Can Outcomes of Intensive Care Unit Patients Undergoing Tracheostomy Be Predicted?

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OBJECTIVE: To determine whether outcomes (mortality and need for intensive care unit [ICU] readmission) of patients undergoing tracheostomy in the ICU can be predicted by common clinical or historical criteria. METHODS: We conducted a retrospective review of data from the medical record and Project Impact database in a 24-bed medical-surgical ICU in a 500-bed university hospital. In 2004 through 2006, 60 adult patients underwent tracheostomy as part of their ICU management. We classified each patient as either not readmitted, readmitted, died on floor (after ICU discharge), died on first ICU admission, or combined readmitted/died-on-the-floor. Patients who died on the regular floor were significantly heavier than patients discharged without need for readmission ($P = .03$). Patients with a history of sepsis and those with a history of neurological disease had a tendency toward worse outcomes, but these did not reach statistical significance. CONCLUSIONS: These findings suggest that it is difficult to predict outcomes of patients who undergo tracheostomy in the ICU. Larger and prospective studies may help elucidate this matter.
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Introduction

Tracheostomy has become an increasingly common procedure in patients requiring prolonged mechanical ventilation in the critical care setting. According to the results of a recent paper reporting on data from over 152 French intensive care units (ICUs), an overall rate of 7.2% of mechanically ventilated patients have reportedly undergone this procedure.[1] This is somewhat less than the 10% reported several years previously from 48 Swiss ICUs.[2] While tracheostomy rates in ICUs in the United States seem to be in the same range,[3] no large-scale data have as yet been reported in the United States. Data accumulated over recent years indicate that patients undergoing tracheostomy may have better outcomes than patients receiving prolonged courses of mechanical ventilation not undergoing tracheostomy.[3-7] However, data evaluating possible predictors of outcomes among patients undergoing tracheostomy (mortality, need for ICU readmission) are lacking.

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We undertook this retrospective review of data from patients who underwent tracheostomy in our ICU to determine if specific prognostic factors could be identified in this population, with the thought that identification of any such factors might lead to changes in clinical management strategies or patient-safety initiatives.

Methods

This study was performed as a retrospective review of patients admitted to the adult medical-surgical ICU at Cooper University Hospital in 2004 through 2006. Data were

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obtained from our database (Project Impact, Cerner, Kansas City, Missouri) and from hospital records. Project Impact is a critical care data system, which incorporates clinical, demographic, and acuteness of illness data on critically ill patients. Approval for this study was obtained from the Cooper University Hospital institutional review board.

Cooper University Hospital is a 500-bed tertiary-care medical center serving a large referral base. Patients were all age 18 years or older, and were located in a 24-bed adult mixed medical-surgical ICU and were under the primary management of the critical care service. No trauma patients were included as part of this study, as those patients are managed by a separate trauma service in a trauma ICU.

Patients undergoing tracheostomy were evaluated for the 2 primary outcome parameters of need for ICU readmission and mortality. Tracheostomies were performed as part of the patients' ongoing critical care management, due to the documented or anticipated need for prolonged mechanical ventilation or prior failed attempts at extubation. All tracheostomies were performed at the bedside by experienced trauma surgeons employing a percutaneous dilational technique. Patients were classified as either not readmitted, readmitted, died during their first ICU admission, or died after transfer out of the ICU (died on the floor). Because of the small numbers of patients in each group, we also evaluated a combined group of all readmitted patients plus those who died after transfer out of the ICU, representing a combined group of patients having poor outcomes after transfer from the ICU.

The following parameters were used to compare patients in the group that was discharged from the hospital alive without the need for ICU readmission to those in the other groups: age, sex, Acute Physiology and Chronic Health Evaluation (APACHE II) score, primary diagnosis (categorized per APACHE II diagnostic category per Project Impact criteria), Glasgow coma score, history of chronic obstructive pulmonary disease, history of congestive heart failure, history of coronary artery disease, history of neurologic disease, sepsis, weight, ICU stay, time from ICU admission to tracheostomy, and time from intubation to tracheostomy.

Categorical variables were compared using the Fisher's exact test, and continuous variables were compared using the Student's *t* test.

Results

A total of 60 patients were identified who underwent tracheostomy during the period studied. There were no significant differences in the distribution of primary admission diagnoses between groups ($P = .90$). The incidence of primary respiratory failure was relatively low (less than 30% for each group) and did not differ between groups ($P = .66$) Twenty-seven patients transferred to the floor were discharged from the hospital alive without the need for ICU readmission. Twenty-one were either readmitted or died outside of the ICU prior to readmission; of those 15 were readmitted and subsequently discharged alive, and 6 died while outside of the ICU. Twelve patients died during their initial ICU admission. There were no statistically significant differences in any parameter between (1) those discharged from the hospital alive and not readmitted to the ICU and (2) those who died during their initial ICU admission, or (3) those readmitted but subsequently discharged alive, or (4) the combined group consisting of those who were readmitted or died outside of the ICU prior to readmission. Patient weight was significantly higher in those who died while outside of the ICU than in those discharged from the hospital alive and not readmitted to the ICU. When assessed for other possible differences, the subset of heaviest patients showed no differences from the other patients in terms of identifiable risk factors for adverse outcomes. While weights tended to be higher in all groups compared to the group discharged from the hospital alive and not readmitted to the ICU, neither any other individual group nor all other groups combined had a statistically different weight than did those discharged from the hospital alive and not readmitted to the ICU. Although sepsis tended to be identified more frequently in patients requiring readmission to the ICU than in those who did not, the difference did not reach statistical significance. Similarly, when patients requiring ICU readmission and those who died on the floor were considered together, those with a history of neurologic disease had an increased likelihood of poor outcome that nearly reached statistical significance, compared to patients not requiring readmission. Results are shown in Table 1. Reasons patients needed to be readmitted to the ICU are shown in Table 2.

Discussion

Data from several studies suggest that tracheostomy may improve outcomes in patients requiring prolonged mechanical ventilation,[3,4,7] although other investigators have not been able to identify any improved outcomes associated with tracheostomy.[8,9] However, data stratifying or predicting outcomes of patients following tracheostomy are scarce.

In a 2005 paper Mpe and Mphahele reported a 57% post-ICU mortality rate in 47 patients undergoing tracheostomy in the ICU.[10] In that study higher mortality rates were associated with Glasgow coma scores below 8. Glasgow coma score, post-ICU mortality, multiple-organ-dysfunction score, and hospital stay were the primary outcome variables evaluated.[10] Glasgow coma score was not identified as a risk factor for poor outcome in our study, but no group had particularly low scores, unlike in the

Table 1. Comparison of Patients Undergoing Tracheostomy in the Intensive Care Unit

Parameter	Not Readmitted (n = 27)	Readmitted (n = 15)	Died on Floor (n = 6)	Readmitted and Died on Floor (n = 21)	Died During First ICU Admission (n = 12)	P vs Not Readmitted			
						Readmitted	Died on Floor	Readmitted and Died	Died in ICU
Age (mean ± SD y)	67.5 ± 15.0	59.4 ± 17.8	63.0 ± 9.3	63.7 ± 12.5	64.0 ± 14.2	.13	.49	.38	.49
Male (n)	13	9	11	10	5	.53	.66	.30	.77
History Prior to ICU Admission (n)									
COPD	8	5	3	8	7	.99	.37	.35	.15
Congestive heart failure	18	8	5	13	8	.51	.64	.75	.99
Coronary artery disease	15	7	4	11	9	.75	.99	.35	.31
Neurologic disease*	12	5	1	6	2	.53	.36	.06	.15
Sepsis during first ICU admission (n)	16	13	4	17	6	.08	.99	.35	.73
Glasgow coma score (mean ± SD)	12 ± 2	13 ± 3	13 ± 1	13 ± 2	11 ± 3	.70	.37	.48	.38
Weight (mean ± SD kg)	81.1 ± 25.5	107.6 ± 95.6	115.4 ± 58.9	99.4 ± 63.1	90.8 ± 63.7	.18	.03	.19	.28
ICU stay (mean ± SD d)	33.5 ± 27.2	37.1 ± 26.3	30.8 ± 21.8	34.5 ± 24.2	34.1 ± 20.8	.68	.83	.19	.95
Time between admission and tracheostomy (mean ± SD d)	16.0 ± 9.1	15.9 ± 10.3	14.5 ± 7.0	15.5 ± 9.3	13.0 ± 8.3	.95	.70	.83	.33
Time between intubation and tracheostomy (mean ± SD d)	14.0 ± 6.8	12.9 ± 7.8	12.0 ± 8.8	18.1 ± 28.4	10.7 ± 6.1	.62	.54	.48	.15
APACHE II score (mean ± SD)	21.4 ± 6.8	18.7 ± 7.0	22.8 ± 6.5	19.9 ± 7.0	24.5 ± 7.0	.29	.68	.52	.29

* Any neurologic disorder; most common condition was cerebrovascular accident.
ICU = intensive care unit
COPD = chronic obstructive pulmonary disease
APACHE = Acute Physiology and Chronic Health Evaluation

Table 2. Reason for Readmission of 15 Patients to the Intensive Care Unit

Diagnosis/Organ Dysfunction Necessitating Readmission	*n*
Respiratory	9
Cardiac	3
Sepsis	0
Gastrointestinal bleeding	2
Unknown	1

study by Mpe and Mphahele (see Table 1). In our population the only risk factor we were able to formally identify for poor outcome was weight, with patients dying outside of the ICU being significantly heavier than patients being discharged alive without need for readmission. This is consistent with the findings of Yaegashi et al, who identified morbid obesity as a risk factor for a variety of poor outcomes, including need for tracheostomy, duration of mechanical ventilation, and mortality.[11] This is in contradistinction to recent data indicating lower overall mortality among obese critically ill patients.[12-14] Even obese patients with acute lung injury have recently been shown to have no greater mortality than patients of normal weight, although they have greater associated morbidities and resource utilization.[15] In our study the need for ICU readmission among patients initially admitted with a diagnosis of sepsis nearly reached statistical significance, but did not quite do so.

In a 2003 paper, Leung et al evaluated the impact of various indications for tracheostomy on time to decannulation.[16] These authors found that patients who underwent tracheostomy due to airway obstruction were able to be decannulated earlier than those who had this procedure performed as a result of trauma or primary respiratory pathology. Although not the primary intent of the study, the authors investigated but could not identify any significant predictor of mortality among tracheostomized patients. Other outcome parameters were not addressed in that study.

Freeman et al performed a multi-institutional review using the Project Impact database to assess the impact of timing of tracheostomy on the duration of mechanical ventilation and other outcomes, including ICU and hospital stay.[17] Data on nearly 44,000 patients were analyzed as part of this study. The investigators found that shorter duration of mechanical ventilation prior to tracheostomy was associated with fewer overall days on mechanical ventilation, as well as shorter ICU and hospital stay. Other outcomes (eg, mortality, ICU readmission) were not evaluated in that study. Scales et al recently reported the results of their review of data on a comparison of early (< 10 d) versus late (> 10 d) tracheostomy performed on nearly 11,000 patients in 114 ICUs over a 12-year period.[18] In this study the authors found a small but statistically significant mortality benefit to early tracheostomy.

It might seem reasonable to expect that those patients with poor outcomes would have significant differences from those not requiring readmission to the ICU. One reason this may not be observed may be that the population of patients undergoing tracheostomy is a relatively homogeneously sick population, in that those patients in a medical-surgical ICU requiring this procedure tend to share a common assortment of diagnoses and medical histories. This assessment seems to be supported overall by the facts that the distribution of primary admission diagnoses, as determined by APACHE II diagnostic category in the Project Impact database, was similar for all groups, and that we were unable to identify any statistically different incidences in comorbidities or past medical problems in any of the groups assessed. The fact that 2 parameters, sepsis (in those ultimately requiring ICU readmission) and a history of neurologic disorder (among those in the combined group of patients eventually readmitted or dying on the floor), approached statistical significance does, however, raise the possibility that a larger sample size may have revealed statistically significant results with regard to these parameters.

One limitation of our study is its design as a retrospective review of data from within the Project Impact database. As such, it is possible that clinically important differences between patients that may have helped identify those with poor outcomes may have been missed. As a parallel limitation, it is possible that we may have failed to consider potential risk factors for adverse outcomes in this population, although we believe that we have considered the likely culprits. Also, because of the relatively small sample size, especially within some of the subgroups of patients (eg, those who died while on the floor), this study was underpowered to detect anything other than extremely large differences between groups. As a retrospective study, we were unfortunately limited to the patient population available to us in our database at the time. The number of patients evaluated was, however, consistent with that reported in several previous studies.[3,6,8,10] Despite this limitation we were able to identify a significant impact of obesity on poor outcomes, as defined by need for readmission, and identified strong trends for need for readmission in patients with a diagnosis of sepsis and a combined end point of death or readmission in patients with a history of neurologic disease. Whether these findings would achieve significance with a larger sample, however, remains uncertain. Also, as a single-center study involving patients from a combined medical-surgical ICU, it remains to be determined whether these findings would be generalizable to other units with different patient populations.

Conclusions

These preliminary findings suggest that it is difficult to predict outcomes of individuals undergoing tracheostomy in the ICU setting. Patients with greater weights or a history of sepsis or underlying neurologic disease may be at higher risk of poor outcomes, whether defined by death or the need for ICU readmission. Larger and/or prospective studies would be useful to further confirm these findings.

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