition is similar to that reported in case series[6,7] of long-term mechanically ventilated patients at the time of planned decannulation. Rumbak et al[8] reported 37 patients who failed weaning attempts due to significant tracheal obstruction.

Reports by Rumbak et al[8] and Law et al[6] have attributed the majority of tracheostomy tube obstructions to tracheal mucosal damage. We identified granulation in only 15% of cases of tube malposition. We found partial occlusion of tracheostomy tube by the posterior tracheal membranous wall in the majority of cases (92%). It has been suggested[14] that pressure necrosis, ischemia, and inflammation contribute to tracheal wall weakness. We found a median time for the detection of tracheostomy tube malposition to be 12 days following tracheostomy. This lag time may be the result of positive-pressure ventilation, which provided tracheal dilatation and thus minimized the clinical manifestations of tube malpositioning. Tracheostomy tube occlusion may

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have worsened with reductions in ventilatory support, manifesting in clinical signs and symptoms and an inability to be liberated from mechanical ventilation. The rapid onset of respiratory distress during weaning should prompt the consideration of tracheostomy tube malposition.

Factors Associated With Tracheostomy Tube Malposition

Prior studies have reported that female gender[7,8] and tube type[15] are risk factors for tracheostomy tube malposition. In our study, these factors were not associated with malposition. However, we found that patients with a shorter height were at increased risk of malposition. The relationship between height and tracheal dimensions has been well established,[16] raising the possibility that tracheostomy tube malposition is due to a disparity between tracheostomy tube size and patient anatomy.

We found a small but significantly greater albumin concentration (2.1 vs 2.4 mg/dL, respectively) associated with tracheostomy tube malposition. This finding is difficult to understand and does not likely reflect clinically important differences.

The risk of malposition increased sixfold if a subspecialty surgeon other than a thoracic surgeon performed the tracheostomy. An explanation for this finding is that nonthoracic subspecialty surgeons perform fewer tracheostomies compared to thoracic surgeons and general surgeons. A relationship between patient outcomes and the number of procedures performed has been established for a variety of surgical procedures, including esophageal cancer surgery, pancreatic surgery, pediatric cardiac surgery, and unruptured abdominal aneurysms.[17] Our data suggest that the relationship between surgical volume and patient outcomes may extend to tracheostomy.

The bronchoscopic evaluation of tube placement at the time of tracheostomy was not protective in our patient series. This may be explained by the following: (1) the initial bronchoscopy may have been performed in paralyzed and fully ventilated patients who were in the supine position; and (2) the tube was initially positioned correctly and the malposition developed subsequent to the procedure. Malposition may only become apparent during attempts to liberate an awake patient from the ventilator or following changes in the patient's position.

From >40 *a priori* determined factors, only 3 were significantly associated with tracheostomy tube malposition. This suggests that it may be impossible to prospectively identify patients who are at high risk for tracheostomy tube malposition. Therefore, a high index of suspicion for tracheostomy tube malposition is required when patients demonstrate unanticipated difficulty in being liberated from mechanical ventilation following tracheostomy.

Outcomes Related to Tracheostomy Tube Malposition

Although it can be a life-threatening event,[9] in our study tracheostomy tube malposition resulted in prolonged mechanical ventilation but did not alter mortality. However, in four patients, the malposition prompted an emergent change of the tracheostomy tube. It is possible that clinical vigilance by a multidisciplinary team prevented mortality in these patients. Tracheomalacia commonly affects a segment of the trachea that is <3 cm in length.[14] Accordingly, in our study, 80% of patients with tracheostomy tube malposition had a tracheostomy tube change performed that resulted in better tube position.

Limitations

Our data are based on a retrospective chart review, and we may have missed subclinical cases.[18,19] Our results are from patients who were transferred within the hospital to the respiratory acute care unit of a tertiary care hospital, which may limit the generalizability of the results to long-term ventilator-weaning facilities. However, our results likely apply to patients requiring prolonged ventilator support following critical illness in any setting. Reflecting local practice during the study period, the majority of the tracheostomy tubes in our study were placed using an open technique rather than a percutaneous technique. Today, many tracheostomies are performed using a percutaneous technique. It is not known whether this change in practice may impact the incidence of tracheostomy malposition. Finally, we did not explore the association between tracheostomy tube malposition and surgeons of all surgical subspecialties who perform this procedure. For example, since our hospital does not have an otolaryngology service, only one tracheostomy was performed by an otolaryngologist. In addition, physicians with nonsurgical specialties do not perform tracheostomies in our hospital.

Conclusions

Tracheostomy tube malposition is a relatively common complication in patients with respiratory failure who are recovering from critical illness and is associated with prolonged mechanical ventilation. Although surgical expertise is a risk factor, identifying patients who are at risk for this complication is difficult. Tracheostomy tube malposition should be

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considered in mechanically ventilated patients who unexpectedly fail to be liberated from mechanical ventilation.

References

1 Esteban A, Anzueto A, Alia I, et al. How is mechanical ventilation employed in the intensive care unit? An international utilization review. Am J Respir Crit Care Med 2000; 161:1450–1458

2 Fischler L, Erhart S, Kleger GR, et al. Prevalence of tracheostomy in ICU patients: a nation-wide survey in Switzerland. Intensive Care Med 2000; 26:1428–1433

3 Nieszkowska A, Combes A, Luyt CE, et al. Impact of tracheotomy on sedative administration, sedation level, and comfort of mechanically ventilated intensive care unit patients. Crit Care Med 2005; 33:2527–2533

4 Diehl JL, El Atrous S, Touchard D, et al. Changes in the work of breathing induced by tracheotomy in ventilator-dependent patients. Am J Respir Crit Care Med 1999; 159:383–388

5 Antonelli M, Michetti V, Di Palma A, et al. Percutaneous translaryngeal versus surgical tracheostomy: a randomized trial with 1-yr double-blind follow-up. Crit Care Med 2005; 33:1015–1020

6 Law JH, Barnhart K, Rowlett W, et al. Increased frequency of obstructive airway abnormalities with long-term tracheostomy. Chest 1993; 104:136–138

7 Rumbak MJ, Graves AE, Scott MP, et al. Tracheostomy tube occlusion protocol predicts significant tracheal obstruction to air flow in patients requiring prolonged mechanical ventilation. Crit Care Med 1997; 25:413–417

8 Rumbak MJ, Walsh FW, Anderson WM, et al. Significant tracheal obstruction causing failure to wean in patients requiring prolonged mechanical ventilation: a forgotten complication of long-term mechanical ventilation. Chest 1999; 115:1092–1095

9 Trivedi M, Park G. Occlusion of a tracheostomy tube after misinsertion. Anaesthesia 2006; 61:407–408

10 Rigg CD, Edmondson L. Percutaneous dilational tracheostomy: malposition leading to delayed weaning. Anaesthesia 1995; 50:724–725

11 Bigatello LM, Stelfox HT, Berra L, et al. Outcome of patients undergoing prolonged mechanical ventilation after critical illness. Crit Care Med 2007; 35:2491–2497

12 Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987; 40:373–383

13 Knaus WA, Draper EA, Wagner DP, et al. APACHE II: a severity of disease classification system. Crit Care Med 1985; 13:818–829

14 Carden KA, Boiselle PM, Waltz DA, et al. Tracheomalacia and tracheobronchomalacia in children and adults: an in-depth review. Chest 2005; 127:984–1005

15 Trottier SJ, Ritter S, Lakshmanan R, et al. Percutaneous tracheostomy tube obstruction: warning. Chest 2002; 122: 1377–1381

16 Griscom NT, Wohl ME. Dimensions of the growing trachea related to body height: length, anteroposterior and transverse diameters, cross-sectional area, and volume in subjects younger than 20 years of age. Am Rev Respir Dis 1985; 131:840–844

17 Halm EA, Lee C, Chassin MR. Is volume related to outcome in health care? A systematic review and methodologic critique of the literature. Ann Intern Med 2002; 137:511–520

18 O'Neil AC, Petersen LA, Cook EF, et al. Physician reporting compared with medical-record review to identify adverse medical events. Ann Intern Med 1993; 119:370–376

19 Andrews LB, Stocking C, Krizek T, et al. An alternative strategy for studying adverse events in medical care. Lancet 1997; 349:309–313

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