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Tracheostomies for respiratory failure are associated with a high inpatient mortality: a potential trigger to reconsider goals of care

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ABSTRACT

Introduction Acute care surgeons are frequently consulted for tracheostomy placement in the intensive care unit (ICU). Tracheostomy may facilitate ventilator weaning and improve physical comfort. Short-term outcomes after tracheostomy are not well studied. We hypothesize that a high proportion of ICU patients who underwent tracheostomy died prior to discharge. These data will help guide clinical decision-making at a key pivot point in care.

Methods We identified 177 mixed ICU patients who received a tracheostomy for respiratory failure between January 2013 and December 2018. We excluded patients with trauma. Patient information was collected and comparisons made with univariable and multivariable statistics.

Results Of the 177 patients who underwent a tracheostomy for respiratory failure, 45% were women, median age was 63 (51–71) years. Of this group 18% died prior to discharge, 63% were discharged to a care facility and only 16% discharged home. Compared with survivors, patients with tracheostomies who died during their admission were older, age 69 (64–76) versus 61 (49–71) years (p<0.01) on univariable analysis. In this model, no single comorbid condition or length of stay (LOS) variable was predictive of death before discharge. A multivariable model controlling for covariation similarly identified age, as well as a longer ICU LOS of 34 (20–49) versus 23 (16–31) days (p=0.003) as factors associated with increased likelihood of death before discharge.

Conclusions Tracheostomy placement in a mixed ICU population is associated with a nearly 20% inpatient mortality and the vast majority of surviving patients were discharged to a care facility. This suggests that the need for tracheostomy could be considered a trigger for re-evaluation of patient goals. The high risk of death due to underlying illness and high intensity care after their hospitalization emphasize the need for clear advanced care planning discussions around the time of tracheostomy placement.

Level of Evidence Level IV, Retrospective cohort study.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Tracheostomy for respiratory failure in critical illness is associated with a high 1-year mortality due to the underlying disease process. There is little data, however, on shorter term outcomes and disposition after tracheostomy for respiratory failure.

WHAT THIS STUDY ADDS

⇒ Primarily an understanding of all-cause post-tracheostomy inpatient mortality at a quaternary-care academic medical center. This approaches 20%, nearly all of whom died after transitioning to comfort measures only as a result of their underlying disease process. Importantly the chances of dying from the underlying critical illness during the hospital stay exceed the chances of being discharged directly home. These data can and should be incorporated into advanced care planning discussions.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ These conclusions support further research to identify specific patient factors associated with inpatient mortality and level of post-discharge care needs, and this study reinforces the importance of early and honest advanced care planning discussions prior to tracheostomy for respiratory failure in the intensive care unit setting.

BACKGROUND

Each year, over 100 000 adult patients receive tracheostomies in the USA, the majority occur in the setting of prolonged mechanical ventilation in critical illness.[1,2] Tracheostomy in the critically ill patient is considered beneficial in that it may lessen the work of breathing, improve pulmonary hygiene, and allow for lower sedation and analgesia needs shortly after placement. In concert, these factors may improve patient engagement with rehabilitation and the ability to communicate.[3,4]

The 1-year mortality rate among all patients who undergo tracheostomy placement in the intensive care unit (ICU) approaches 50%, frequently with multiple hospital readmissions in this time frame.[2,5] There is also a marked decrease in health-related quality of life and increases in distress due to impaired communication, mobility, and socialization.[6,7] Tracheostomy could be considered as a procedural marker of risk in these cases, as the underlying factor is almost certainly the primary cause of critical illness. Even in cases where tracheostomy was initially welcomed, the longer term and more negative physical, psychological, and social impacts were frequently more severe than initially expected.[7,8] It may be that the decision to proceed

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with a tracheostomy is a key, and potentially perilous, pivot point in a patient's care and an opportunity to critically re-evaluate goals and undertake thoughtful advanced care planning.

Acute care surgeons frequently perform tracheotomy for traumatically injured patients as well as those in respiratory failure in the ICU setting. Although injury patterns and clinical guidelines facilitate tracheostomy decision-making in the setting of trauma, acute care surgeons considering tracheostomy placement in critically ill patients are met with a challenging decision for which there is little guiding evidence.[3 9] To better guide acute care surgeons, patients and their surrogate decision-makers, there is a need for more information on the short-term outcomes after tracheostomy for respiratory failure.

The purpose of this project is to help fill the above-noted gap by characterizing the in-hospital outcomes after tracheostomy placement. We hypothesize that tracheostomy placement for prolonged mechanical ventilation in a mixed ICU population is associated with a high inpatient mortality and that many patients require prolonged high intensity care after hospital discharge. These data will help inform risk/benefit discussions around the decision to proceed with tracheostomy and facilitate advanced care planning in critically ill patients.

METHODS

This study is a retrospective cohort study of all critical care patients receiving tracheostomy for prolonged mechanical ventilation at the Oregon Health and Science University Hospital between January 2013 and December 2018. A search of Current Procedural Terminology and International Classification of Disease codes identified all tracheostomies performed during this 6-year period. Each electronic health record was reviewed by study personnel to determine inclusion in the study. Patients were excluded if prior documentation of tracheostomy planning existed, or if a tracheostomy was placed in the setting of traumatic injury. Pediatric patients (<18 years) were also excluded. For all patients meeting inclusion criteria, electronic health record data were collected and maintained in a secure REDCap electronic database. Data regarding technique of tracheostomy (ie, open vs percutaneous) were not recorded, as the authors assume decisions around technique were made to provide maximum benefit.

Recorded variables include basic demographic data, admission information (length of stay (LOS), ICU LOS, timing of tracheostomy), comorbidities, primary diagnoses, specialties of treating teams and discharge disposition. Additionally, palliative measures were recorded. The presence of a formal palliative care consult was noted, and each patient chart was reviewed to determine if the patient was transitioned to comfort care prior to discharge.

The primary outcome was discharge disposition, which was categorized as inpatient mortality, discharge to skilled nursing facility (SNF), discharge to a long-term acute care hospital (LTAC), or discharge to home. Patient data was then dichotomized and compared by discharge disposition: survival to time of discharge (ie, discharge to SNF, LTAC, or home), or death prior to discharge. Baseline demographics, LOS parameters, primary diagnoses, and comorbidities were compared between groups. Among those who survived to time of discharge, further categorization and comparison was performed between patients who were discharged home and those who were discharged to a healthcare facility. Finally, the electronic health records of all patients surviving until discharge were searched for documentation of death within 30 days of tracheostomy placement; this patient group was combined with the inpatient mortality cohort and compared with patients surviving 30+ days after tracheostomy.

Descriptive statistics are reported for all patients, and by discharge group. Because most continuous variables were skewed, all are presented and compared as medians with IQR. All categorical variables are presented as frequencies and percentages. For all univariable comparisons made between discharge groups, Wilcoxon rank-sum tests were used to compare median values for continuous variables and χ^2 tests were used to compare frequency and percentages for categorical variables.

A multivariable logistic regression model was used to identify variables independently associated with inpatient mortality among all patients, and to assess for characteristics associated with home discharge among patients surviving until discharge. Variables for this model were selected to include clinically useful and readily available data (ie, data available at time of tracheostomy decision) whereas restricting highly collinear variables as to not confound analysis (eg, "total LOS prior to trach" and

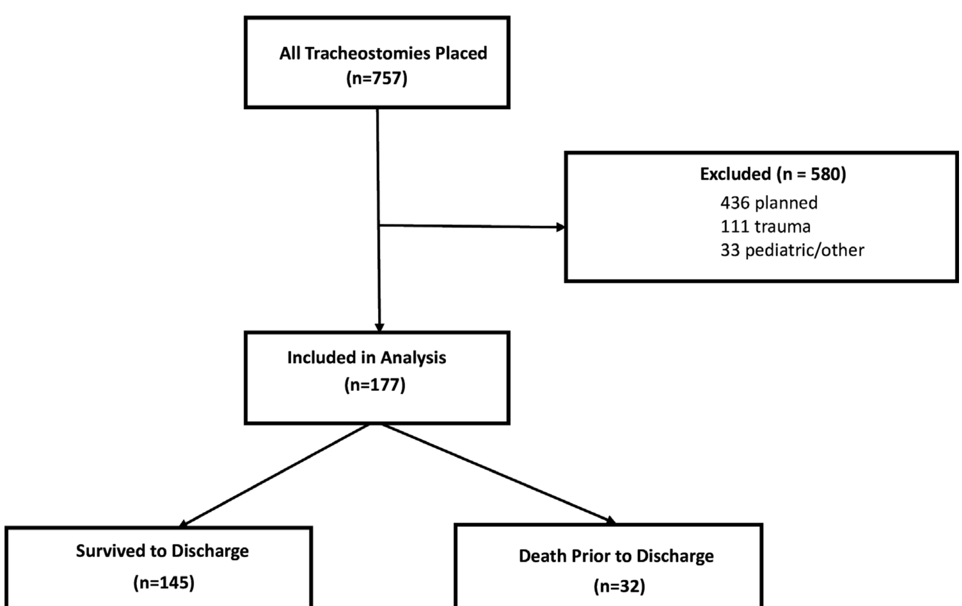

Figure 1 Flow diagram of tracheostomy patients included in analysis.

Table 1 Baseline demographic, admission, and discharge data by survival versus death prior to discharge groups

Characteristic	All patients (N=177)	Survived to discharge (N=145)	Died prior to discharge (N=32)	P value
Patient characteristics				
Age	63.0 (51.0–71.0)	61.0 (49.0–71.0)	69.0 (63.8–76.2)	0.003
% female	78 (44.1)	64 (44.1)	14 (43.8)	0.968
BMI	27.7 (23.9–33.4)	27.7 (23.9–33.9)	27.2 (24.0–32.4)	0.515
Team placing trach				
EGS	95 (53.7%)	79 (54.5%)	16 (50.0%)	0.646
ENT	73 (41.2%)	62 (42.8%)	11 (34.4%)	0.385
Comorbidities				
Comorbid HTN	116 (65.5%)	95 (65.5%)	21 (65.6%)	0.991
Comorbid CAD	47 (26.6%)	32 (22.1%)	15 (46.9%)	0.005
Comorbid COPD	31 (17.5%)	23 (15.9%)	8 (25.0%)	0.223
Comorbid DM	37 (20.9%)	35 (24.1%)	2 (6.2%)	0.039
Comorbid CKD	5 (2.8%)	5 (3.4%)	0 (0%)	0.989
None of above	38 (21.5%)	35 (24.1%)	3 (9.4%)	0.078
Primary diagnosis				
Neuromuscular Dz	15 (8.5%)	15 (10.3%)	0 (0%)	0.987
Stroke/CVA	48 (27.1%)	43 (29.7%)	5 (15.6%)	0.113
Respiratory failure	58 (32.8%)	44 (30.3%)	14 (43.8%)	0.147
LOS variables				
Total hospital LOS	32.8 (23.1–50.2)	30.3 (21.5–50.0)	36.4 (29.5–50.7)	0.783
LOS prior to trach	15.2 (10.3–20.6)	14.7 (9.9–19.9)	17.7 (14.6–21.6)	0.179
Total ICU LOS	23.9 (16.4–34.8)	23.1 (15.9–31.4)	33.6 (19.9–49.0)	0.061
Discharge disposition				
Home	28 (15.9%)	28 (19.3%)	–	–
SNF	31 (17.6%)	31 (21.4%)	–	–
LTAC	80 (45.5%)	80 (55.2%)	–	–
Death (inpatient)	32 (18.2%)	–	32 (100%)	–
Other healthcare facility	6 (2.8%)	6 (3.4%)	–	–
Palliative measures				
Palliative care consult	81 (45.8%)	58 (40.0%)	23 (71.9%)	0.001
Comfort care only	32 (18.1%)	2 (1.4%)	30 (93.8%)	0.002

Data reported as median (IQR) or count (per cent). Wilcoxon rank-sum tests were used to compare median values. X^2 tests were used to compare count/per cent data.
BMI, body mass index; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; DM, diabetes mellitus; Dz, Disease; Dz, Disease; EGS, emergency general surgery; ENT, otolaryngology; HTN, hypertension; ICU, intensive care unit; LOS, length of stay; LTAC, long-term acute care hospital; SNF, skilled nursing facility; trach, tracheostomy .

"ICU LOS prior to trach" were not included in the same model). The unit of change for all included LOS variables was 1 day; when considering patient age, the unit of change was 1 year. Logarithmic odds were converted to ORs for readability and presented in table form.

RESULTS

We identified 757 patients who received a tracheostomy during our study period. Of these patients, 436 were excluded as tracheostomy was placed as a planned procedure (almost exclusively in the context of head and neck malignancy). An additional 111 patients with trauma were excluded, as were 33 pediatric patients (figure1). All remaining 177 patients were included in analysis, 44.1% were women, with a median age of 63 years. Patients were most often admitted to neurosurgery/neurology services (38%), followed by general surgery (20%) and medicine/medical ICU (20%). Principle diagnoses were most often primary respiratory failure/adult respiratory distress syndrome (33%), followed by stroke/cerebrovascular accident (CVA) (27%), and neuromuscular disease (9%). For 56 patients (32%), no standalone primary indication for tracheostomy was identifiable on review of health records (ie, tracheostomy indication was multifactorial and eluded categorization), as groups were intentionally restrictive to ensure proper categorization, as further discussed in limitations. The emergency general surgery service placed 95 (54%) tracheostomies, whereas the otolaryngology service placed 73 (41%) tracheostomies. The remaining nine tracheostomies were placed either by cardiothoracic surgery or primary ICU services. During review of records, no significant complications or technical mistakes directly associated with tracheostomy were noted. To evaluate the potential for overfitting of the multivariable models, a McFadden's R^2 value was calculated for each. This is a likelihood-based pseudo-R^2 for logistic regression similar to the R^2 used in ordinary least squares or linear regression. Each multivariable model presented here had a pseudo-R^2 value below 0.4, consistent with good fit, suggesting that overfitting of these models is unlikely.

Of all 177 patients, 32 (18.1%) died prior to discharge from any cause, regardless of comfort care status or any other clinical factor. 80 (45.5%) patients were discharged to LTAC, 31 patients (17.6%) to an SNF, and 28 patients (15.9%) discharged home. 6 patients were discharged to healthcare facilities (other than home) that were not listed above.

Among the cohort presented here, 81 of 177 (45.8%) had an official palliative care consult note during their admission. 32 of 177 (18.1%) of patients transitioned to comfort measures only, including 30 of 32 (93.8%) who died prior to discharge. These measures of palliative care involvement are not included in statistical models below, as they are not readily available at time of decision-making and are directly related to outcomes of mortality and discharge disposition.

Compared with patients surviving until discharge, those who died in the inpatient setting were older, median age 69 (64–76) versus 61 (49–71) years ($p<0.01$) on Wilcoxon rank-sum analysis. There were no significant associations between any principal diagnoses and inpatient mortality risk, nor where there any LOS parameters associated with inpatient mortality on univariable analysis (table 1).

On multivariable analysis, increased age (OR 1.04; 95% CI 1.00 to 1.08) and longer ICU LOS (OR 1.12; 95% CI 1.05 to 1.22) were both independently associated with inpatient mortality. Conversely, total hospital LOS was negatively associated with mortality (OR 0.90; 95% CI 0.83 to 0.97) (table 2).

Among the 145 patients surviving to discharge, 117 (80.7%) went to a care facility (SNF, LTAC, or other), and the remaining 28 patients (19.3%) discharged home. Median age was not significantly different between those patients discharged home and those discharged to a care facility (p=0.06). There were no significant differences in the LOS parameters between groups, although median total hospital stay was higher among patients discharged home (38.2 days, IQR 24.8–56.8) compared with those discharging to care facility (29.4 days, 21.2–45.0) (table 3).

Of the 145 patients who survived until discharge, 9 had documented evidence of out-of-hospital mortality within 30 days of tracheostomy placement. This subgroup was combined with the 32 patients who died prior to discharge and compared with the 136 patients in the survival group. This health record-based search method may underestimate total 30-day mortality when compared with a more exhaustive method (eg, search of the Centers for Disease Control and Prevention's National Death Index), as discussed further in the limitations section.

In concordance with inpatient mortality analysis presented in table 2, greater age and longer total ICU LOS were associated

Table 2 Univariable and multivariable analyses for characteristics associated with death prior to discharge

	Univariable model		Adjusted multivariable model	
Characteristic	**OR**	**95% CI**	**OR**	**95% CI**
Age	**1.05**	**1.02 to 1.08**	**1.04**	**1.00 to 1.08**
Sex (male)	1.02	0.47 to 2.23	0.92	0.34 to 2.48
BMI	0.99	0.94 to 1.02	1.00	0.95 to 1.05
Total hospital LOS	1.00	0.98 to 1.01	**0.90**	**0.83 to 0.97**
LOS prior to trach	1.03	0.99 to 1.07	1.05	0.97 to 1.13
Total ICU LOS	1.02	1.00 to 1.04	**1.12**	**1.05 to 1.22**
ICU LOS prior to trach	1.03	0.98 to 1.08	–	–
Comorbid HTN	1.00	0.46 to 2.32	0.67	0.18 to 2.50
Comorbid CAD	**3.12**	**1.40 to 6.95**	1.69	0.57 to 5.03
Comorbid COPD	1.77	0.68 to 4.30	–	–
Comorbid DM	**0.21**	**0.03 to 0.74**	0.22	0.03 to 0.94
None of above	0.33	0.07 to 0.99	0.44	0.07 to 2.38
Stroke/CVA	0.44	0.14 to 1.13	0.32	0.07 to 1.33
Respiratory failure	1.79	0.81 to 3.90	0.98	0.34 to 2.87

Note: Univariable model displays ORs without controlling for any covariates. Values in the adjusted multivariable model reflect ORs controlling for each of listed variables for which an OR is calculated. Bolded values are statistically significant (p<0.05). Comorbid CKD and primary diagnosis of neuromuscular disease were excluded as n=0 for the inpatient mortality group.
BMI, body mass index; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; DM, diabetes mellitus; HTN, hypertension; ICU, intensive care unit; LOS, length of stay; trach, tracheostomy.

with 30-day mortality risk (table 4). Differing from analysis of death prior to discharge (table 2), when considering out-of-hospital deaths within 30 days, a longer hospital LOS prior to tracheostomy was positively associated with mortality, and a primary diagnosis of stroke/CVA was negatively associated with 30-day mortality.

DISCUSSION

In a group of critically ill adults receiving a tracheostomy for respiratory failure during a 6-year period at a single academic medical center, we found a nearly 20% risk of inpatient mortality and, among survivors, a greater than 80% chance of being discharged directly to another healthcare facility. The cause of death in the majority of patients is an intentional decision to transition to comfort measures only, presumably related to an assessment of the underlying disease process rather than the technical details of the tracheostomy procedure itself. Although a relatively straightforward technical undertaking, the decision to proceed with a tracheostomy could be considered a key, and potentially perilous, moment in the clinical course that should be a point to stop and reconsider a patient's care goals and undertake detailed, formal advanced care planning. The high acuity and clinical breadth of patients included in this study is useful to contextualize bedside clinical decision-making, particularly given that clinical guidelines for tracheostomy placement in critical illness remain poorly defined.[5,10]

Our data are broadly consistent with Pandian *et al* who demonstrated a 19% mortality within 30 days of a percutaneous dilatational tracheostomy (PDT).[11] In addition to replicating this single center study, we extend their findings by focusing specifically on the outcomes after tracheostomy in the non-trauma population, not restricting our inclusion criteria to PDT and including patient-centric data on discharge disposition. There currently exists a trend toward earlier tracheostomy placement and this decision may be associated with a shortened hospital stay and decreased in-hospital mortality.[1,2,12] Although these data seem to provide reason for optimism, it is important to note that no associated decrease in 1-year mortality has been shown and utilization of post-hospital care facilities has increased.[7,12]

Post-tracheostomy mortality

In our study, all-cause inpatient mortality was 18.1%, with total ICU LOS and greater patient age shown to be the variables most strongly associated with mortality. All-cause mortality was specifically chosen for this study because it is highly likely that death after tracheostomy is due to the underlying medical condition rather than any sequelae of the operation. Our reported inpatient mortality rate of 18.1% may be higher than expected in a more broad mixed-ICU cohort, as this cohort was specifically enriched in patients who had prolonged respiratory failure whose clinical courses were likely more complex than average.

Although the positive association between mortality and greater patient age is neither a particularly novel nor clinically surprising finding, it bears consideration as practice patterns regarding tracheostomy continue to evolve. The median age of patients in our study is 4 years greater than in a national cross-section published 6 years ago.[1] It is unclear whether there are distinct factors surrounding tracheostomy at a quaternary care center such as ours that may explain this relatively greater patient age or if this finding is reflective of changing patient selection.

Table 3 Baseline demographic and admission data for all patients surviving to discharge by home versus other discharge location groups

Characteristic	Survived to discharge (N=145)	Discharge home (N=28)	Other discharge location (N=117)	P value
Patient characteristics				
Age	61.0 (49.0–71.0)	59.0 (35.8–65.8)	63.0 (50.0–71.0)	0.06
% female	64 (44.1)	13 (46.4)	51 (43.6)	0.786
BMI	27.7 (23.9–33.9)	26.3 (23.9–32.4)	28.1 (24.2–34.4)	0.342
Team placing trach				
EGS	79 (54.5%)	10 (35.7%)	69 (59.0%)	0.03
ENT	62 (42.8%)	17 (60.7%)	45 (38.5%)	0.036
Comorbidities				
Comorbid HTN	95 (65.5%)	16 (57.1%)	79 (67.5%)	0.301
Comorbid CAD	32 (22.1%)	4 (14.3%)	28 (23.9%)	0.275
Comorbid COPD	23 (15.9%)	5 (17.9%)	18 (15.4%)	0.748
Comorbid DM	35 (24.1%)	7 (25.0%)	28 (23.9%)	0.906
None of above	35 (24.1%)	7 (25.0%)	28 (23.9%)	0.906
Primary diagnosis				
Neuromuscular Dz	15 (10.3%)	4 (14.3%)	11 (9.4%)	0.449
Stroke/CVA	43 (29.7%)	2 (7.1%)	41 (35.0%)	0.01
Respiratory failure	44 (30.3%)	9 (32.1%)	35 (29.9%)	0.818
LOS variables				
Total hospital LOS	30.3 (21.5–50.0)	38.2 (24.8–56.8)	29.4 (21.2–45.0)	0.119
LOS prior to trach	14.7 (9.9–19.9)	14.4 (8.4–19.8)	14.8 (9.9–20.5)	0.921
Total ICU LOS	23.1 (15.9–31.4)	23.6 (10.9–37.7)	23.1 (16.4–31.0)	0.608
ICU LOS prior to trach	13.3 (8.8–18.3)	12.5 (7.8–19.4)	13.6 (9.2–18.1)	0.954
Palliative measures				
Palliative care consult	58 (40.0%)	12 (42.9%)	46 (39.3%)	0.731
Comfort care only	2 (1.4%)	1 (3.6%)	1 (0.9%)	0.308

Data reported as median (IQR) or count (per cent). Wilcoxon rank-sum tests were used to compare median values. X^2 tests were used to compare count/per cent data.
The only characteristic that was independently associated with discharge location on both univariable and multivariable analysis was a primary diagnosis of stroke/cerebrovascular accident (OR 0.09, 95% CI 0.01 to 0.44), meaning among these patients, discharge to a care facility was significantly more likely than discharge home (table 4).
BMI, body mass index; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; DM, diabetes mellitus; EGS, emergency general surgery; ENT, otolaryngology; HTN, hypertension; ICU, intensive care unit; LOS, length of stay; trach, tracheostomy.

Table 4 Univariable and multivariable analyses of characteristics associated with discharge home for all patients surviving to discharge

	Univariable model		Adjusted multivariable model	
Characteristic	OR	95% CI	OR	95% CI
Age	0.98	0.95 to 1.00	0.98	0.95 to 1.01
Sex (male)	0.89	0.39 to 2.06	1.02	0.39 to 2.73
BMI	0.98	0.93 to 1.02	0.97	0.92 to 1.02
Total hospital LOS	1.01	1.00 to 1.02	1.02	1.00 to 1.06
LOS prior to trach	1.00	0.95 to 1.04	0.96	0.90 to 1.02
Total ICU LOS	1.01	0.98 to 1.03	0.97	0.93 to 1.02
ICU LOS prior to trach	1.00	0.94 to 1.05	–	–
Comorbid HTN	0.64	0.28 to 1.51	0.67	0.17 to 2.88
Comorbid CAD	0.53	0.15 to 1.52	0.53	0.13 to 1.87
Comorbid COPD	1.20	0.37 to 3.37	1.16	0.28 to 4.30
Comorbid DM	1.06	0.38 to 2.66	0.95	0.26 to 3.25
None of above	1.06	0.38 to 2.66	0.24	0.04 to 1.30
Neuromuscular Dz	1.61	0.42 to 5.16	0.70	0.14 to 3.00
Stroke/CVA	**0.14**	**0.02 to 0.51**	**0.09**	**0.01 to 0.44**
Respiratory failure	1.11	0.44 to 2.64	0.53	0.17 to 1.56

Note: Univariable model displays ORs without controlling for any covariates. Values in the adjusted multivariable model reflect ORs controlling for each of listed variables for which an OR is calculated. Bolded values are statistically significant (p<0.05).
Neither univariable nor multivariable analysis did not reveal any variables independently associated with discharge location beyond primary diagnosis of stroke/CVA (table 5).
BMI, body mass index; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; DM, diabetes mellitus; Dz, Disease; HTN, hypertension; ICU, intensive care unit; LOS, length of stay; trach, tracheostomy.

These findings, however, should be integrated into advanced care planning discussions around the time of tracheostomy.

In this study, we additionally demonstrated a 23.2% mortality rate within 30 days of tracheostomy, though this number is likely somewhat low due to missing patient data. In contrast to our results from the inpatient mortality cohort, multivariable regression analysis of death within 30 days identified a longer hospital LOS prior to tracheostomy to be independently associated with death within 30 days. An important data point, it must also be considered that prolonged hospital stay prior to tracheostomy may be a result of clinical uncertainty, decisional challenges, rapid decompensation, or other factors that may influence mortality. As with the inpatient mortality data, however, the important point for advanced care planning is that nearly one in four patients who underwent tracheostomy for respiratory failure died within the next month. This is essential information to convey to patients and their surrogates at this perilous pivot point in patient care.

Table 5 Univariable and multivariable analyses for characteristics associated with death within 30 days of tracheostomy

	Univariable model		Adjusted multivariable model	
Characteristic	OR	95% CI	OR	95% CI
Age	**1.05**	**1.02 to 1.08**	**1.05**	**1.02 to 1.10**
Sex (male)	1.50	0.74 to 3.13	2.01	0.83 to 5.11
BMI	0.98	0.94 to 1.02	1.01	0.95 to 1.05
Total hospital LOS	1.00	0.98 to 1.01	**0.90**	**0.84 to 0.96**
LOS prior to trach	**1.04**	**1.01 to 1.08**	**1.09**	**1.02 to 1.18**
Total ICU LOS	1.02	1.00 to 1.04	**1.11**	**1.04 to 1.19**
ICU LOS prior to trach	1.04	0.99 to 1.08	–	–
Comorbid HTN	1.02	0.49 to 2.17	0.57	0.19 to 2.24
Comorbid CAD	**2.17**	**1.02 to 4.55**	0.74	0.33 to 2.42
Comorbid COPD	1.77	0.73 to 4.07	0.60	0.18 to 1.77
Comorbid DM	0.34	0.10 to 0.92	0.43	0.10 to 1.36
None of above	0.43	0.14 to 1.11	0.47	0.10 to 2.44
Neuromuscular Dz	0.22	0.01 to 1.14	**0.10**	**0.00 to 0.69**
Stroke/CVA	0.48	0.18 to 1.11	**0.23**	**0.05 to 0.71**
Respiratory failure	1.43	0.68 to 2.94	0.79	0.24 to 1.83

Univariable model displays ORs without controlling for any covariates. Values in the adjusted multivariable model reflect ORs controlling for each of listed variables for which an OR is calculated. Bolded values are statistically significant (p<0.05).
BMI, body mass index; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CVA, cardiovascular accident; DM, diabetes mellitus; Dz, Disease; HTN, hypertension; ICU, intensive care unit; LOS, length of stay; trach, tracheostomy.

Site of discharge

Although inpatient mortality is of central focus in this study, quality of life and discharge disposition are well known to be key patient centered outcomes in the critically ill.[13] In our study, only 15.9% of all patients discharged directly home from the hospital, with most discharging to LTAC and SNF. Unsurprisingly, identification of prognostic variables associated with discharge disposition proved challenging, given the diversity of the underlying pathophysiology.

A primary diagnosis of stroke or CVA was the only characteristic associated with a specific discharge disposition, with these patients more likely to require discharge to a care facility. Interestingly, a primary diagnosis of stroke/CVA was negatively associated with 30-day mortality. Although those data present reason for optimism for the neurologic patient considering tracheostomy, this suggests that the short-term care needs, and by extension, degree of disability, are quite high, even if their likelihood of death may be lower. As before, these are key data to be integrated into advanced care planning discussion.

Care planning considerations

Patient and caregiver expectations regarding quality of life and future functional status can be widely discordant. As an example, surrogate decision-makers vastly overestimated patient independence and happiness when interviewed at the time of tracheostomy versus 1 year later.[6 14] Although the source of this discordance is beyond the scope of this study, there is a clear inequity of information as it pertains to critically ill patients undergoing tracheostomy between physicians and patients. We observed that nearly 94% of the inpatient deaths in this hospital were due to a transition to comfort measures only. Reframed, 30 of 177 (16.9% of our cohort) were consented for and underwent tracheostomy only to transition to comfort measures and die during the same admission. This suggests an opportunity for more detailed advanced care planning prior to a tracheostomy procedure.

Palliative care consultations in the ICU represent an excellent path towards better understanding patient goals, but are often called too late in the patient's course.[15 16] In our study, less than 50% of patients received a formal palliative care consultation. This may be due to a demonstrated emphasis on practicing primary palliative care among our acute care surgery group and warrants attention in future studies.[17] It is reasonable to think, however, that virtually all patients will find benefit from palliative care involvement at these key pivot points in care.[18 19]

Limitations

This retrospective cohort study is limited in its ability to infer causality and is not intended to serve as a predictive model to guide decision-making. Similarly, the retrospective structure of this study did not allow for inclusion of important subjective patient data or continued follow-up assessments and reliance on past documentation often complicated categorization of patients into clear diagnostic groups. There may be limited generalizability of data from a single, academic medical center as patient populations, practice patterns, and societal expectation vary. A further drawback of the relatively limited sample size exists in that there are not ample patients to populate important subcategories that warrant further study. Groupings based on primary diagnosis were constructed to be highly specific as to avoid mischaracterization, at the expense of excluding some participants from group analysis. It must also be considered that practice patterns have changed during the period of study, which would not have been captured well in this study design. Similarly, the period of study did not include the COVID-19 pandemic, which caused innumerable changes to the practice of critical care as well as more specific considerations for the role of tracheostomy. Creation of the 30-day mortality cohort relied on manual chart review by study team rather than a National Death Index search; it is possible that additional patients may have died between discharge and 30-days status post tracheostomy that escaped categorization, although it is unlikely any patients included in the mortality group were incorrectly included.

CONCLUSION

In this study we demonstrate that a mixed ICU population of patients who underwent tracheostomy were more likely to die in the inpatient setting than they were to discharge to home. Nearly one in four patients who underwent a tracheostomy died in the subsequent 30 days and nearly all patients who died prior to discharge did so after transitioning to comfort measures only. This speaks to the severity of their underlying critical illness and importance of advanced care planning at this perilous pivot point in care. These findings warrant additional study and emphasis in early and honest advanced care planning discussions with patients, families, and caregivers.

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REFERENCES

1 Abril MK, Berkowitz DM, Chen Y, Waller LA, Martin GS, Kempker JA. The epidemiology of adult Tracheostomy in the United States 2002-2017: A serial cross-sectional study. *Crit Care Explor* 2021;3.
2 Mehta AB, Walkey AJ, Curran-Everett D, Douglas IS. One-year outcomes following Tracheostomy for acute respiratory failure. *Crit Care Med* 2019;47:1572–81.
3 Freeman BD. Tracheostomy update: when and how. *Crit Care Clin* 2017;33:311–22.
4 Wallen TE, Elson NC, Singer KE. Tracheostomy decreases continuous analgesia and sedation requirements. *J Trauma Acute Care Surg* 2022;93:545–51.
5 Cinotti R, Voicu S, Jaber S, *et al*. Tracheostomy and long-term mortality in ICU patients undergoing prolonged mechanical ventilation. *PLoS One* 2019;14:e0220399.
6 Huttmann SE, Magnet FS, Karagiannidis C, Storre JH, Windisch W. Quality of life and life satisfaction are severely impaired in patients with long-term invasive ventilation following ICU treatment and unsuccessful Weaning. *Ann Intensive Care* 2018;8:38.
7 Nakarada-Kordic I, Patterson N, Wrapson J, Reay SD. A systematic review of patient and Caregiver experiences with a Tracheostomy. *Patient* 2018;11:175–91.
8 Sherlock ZV, Wilson JA, Exley C. Tracheostomy in the acute setting: patient experience and information needs. *J Crit Care* 2009;24:501–7.
9 Young D, Harrison DA, Cuthbertson BH, Rowan K, TracMan Collaborators. Effect of early vs late Tracheostomy placement on survival in patients receiving mechanical ventilation: the Tracman randomized trial. *JAMA* 2013;309:2121–9.
10 Chorath K, Hoang A, Rajasekaran K, Moreira A. Association of early vs late Tracheostomy placement with pneumonia and ventilator days in critically ill patients: A meta-analysis. *JAMA Otolaryngol Head Neck Surg* 2021;147:450–9.
11 Pandian V, Gilstrap DL, Mirski MA, *et al*. Predictors of short-term mortality in patients undergoing percutaneous Dilatational Tracheostomy. *J Crit Care* 2012;27:420.
12 Mehta AB, Cooke CR, Wiener RS, Walkey AJ. Hospital variation in early Tracheostomy in the United States: A population-based study. *Crit Care Med* 2016;44:1506–14.
13 Rubin EB, Buehler AE, Halpern SD. States worse than death among hospitalized patients with serious illnesses. *JAMA Intern Med* 2016;176:1557–9.
14 Cox CE, Martinu T, Sathy SJ, *et al*. Expectations and outcomes of prolonged mechanical ventilation. *Crit Care Med* 2009;37:2888–94.
15 Ballou JH, Brasel KJ. Palliative care and geriatric surgery. *Clin Geriatr Med* 2019;35:35–44.
16 Lilley EJ, Cooper Z, Schwarze ML, Mosenthal AC. Palliative care in surgery: defining the research priorities. *Ann Surg* 2018;267:66–72.
17 Edsall A, Howard S, Dewey EN, *et al*. Critical decisions in the trauma intensive care unit: are we practicing primary palliative care. *J Trauma Acute Care Surg* 2021;91:886–90.
18 Pan CX, Gutierrez C, Maw MM, *et al*. Impact of a palliative care program on Tracheostomy utilization in a community hospital. *J Palliat Med* 2015;18:1070–3.
19 Ma J, Chi S, Buettner B, Dans M, *et al*. Early palliative care consultation in the medical ICU: A cluster randomized crossover trial. *Crit Care Med* 2019;47:1707–15.