One-Year Outcomes Following Tracheostomy for Acute Respiratory Failure

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Abstract

Objectives—Tracheostomy utilization has dramatically increased recently. Large gaps exist between expected and actual outcomes resulting in significant decisional conflict and regret. We determined 1-year patient outcomes and healthcare utilization following tracheostomy to aid in decision-making and resource allocation.

Design—Retrospective cohort study.

Setting—All California hospital discharges from 2012 to 2013 with follow-up through 2014.

Patients—Nonsurgical patients who received a tracheostomy for acute respiratory failure.

Interventions—None.

Measurements and Main Results—Our primary outcome was 30-day, 90-day, and 1-year mortality. We also determined hospitals readmissions rates and healthcare utilization in the first year following tracheostomy. We identified 8,343 tracheostomies during the study period. One-year mortality following tracheostomy was high, 46.5%. Older adults (65 yr) had significantly higher mortality compared with younger patients (< 65 yr) (54.7% vs 36.5%; $p < 0.0001$). Median survival for older adults was 175 days (95% CI, 150–202 d) compared with greater than 1 year for

younger adults (adjusted hazard ratio, 1.25; 95% CI, 1.14–1.36). Within 1 year of tracheostomy, 60.3% of patients required hospital readmission. Older adults were more likely to be readmitted in the first year after tracheostomy compared with younger adults (66.1% vs 55.2%; adjusted hazard ratio, 1.19; 95% CI, 1.09–1.29). Total short-term acute care hospital costs (index and readmissions) in the first year after tracheostomy were high (mean, $215,369; SD, $160,874).

Conclusions—Long-term outcomes following tracheostomy are extremely poor with high mortality, morbidity, and healthcare resource utilization especially among older patients. Some subsets of younger patients may have better outcomes compared with the general tracheostomy population. Short-term acute care costs were extremely high in the first year following tracheostomy. If extended to the entire U.S. population, total short-term acute care hospital costs approach $11 billion dollars per year for tracheostomy-related to acute respiratory failure. These findings may aid families and surrogates in the decision-making process.

Keywords

health services; hospital readmission; mechanical ventilation; mortality; respiratory failure; tracheostomy

More than 100,000 adults receive a tracheostomy in the United States each year, and more than half are performed to facilitate prolonged mechanical ventilation (MV) for acute respiratory failure (1, 2). These patients account for a disproportionate amount of the $263 billion spent annually on critical illness (3, 4). Utilization of MV and tracheostomy among both surgical and nonsurgical patients has risen dramatically in the United States in the past 2 decades with the growth of tracheostomy outpacing that of MV (2, 5). Simultaneously, there has been a trend toward earlier tracheostomies, shorter hospital length of stay, decreasing in-hospital mortality, and an increase in discharges to long-term care facilities as opposed to home (2). Some have questioned whether these hospital-based changes in outcomes have actually translated into improvements in long-term outcomes or if mortality and high healthcare utilization have been shifted to into settings other than short-term acute care hospitals without meaningful changes in actual patient outcomes (6).

Prognostication of long-term outcomes following tracheostomy is an important part of the decision-making process for patients and families. However, current tools to support decision-making have limitations. The ProVENT score can predict mortality at 14 days and 21 days of MV but the majority of tracheostomies occur well before these time points, making the score less informative for tracheostomy-related decisions (7–10). A decision-aid for prolonged MV (not tracheostomy) also based its outcome predictions on a small sample of patients. Finally, the majority of investigations into tracheostomy outcomes focus on mortality, but many patients view multiple states (such as being attached to machines or living in a hospital) as "worse than death" (11). Unfortunately, the lack of information with which to guide patients contributes to patients and families feeling significant decisional conflict and regret, an overly optimistic view of potential outcomes, and sense of poor communication from the care team (12–15).

We conducted an epidemiologic study to investigate 1-year outcomes including mortality, hospital readmission, days in a short-term acute care hospital, and total costs of short-term acute care hospitalization using a population-level database.

MATERIALS AND METHODS

See Online Supplemental Methods (Supplemental Digital Content 1, http://links.lww.com/CCM/E857) for full details.

We conducted a retrospective cohort study using the California Office of Statewide Health Planning and Developing Patient Discharge Database with linkage to the State's Vital Statistics File (PDD-VSF) (16, 17). The PDD-VSF is an administrative discharge database with 100% of discharge records from nonfederal hospitals within California that allows for longitudinal analyses with linkage to state death data. It is one of the largest and most diverse population-level databases capable of longitudinal tracking patients of all ages. We analyzed hospital discharges between January 1, 2012, and December 31, 2013, with follow-up of readmissions through December 31, 2014. The PDD-VSF typically has a 3- to 4-year delay in release after data are collected, and 2013 is the last year for which linked death information is available.

Patients

In line with previous studies, we identified adult patients (18 yr) who received MV with *International Classification of Diseases*, 9th Edition, Clinical Modification billing codes 96.7x and tracheostomy with codes 31.x and 32.x (5, 18). We excluded all patients with a major therapeutic operating room procedure other than tracheostomy (surgical patients) at any time during the hospitalization, as defined by the Healthcare Cost and Utilization Project's procedure classification system (19). We excluded individuals with tracheostomy related to head and neck disease (diagnosis-related group 011, 012, and 013) and non-California residents (Fig. 1).

Outcomes

The primary outcome was 1-year mortality after the day of tracheostomy. We also determined mortality at hospital discharge, 30 days, and 90 days after tracheostomy. Secondary outcomes included discharge destination for hospital survivors, all-cause readmissions for survivors following hospital discharge, and healthcare utilization following tracheostomy. We stratified our analyses by age (< 65 yr and 65 yr).

Healthcare utilization was assessed with days in a short-term acute care hospital and total hospital costs. Given the competing risks of cumulative hospital days and death, we measured short-term acute care hospital utilization in several ways: 1) days in a short-term acute care hospital, 2) percent of days alive in a short-term acute care hospital in the first year following tracheostomy, and 3) percent of patients who spent 50% or more of their days alive in a short-term acute care hospital.

We also assessed healthcare utilization in terms of costs associated with short-term acute care hospitalization in the first year after tracheostomy including the index hospitalization

and all readmissions (20). Cost data on postacute care (e.g., long-term facilities, nursing facilities, outpatient care) were not available. We excluded patients with hospitalizations with missing cost data (11.6%) from the financial analysis.

Statistical Analysis

Continuous and categorical variables are reported as means, medians, SDs, interquartile ranges (IQRs), and percentages as appropriate. We report patient demographics, comorbidities, severity of illness at admission, and acute illnesses for patients with tracheostomy with patients who received MV but did not have a tracheostomy as a reference point to describe tracheostomy utilization. We used Student t test, Wilcoxon rank-sum test, and chi-square test for univariate comparisons as appropriate. We report the outcomes for all patients with tracheostomy and also stratified by age (65 vs > 65 yr). We used multivariable generalized estimating equations with a compound symmetry covariance structure to account for correlation within hospitals to identify factors associated with 1-year outcomes (21, 22). We generated Kaplan-Meier curves for survival and hospital readmission (censoring for death). We compared survival curves by age category with the log-rank test and used multivariable Cox proportional hazard models to compare age groups. Multivariable models were adjusted for patient demographics, comorbidities, acute organ failures at admission, and causes of respiratory failure for nonsurgical patients (Tables E1 and E2, Supplemental Digital Content 1, http://links.lww.com/CCM/E857) (23–25).

Exploratory Analyses

It is unknown if there is a survival benefit for extremely old adults (85 yr). As such, we stratified age into three categories (< 65, 65–85, and 85 yr old) as outcomes may differ for the extremely old.

Additionally, our previous work has demonstrated different outcomes and temporal trends based on patient type (e.g., surgical vs nonsurgical patients) (2, 7). Therefore, we conducted an exploratory analysis in which we considered the broader population of patients who received a tracheostomy only excluding patients with a tracheostomy for head and neck disease and not all surgical patients. We evaluated 1-year mortality, readmissions, and resource utilization following tracheostomy for patients with a primary neurologic diagnosis (e.g., stroke, cerebral hemorrhage) (Table E3, Supplemental Digital Content 1, http://links.lww.com/CCM/E857), surgical patients, and nonneurologic nonsurgical patients (i.e., medical patients). We used similar methods to our primary analysis with comparisons by age group (< 65 vs 65 yr).

The study was approved by the California Committee for the Protection of Human Subjects and deemed exempt by the National Jewish Health Institutional Review Board. All statistical analyses were two-tailed with α equals to 0.05 and used SAS v9.4 (SAS Institute, Cary, NC).

RESULTS

Patients

During the study period, we identified 133,765 cases of nonsurgical MV of which 8,343 resulted in tracheostomy. Patient characteristics are presented in Table 1. Patients who received a tracheostomy tended to be slightly older with more chronic comorbidities than individuals who did not receive a tracheostomy. Patients who required MV but did not have a tracheostomy performed were more acutely ill. Table 2 presents differences in patients who receive a tracheostomy by age category (65 vs < 65 yr). Overall, patients greater than or equal to 65 years were more chronically ill. Differences in rates of acute organ failures and acute illness such as pneumonia and sepsis were also present but to a smaller magnitude.

Mortality

In-hospital mortality for patients with tracheostomy was 18.9% (95% CI, 18.1–19.8). Thirty-day mortality after tracheostomy was 22.1% (95% CI, 21.2–23.0%), increasing to 42.8% (95% CI, 41.7–43.8%) at 6 months and 46.5% (95% CI, 45.4–47.5%) at 1-year following tracheostomy (Table 3). Individuals greater than or equal to 65 years had significantly higher mortality than those less than 65 years at each time point with an absolute mortality difference of 18.2% (36.5% vs 54.7%; $p < 0.0001$) at 1 year (Fig. 2A). Median survival for those less than 65 years was greater than 1 year. Median survival for those greater than or equal to 65 years was 175 days (95% CI, 150–202 d), significantly lower than individuals less than 65 years ($p < 0.0001$ for difference between age strata). Patients greater than or equal to 65 years had a 25% higher hazard of death at any time point in the first year following tracheostomy (adjusted hazard ratio [aHR], 1.25; 95% CI, 1.14– 1.36). Among patients with tracheostomy, sepsis and chronic comorbidities (e.g., heart failure, chronic renal insufficiency, and cancer) were more strongly associated with death at 1 year than severity of illness (Table E4, Supplemental Digital Content 1, http://links.lww.com/CCM/E857). Neurologic comorbidities appeared to have some protective effect over other comorbidities.

Discharge Destination

Survivors of the index hospitalization overwhelmingly required care in a long-term facility (Table 2). There were significant differences by age with 91.2% of patients greater than or equal to 65 years being discharged to a long-term facility compared with 80.0% of patients less than 65 years ($p < 0.0001$).

Hospitalization

Patients with tracheostomy had high likelihood of being readmitted (Table 3). Among patients who survived for 30 days after hospital discharge, 40.2% (95% CI, 38.9–414.4) required readmission within 30 days. One year after discharge, 60.3% (95% CI, 58.8–61.7%) of survivors required readmission. Patients greater than or equal to 65 years had significantly higher 1-year readmission rates (66.1% vs 55.2%; $p < 0.0001$). Median time to readmission was 72 days (95% CI, 63–82 d). However, adults greater than or equal to 65 years had significantly shorter median time to readmission compared with adults less than

65 years (35 d [95% CI, 29–40 d] vs 154 d [95% CI, 132–181 d]; $p < 0.0001$) (Fig. 2B). After adjusting for patient and disease characteristics, adults greater than or equal to 65 years had a 19% increased risk of readmission during the first year following tracheostomy (aHR, 1.19; 95% CI, 1.09–1.29).

The majority of patients who survived the first month following tracheostomy spent almost the entire month in a short-term acute care hospital (Table 3) and adults greater than or equal to 65 years spent more days in the hospital compared with adults less than 65 years. There was little increase in short-term acute care hospital days for individuals who survived the entire first year following tracheostomy. However, the variation between survivors broadened during this time. At 30 and 90 days, patients greater than or equal to 65 years spent more time in a short-term acute care hospital. At 1 year, there was a trend toward more hospital days for adults greater than or equal to 65 years (median, 32 d; IQR, 14–57) compared with adults less than 65 years (median, 29 d; IQR, 15–52) ($p = 0.10$). One out of five adults less than 65 years and 23.5% of adults greater than or equal to 65 years spent more than 60 days in a short-term acute care hospital setting ($p = 0.006$). More than one-third of patients spent greater than 50% of days alive in a short-term acute care hospital with higher rates for patients greater than or equal to 65 years (28.7% vs 42.5%; $p < 0.0001$) (Table 2 and Table E5, Supplemental Digital Content 1, http://links.lww.com/CCM/E857).

We summed hospital costs across all short-term acute care hospitalizations in the first year following tracheostomy. Mean total hospital costs for individuals who survived the first year were $215,369 (SD, $160,874). There was no significant difference in mean costs between age groups (Table 2). For all patients (including those who died) mean total hospital costs in the first year was $204,306 (SD, $154,442) with slightly lower costs for adults greater than or equal to 65 years (Table E5, Supplemental Digital Content 1, http://links.lww.com/CCM/E857).

Sensitivity Analyses

Extremely old patients (85 yr) experienced worse outcomes than younger patients (65–85 and   65 yr) without evidence of a survivor benefit (Tables E6 and E7 and Fig. E2, Supplemental Digital Content 1, http://links.lww.com/CCM/E857). Additionally, we conducted an exploratory analysis including all patients with tracheostomy except those who had a tracheostomy for head and neck disease. Medical patients were older and sicker when compared with neurologic and surgical patients (Table E8, Supplemental Digital Content 1, http://links.lww.com/CCM/E857). One-year outcomes were poor for all patients but worse for medical patients compared with neurologic and surgical patients (Table E9 and Figs. E3 and E4, Supplemental Digital Content 1, http://links.lww.com/CCM/E857). Age differences persisted across all groups with much worse survival and higher risk of readmission for adults greater than or equal to 65 years (Tables E10–E12 and Figs. E5 and E6, Supplemental Digital Content 1, http://links.lww.com/CCM/E857).

DISCUSSION

We investigated long-term patient outcomes and healthcare resource utilization following tracheostomy for acute respiratory failure in a large population-level claims database. We

observed high 30-day, 90-day, and 1-year mortality, hospital readmission, and healthcare utilization following tracheostomy with large differences between age groups (5, 26). Our analysis is unique in that it uses more recent data than previous studies, provides time to event analyses to provide information about outcome trajectories, and goes well beyond mortality to create a picture of morbidity and healthcare utilization following tracheostomy. Our findings can play a significant role in tracheostomy decision-making.

Our mortality findings extend prior works. Engoren et al (27, 28) used data from 429 patients from a single center from 1998 to 2000 to identify a 36% 1-year mortality following tracheostomy. Cox et al (14) and Unroe et al (29) studied 126 patients with a tracheostomy hospitalized in 2008 and observed a 44% 1-year mortality rate. Cox et al (30, 31) also developed a decision-aid for prolonged MV based on the outcomes data from his earlier study. However, these studies were based on a small sample of patients and did not provide significant details about outcome trajectories. The ProVENT studies created a scoring system to predict 1-year mortality at 14 days and 21 days of MV. However, they are unable to inform tracheostomy decision-making as the majority of tracheostomies happen well before day 14 (8–10).

To our knowledge, our findings represent the first description of long-term tracheostomy outcomes using a large population-level database. The overall 1-year mortality we observed was slightly higher than that which has been previously reported. Our previous work showed that in-hospital tracheostomy mortality has dramatically decreased in the last 20 years (2). Given trends toward earlier tracheostomies, shorter hospital length of stay, and increases in discharges to long-term care facilities versus home, our findings indicate that long-term mortality has not really changed over time but rather that the location of death has been shifted to the postacute care locations. Not surprisingly, older adults had a 50% much higher mortality compared with younger adults.

We also provide a broader understanding of survival with time to event analyses than has not previously been described. Younger patients had a median survival of greater than 1 year suggesting that a subgroup of younger patients may do well following tracheostomy. However, half of older adults died within 6 months of tracheostomy. In the context of other chronic conditions, our findings suggest that older adults who receive a tracheostomy have worse survival than patients with advanced lung and pancreatic cancer (32). However, for both age groups, mortality essentially plateaued 6 months after tracheostomy. Further studies investigating the events related to mortality in the first 6 months after tracheostomy may provide insight toward reducing tracheostomy related mortality.

The exploratory analyses suggest that poor outcomes persist across additional age categorizations and patient subtypes. No survivor benefit was observed for individuals greater than or equal to 85 years. Individuals greater than or equal to 85 years suffered worse outcomes compared with younger patients. Furthermore, when we included all tracheostomy patients but categorized them as neurologic, surgical, or medical, we observed similarly poor outcomes especially for adults greater than or equal to 65 years. Although neurologic and surgical patients had slightly better outcomes compared with medical patients, the differences were relatively small especially when subcategorized by age. Age alone may

have a larger impact on outcomes compared with the whether the patient's primary issue was neurologic, surgical, or medical.

As outcomes other than mortality are equally important to many patients and families, we investigated healthcare utilization and costs following tracheostomy (11). A large percentage of patients required readmission following tracheostomy with older adults having a much shorter time out of hospital. The competing risks between long-term healthcare utilization (e.g., days in hospital, costs) and death necessitated multiple different views of time spent in the hospital following tracheostomy. In terms of days in the hospital, most patients spent around 1 month in the hospital, although there was wide variation. However, this number likely underrepresents the true burden of hospitalization as individuals who died spent more time in the hospital but were not included in the calculation given the competing risks between death and hospital days. We did observe that a high percentage of patients spent more than 50% of their days alive in a short-term acute care setting. These multiple measures highlight the many issues looking at long-term outcomes for conditions with high mortality. When dealing with individual patients/families, it is important to translate this information into terms that they need and understand. We are unaware of previous population-level descriptions of healthcare utilization following tracheostomy.

We also describe total short-term acute care hospitalization costs in the first year following tracheostomy. Costs approached one-quarter of a million dollars regardless of survivor status. Interestingly costs did not differ significantly by age for individuals who survived the first year. However, when all patients (included those who died) were included in the cost analysis, older patients had a slightly lower total cost likely because of higher mortality. With half of tracheostomies being performed for nonsurgical patients, our findings suggest that annualized national short-term acute care costs for tracheostomy approach $11 billion dollars (2). This estimate does not include postacute care (e.g., long-term care/nursing facilities, outpatient care), lost productivity, or costs incurred by family members. These findings have significant societal implications especially given an aging population for whom postacute care utilization is higher.

We stratified our analyses by age based on preliminary qualitative data on how tracheostomy decisions are made and the strong association between age and poor outcomes for other critical care conditions (26, 33–35). As anticipated, we found far worse outcomes for older adults. However, when investigating factors associated with 1-year mortality, we observed several baseline comorbidities and causes of respiratory failure that were as strongly associated with 1-year mortality as age. Similarly, when investigating healthcare utilization, we found multiple subgroups of patients with different utilization profiles even within age groups. Some patients only spent 1 month in a short-term acute care hospital while others spent a large percentage of days alive hospitalized. These findings highlight the potential of studies utilizing deep-learning algorithms to determine combinations of age groups, comorbidities, and acute illness that can predict different outcome trajectories. A broader understanding of different patient trajectories following tracheostomy may help families with complex decision-making.

Taken together, these findings have the potential to greatly affect the decision-making process. Older patients tend to do far worse compared with younger patients. However, patients with primary neurologic comorbidities may have better outcomes compared with individuals with cancer or cardiovascular disease. Although preliminary, these findings may help families find value-concordant decisions or have less decisional conflict given a broader understanding of potential outcomes.

Our study has several important limitations. The use of California state data may limit the generalizability of our conclusions. However, the PDD-VSF provides one of the largest and most diverse population-based datasets inclusive of all ages and payers with longitudinal tracking and linkage to state death data. Additionally, nationally representative databases that have information about long-term outcomes such as Medicare databases would ignore the large percentage of tracheostomies performed for younger patients. We speculate that outcomes in other regions of the United States may be significantly worse owing to higher rates of chronic comorbidities. Billing codes in administrative datasets used to identify tracheostomy and medical diagnoses can be subject to misclassification. Our approach was to use high fidelity codes that are well represented in the literature. Billing codes also only partially capture severity of illness. Although previous studies have shown that risk-adjustment with administrative data approaches more physiologic scores (e.g., Acute Physiology and Chronic Health Evaluation IV or Simplified Acute Physiology Score 3), we recognize the inherent limitations of using administrative for gauging severity of illness. We were also unable to determine the total financial costs associated with tracheostomy, as we did not have postacute care costs. Finally, we were unable to measure quality of life in either a qualitative or a quantitative way (e.g., quality-adjusted life years). These measures are likely of key importance to decision-makers and should be included in future prospective studies. Despite these limitations, this study provides novel and in-depth insight into mortality and healthcare utilization following tracheostomy not previously described at the population-level.

CONCLUSIONS

Our findings of high mortality, low median survival for older patients, high readmission rates, potentially burdensome cost, and informative outcome trajectories provide significant insight into long-term outcomes following tracheostomy. Outcomes for older adults remain poor but certain subsets of younger patients and patients with few comorbidities may have better survival and lower risk of readmission. As comorbidities play a crucial role in long-term outcomes, future studies should attempt to identify different patient trajectories based on a combination of age and comorbidities. A key part of this discontent has been the lack of robust outcomes data to ground expectations. Our results provide some highly informative data to improve the decision-making process, providing families with a greater sense of what to expect following tracheostomy, a major current limitation (14, 30). Additionally, our findings highlight the significant impact on healthcare utilization and cost associated with prolonged MV. Future studies are needed to investigate long-term outcomes of other more granular patient-centered outcomes and how this information can be used to improve decision-making.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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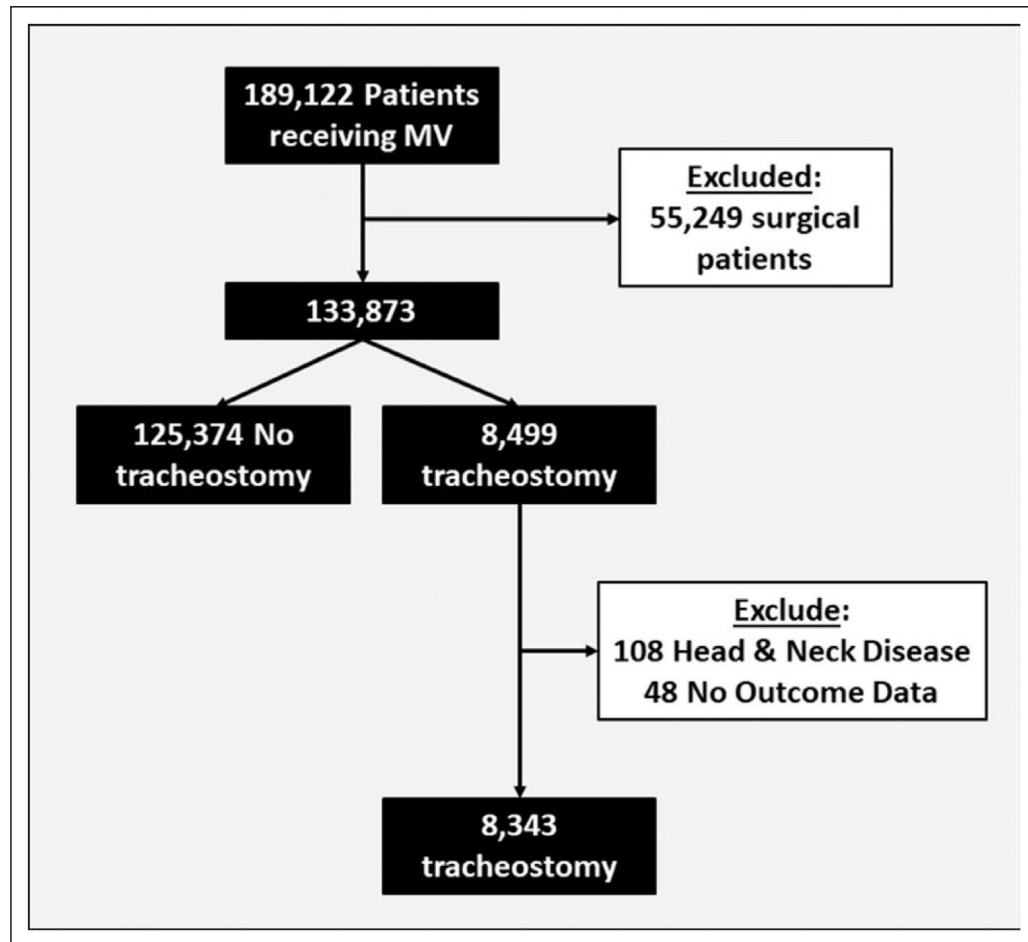
Figure 1.
Study design: we identified 189,122 patients who received mechanical ventilation (MV) during the study period. After excluding patients with a major therapeutic surgical procedure other than tracheostomy, patients with head and neck disease, and patients who did not have outcome data, we identified 8,343 patients who received tracheostomy during a short-term acute care hospitalization and were discharged between January 1, 2012, and December 31, 2013.
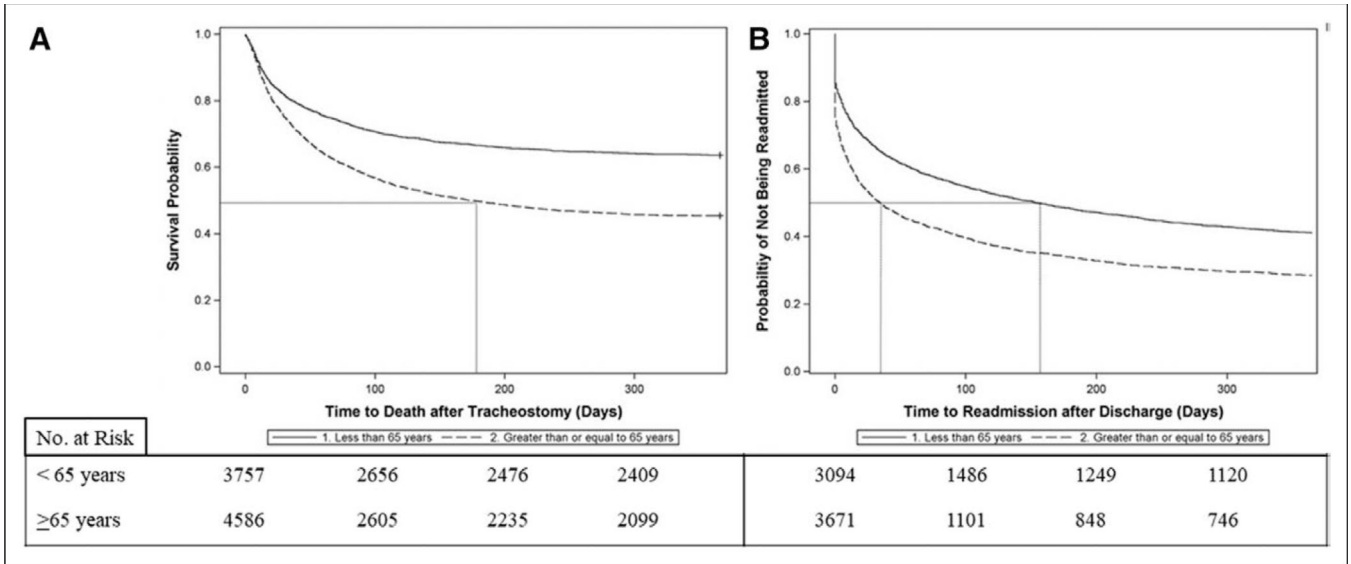
Figure 2.
Kaplan-Meier survival and readmission curves for patients with tracheostomy. **A**, Survival curves. Median survival was greater than 1 yr for patients less than 65 yr old and 175 d for patients greater than or equal to 65 yr. Older patients had higher risk of death at any time point (adjusted hazard ratio [aHR], 1.25; 95% CI, 1.14–1.36). Number at risk indicates the number of patients alive at each time point. **B**, Readmission curves. Patients were censored at the time of death (as they were no longer eligible for readmission) or at 1 yr. Median time to readmission for older patients was 35 d versus 154 d for younger patients. Older patients had a higher risk of readmission throughout the first year (aHR, 1.19; 95% CI, 1.09–1.29). Number at risk indicates the number of patients alive who have not been readmitted at each time point.

TABLE 1.

Characteristics of Patients Who Received Tracheostomy Compared to Mechanically Ventilated Patients Who Did Not Receive Tracheostomy

Variable	Tracheostomy (n = 8,391)	Mechanical Ventilation Without Tracheostomy (n = 125,374)	p
Mean age (SD), yr	65.2 (16.0)	64.8 (17.3)	< 0.03
Female (%)	45.5	46.0	0.33
Race/ethnicity (%)			< 0.0001
White	48.4	53.0	
Black	13.9	11.5	
Hispanic	22.0	21.7	
Asian	11.7	9.8	
Other	3.9	4.0	
Primary payer (%)			< 0.0001
Medicare	60.7	60.2	
Medicaid	19.8	17.0	
Private insurance	15.2	15.0	
Self-pay	1.4	3.5	
Other	2.8	4.3	
Median Elixhauser comorbidity score (IQR) [a]	14.0 (8.0–20.0)	10.0 (4.0–16.0)	< 0.0001
Early do not resuscitate order (within 24 hr of admission) (%)	5.4	12.8	< 0.0001
Organ failures present at admission (%)			
Shock	26.5	28.4	0.0002
Renal failure	31.6	32.4	0.13
Neurologic failure	26.7	24.2	< 0.0001
Hematologic failure	14.0	13.9	0.76
Hepatic failure	3.9	6.1	< 0.0001
Metabolic acidosis	15.6	18.7	< 0.0001
Common causes of respiratory failure (%) [b]			
Pneumonia	79.4	54.0	< 0.0001
Severe sepsis	56.0	42.3	< 0.0001
Acute exacerbation of chronic obstructive pulmonary disease	14.0	10.8	< 0.0001
Acute exacerbation of asthma	3.3	3.4	0.62

Variable	Tracheostomy (*n* = 8,391)	Mechanical Ventilation Without Tracheostomy (*n* = 125,374)	*p*
Acute exacerbation of heart failure	12.2	10.5	< 0.0001
Median time to tracheostomy (IQR) (d)	11.0 (7.0–16.0)	NA	NA
Early tracheostomy (%)[c]	27.9	NA	NA

IQR = interquartile range, NA = not applicable.

[a] Calculated without arrhythmia comorbidity. Higher score indicates more chronically ill.

[b] Diagnoses present during hospitalization. More than one diagnosis possible.

[c] Early tracheostomy defined as tracheostomies performed on day 7 of mechanical ventilation or before.

TABLE 2.

Characteristics of Patients Who Received Tracheostomy by Age

Variable	Age < 65 yr (*n* = 3,757)	Age ≥ 65 yr (*n* = 4,586)	*p*
Mean age (SD), yr	51.0 (11.2)	76.8 (7.9)	< 0.0001
Female (%)	42.0	48.4	< 0.0001
Race/ethnicity (%)			< 0.0001
White	47.4	49.3	
Black	16.0	12.3	
Hispanic	24.8	18.8	
Asian	8.3	14.6	
Other	3.7	4.0	
Primary payer (%)			< 0.0001
Medicare	28.2	87.3	
Medicaid	36.9	5.8	
Private insurance	26.2	6.4	
Self-pay	3.1	0.2	
Other	5.7	0.5	
Median Elixhauser comorbidity score (IQR)[a]	12.0 (5.0–18.0)	15.0 (10.0–21.0)	< 0.0001
Early do not resuscitate order (within 24 hr of admission) (%)	3.7	6.7	< 0.0001
Organ failures present at admission (%)			
Shock	24.7	28.0	0.0007
Renal failure	28.7	34.2	< 0.0001
Neurologic failure	25.9	27.1	0.22
Hematologic failure	14.5	13.7	0.28
Hepatic failure	5.6	2.5	< 0.0001
Metabolic acidosis	15.8	15.3	0.51
Common causes of respiratory failure (%)[b]			
Pneumonia	75.8	82.1	< 0.0001
Severe sepsis	51.8	59.3	< 0.0001
Acute exacerbation of chronic obstructive pulmonary disease	9.5	17.6	< 0.0001
Acute exacerbation of asthma	3.7	3.0	0.06

Variable	Age < 65 yr (*n* = 3,757)	Age 65 yr (*n* = 4,586)	*p*
Acute exacerbation of heart failure	8.5	15.1	< 0.0001
Median time to tracheostomy (IQR) (d)	11.0 (6.0–16.0)	12.0 (7.0–17.0)	< 0.0001
Early tracheostomy (%)[c]	30.8	25.2	< 0.0001

IQR = interquartile range.

[a] Calculated without arrhythmia comorbidity. Higher score indicates more chronically ill.

[b] Diagnoses present during hospitalization. More than one diagnosis possible.

[c] Early tracheostomy defined as tracheostomies performed on day 7 of mechanical ventilation or before.

TABLE 3.

Outcomes for Patients With Tracheostomy

Outcome	Overall (*n* = 8.343)	Age < 65 yr (*n* = 3,757)	Age	65 yr (*n* = 4,586)	*p*
Hospital discharge destination, *n* (%) [a]					< 0.0001
Home	758 (11.2)	545 (17.6)		213 (5.8)	
Long-term facility	5,825 (86.1)	2,476 (80.0)		3,349 (91.2)	
Other	182 (2.7)	73 (2.4)		109 (3.0)	
Mortality, *n* (%) [b]					
Hospital	1,578 (18.9)	663 (17.7)		915 (20.0)	0.008
30-d	1,846 (22.1)	695 (18.5)		1,151 (25.1)	< 0.0001
90-d	2,987 (35.8)	1,071 (28.5)		1,916 (41.8)	< 0.0001
1-yr	3,877 (46.5)	1,370 (36.5)		2,507 (54.7)	< 0.0001
All cause hospital readmission, *n* (%) [c]					
30-d	2,361 (40.2)	922 (32.6)		1,439 (47.1)	< 0.0001
90-d	2,464 (48.4)	1,070 (41.6)		1,394 (55.4)	< 0.0001
1-yr	2,648 (60.3)	1,299 (55.2)		1,349 (66.1)	< 0.0001
Median hospital days following tracheostomy for survivors (interquartile range) [d]					
Within 30 d	26 (12–30)	24 (13–30)		27 (12–30)	0.03
Within 90 d	28 (13–50)	27 (14–47)		30 (13–53)	0.006
Within 1 yr	30 (15–55)	29 (15–52)		32 (14–57)	0.11
Percent of patients that spent 50% of days alive in hospital, *n* (%)	3,015 (36.3)	1,075 (28.7)		1,940 (42.5)	< 0.0001
Total hospital costs (U.S. dollars), mean (SD) [e]	$215,369 (160,874)	$215,570 (166,124)		$215,138 (154,658)	0.93

[a] Among survivors of index hospitalization.

[b] 30-d, 90-d, and 1 yr mortality is calculated from date of tracheostomy procedure.

[c] All cause readmission rates are calculated from date of discharge for patients that survive the specified time-period (survive 30 d, 90 d, and 1 yr post discharge).

[d] Acute care hospital days were calculated among individuals who survived the specified period.

[e] Indicates total acute care hospital costs in the first year following tracheostomy for individuals who survive the first year. Costs do not include postacute care.