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Mortality and patient disposition after ICU tracheostomy for secretion management vs. prolonged ventilation: a retrospective cohort study

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Abstract

Background There is little research on long-term, patient-centered outcomes in critically ill patients undergoing tracheostomy for secretion management or prolonged ventilation. The goal of this study was to determine and compare hospital and long-term mortality, and incidence of new institutionalization amongst patients who underwent an ICU tracheostomy for these two aforementioned indications.

Methods This was a single center historic cohort study of all ICU patients who received a tracheostomy for secretion management or prolonged ventilation from 2011 to 2022. We compared hospital and long-term mortality and incidence of new institutionalization between these two groups.

Results A cohort of 247 patients (133 secretion management, 114 prolonged ventilation) was established. Overall hospital mortality was 86/247 (35%), mortality at 1 year was 106/207 (51%), and at 3 years was 117/167 (70%), with no significant difference between the two indications. Patients with prolonged ventilation indication had a significantly higher ICU mortality [34/114 (30%) vs. 13/133 (10%), $P<0.001$]. Amongst hospital survivors, 49/137 (36%) were unable to return home, with significantly more patients tracheostomized for secretion management requiring new institutionalization [37/78 (47%) vs. 12/59 (20%), $P=0.002$].

Conclusions Tracheostomy indication may be an important determinant of short- and long-term patient-centered outcomes. Patients receiving a tracheostomy for secretion management were twice as likely to be discharged to a new institution compared to prolonged ventilation patients. Patient-centered outcomes should be included in future studies and if confirmed, these outcomes should be incorporated into discussions about tracheostomy decision making.

Keywords Tracheostomy, Secretion management, Prolonged ventilation, Intensive care unit, Institutionalization

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Background

Critically ill patients who require prolonged mechanical ventilation or additional assistance with secretion management frequently undergo tracheostomy in the intensive care unit (ICU). Such patients often are unable to advocate for themselves, requiring surrogate decision makers to act on their behalf and make decisions regarding their treatment and care [1]. Decisions to proceed with a tracheostomy are based on the clinician's experience while balancing the risks versus benefits in a shared decision-making process with the patient or surrogate decision maker (SDM). The association of tracheostomy timing on 28-day mortality and duration of mechanical ventilation has been thoroughly studied, however there is less research on long-term, patient-centered outcomes which may help inform the decision to proceed with this procedure [2, 3]. Patients and surrogate decision makers often lack information regarding prognosis and functional recovery, which can result in patients receiving treatment that is not aligned with their goals of care [4, 5, 6]. The absence of such information may hinder appropriate care as patients, or their SDM may prefer to forego tracheostomy when provided with real world outcome data [6]. To help address this, recent efforts have focused on patient-centered research examining outcomes such as tracheostomy complications, time to vocalization, oral intake, and mobilization, however data on discharge disposition remains limited [7, 8, 9]. Tracheostomy, and the medical conditions leading to this procedure may be associated with a significant change to their baseline function. This may impact their ability to perform activities of daily living, possibly requiring additional assistance that may only be available in a skilled healthcare facility. Institutionalization therefore represents an important patient-centered outcome to explore in this population. In a recent article, Lee et al. investigated the short- and long-term patient-centered outcomes for elderly tracheostomized patients (age ≥ 70) in the ICU of a Canadian center [10]. They found that this patient population experienced elevated hospital mortality with the majority of survivors experiencing severe frailty and functional impairments at discharge, which ultimately impeded patients' ability to return home after hospitalization [10]. We therefore conducted a historic cohort study to further explore these findings in a non-age limited, general ICU population and examined the association between tracheostomy indication (secretion management versus prolonged ventilation) and incidence of institutionalization.

Methods

Study design and setting

This historic cohort study was conducted in the 27-bed intensivist-led medical-surgical intensive care unit (ICU) of the Jewish General Hospital in Montreal, QC, Canada. We are a university affiliated hospital, that operates using a closed model and covers neuro and cardiac surgery, with a non-trauma population.

Ethics

This study was approved by the Research Ethics Committee of the Centre Intégré Universitaire en Santé et Services Sociaux (CIUSSS) West-Central Montreal. (Study Identifier 2023–3585; approved on 8 December 2022). Due to the nature of the study and anonymous data collection, the need for informed consent was waived.

Cohort assembly

We established our cohort from a complete patient list maintained by our hospital's Speech-Language Pathology department of all patients who underwent a tracheostomy during their hospital admission between November 1, 2011 and September 30, 2022. All patients on this list were considered eligible for cohort inclusion, and underwent a preliminary chart review. Patients were excluded if they met any of the following criteria: (1) indication for tracheostomy other than prolonged ventilation or secretion management (e.g. anatomical indication in head and neck cancer as this decision is not made by intensivists at our institution), (2) tracheostomy occurred outside of the patient's stay in the ICU, or (3) tracheostomy performed in another facility. In cases of uncertainty about inclusion, case details of 46 patients were reviewed with a senior author (B.S.) for final decisions.

Data sources and study variables

Subjects had their full chart for the relevant admission reviewed using the Chartmaxx database (Quest Diagnostics Inc. Version 9.0-A, Secaucus NJ, United States). Relevant data was extracted from the medical record into a secure spreadsheet by two authors (D.DB & L.Z). Patient demographics, patient medical comorbidities on history and reason for ICU admission (medical, surgical or cardiac surgery) were collected from the ICU admission note. End stage renal disease requiring hemodialysis or peritoneal dialysis and vasopressor use at time of tracheostomy, extubation attempt prior to tracheostomy, type of tracheostomy (percutaneous or surgical), duration of ventilation prior to and after the tracheostomy, decannulation status, ICU and hospital mortality and discharge disposition were determined based on review of the medical record. Decannulation status was determined among the cohort of survivors, both as inpatient and outpatient, by reviewing nursing progress notes as well as charting from the Speech Language Pathology team.

We classified cohort patients into 2 groups based on the indication for tracheostomy: (i) secretion management or (ii) prolonged mechanical ventilation. Patients

were categorized as "secretion management" if the indication for tracheostomy was deemed to be related to difficulty with clearing chest secretions, (e.g. severe stroke or profound neuromuscular weakness). Patients were categorized as "prolonged ventilation" if they underwent tracheostomy due to anticipated prolonged mechanical ventilation. These classifications were conducted by two authors (D.DB and L.Z) and in cases of uncertainty were discussed with the senior author (B.S) to achieve consensus. The initial classification of indication for tracheostomy was carried throughout the study as our goal was to help improve informed decision-making regarding insertion of tracheostomy.

An extubation attempt or a failed extubation was defined as requiring re-intubation after fewer than 7 days as indicated in the progress notes. Successful mechanical ventilation cessation after tracheostomy was defined as being off mechanical ventilation for 7 days or more and once sustained, duration of ventilation was calculated from the first complete day off the ventilator, as indicated in the respiratory therapy flowsheets.

Post-tracheostomy, all patients are rounded on weekly by a multidisciplinary tracheostomy team comprised of ENT (ear nose and throat) surgeons, speech language pathologists and ENT nurse. Decisions regarding decannulation are made in a shared decision fashion with the tracheostomy team and the patient's admitting clinical team.

Intensive Care Unit and hospital length of stay was determined in days from the progress notes and hospital admission/discharge data respectively. Mortality at 1 and 3 years was determined by reviewing our institution's medical records for death notification. Patient mortality at 28 days, 1 and 3 years were calculated from time of tracheostomy. To account for possible survival bias, ICU and hospital length of stay as well as post-tracheostomy ventilation days were analyzed by excluding those who did not survive to hospital discharge. Patients who were discharged to a secondary hospital before being transferred back to our institution and dying during this "readmission" were classified as having died in hospital.

Discharge disposition was determined by reviewing progress notes and discharge summaries at our institution. For patients discharged to a temporary location such as a rehabilitation center or another acute hospital, we contacted these facilities to confirm the patients' final discharge location. We defined new institutionalization as placement of a patient who is unable to return to previous living arrangements in a long-term care facility following discharge from hospital or from inpatient rehabilitation facility.

Outcomes

The primary outcome of this study was hospital mortality.

Secondary outcomes included ICU mortality, 28-day mortality, 1- and 3-year mortality, patient discharge disposition, duration of ventilation prior to and post tracheostomy, decannulation status, and length of stay in ICU and in hospital.

Statistical analysis

We used descriptive statistics to summarize baseline demographic and clinical characteristics. Continuous variables are presented as median [interquartile range (IQR)] values because of data distribution. Categorical variables are presented as count and percentage unless otherwise indicated. We conducted comparisons between the two tracheostomy indication groups using the Wilcoxon rank-sum test for continuous data after verifying non normal distribution using the Shapiro-Wilk test and the Chi square test for categorical variables. All analyses were conducted in a two-tailed fashion with pre-specified statistical significance set *at* $P<0.05$ using StataIC version 12 (StataCorp LLC, College Station, TX, USA).

Results

Cohort characteristics

A total of 353 patients were screened for inclusion based on having undergone a tracheostomy in the study period, according to the Speech-Language Pathology database. Upon initial review of the database, 47 patients were excluded as tracheostomy was done for head and neck anatomical reasons and 18 were excluded as tracheostomy was performed at another institution. Upon full chart review of the remaining 288 patients, an additional 41 patients were excluded: 17 patients had a tracheostomy for an anatomical indication, 8 were from another institution, 11 were excluded as tracheostomy was requested outside the ICU, 1 died before the tracheostomy procedure, 1 received a tracheostomy twice and so the second tracheostomy was excluded, and 3 were excluded due to missing information. This left 247 patients for analysis in our cohort (Fig. 1).

Patient characteristics

Patients who underwent tracheostomy in our cohort were 59% male with a median age of 72 years [62–79], with the procedure indicated for secretion management in 133 (54%) patients and for prolonged ventilation in 114 (46%) patients (Table 1). Overall 173 (70%) patients received a percutaneous tracheostomy. Both indication groups were similar with regards to age, gender, extubation attempts prior to tracheostomy and type of tracheostomy performed. Medical comorbidities in this cohort are listed in Table 1. More patients in the prolonged ventilation group had COPD and CHF compared to the secretion management group: 23 (20%) vs. 13 (10%), $P=0.02$ and 26 (23%)

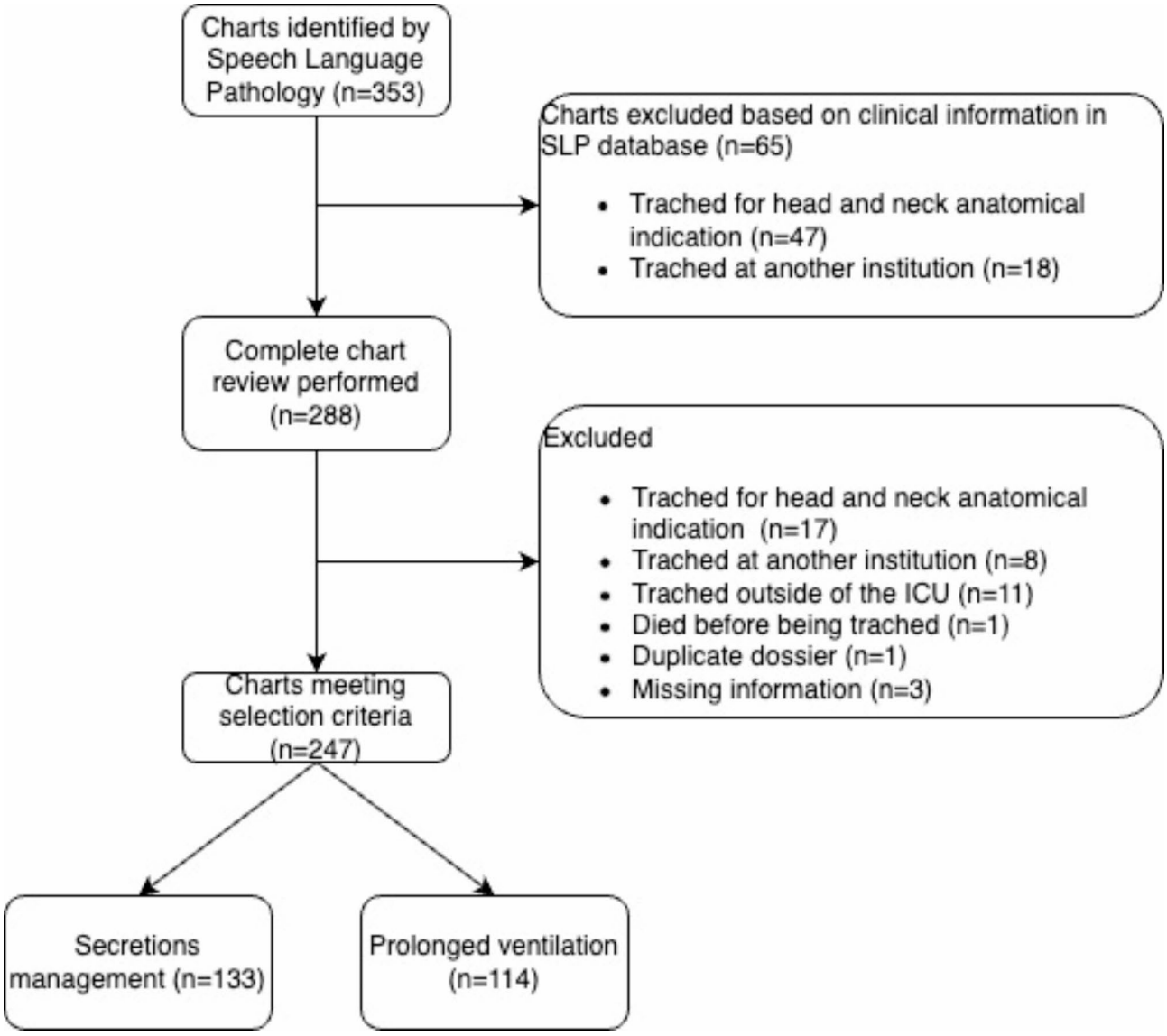

Fig. 1 Flow diagram for patient inclusion and exclusion

vs. 13 (10%), $P=0.005$ respectively. At time of tracheostomy, patients in the prolonged mechanical ventilation group were more likely to have end stage renal disease 27 (24%) vs. 15 (11%), $P=0.01$ and be on vasopressors 46 (40%) vs. 15 (11%), $P<0.001$.

Outcomes

Mortality

Overall hospital mortality was 86/247 (35%) with no significant difference between the two groups ($P=0.37$) (Table 2).

Intensive Care Unit mortality was 47/247 (19%), with significantly higher ICU mortality seen amongst patients undergoing tracheostomy for prolonged mechanical ventilation 34 (30%) vs. 13 (10%) for secretion management, $P<0.001$. Overall mortality at 28 days post-tracheostomy was 34/247 (14%), with 15/133 (11%) in the secretion management group and 19/114 (17%) in the prolonged mechanical ventilation group ($P=0.22$). Overall mortality at 1 year was 106/207 (51%) and at 3 years was 117/167 (70%) with no significant difference between the two groups (Table 2). Patient flow and mortality outcomes at various stages are summarized in Fig. 2.

It should be noted that in addition to the 86 patients who died in hospital, 5 were discharged to a secondary hospital before being transferred back to our institution and dying during this "re-admission". These patients were classified as having died in hospital.

Duration of mechanical ventilation

Median (interquartile range) duration of mechanical ventilation prior to tracheostomy was significantly longer for

Table 1 Patient characteristics

	All (*N* = 247)	Secretion Management (*N* = 133)	Prolonged Ventilation (*N* = 114)	*P* value
Gender				
Male	145 (59%)	83 (62%)	62 (54%)	0.20
Age (yrs)				
Median [interquartile range]	72 [62–79]	71 [63–77]	72.5 [60–80]	0.32
Comorbidities				
Diabetes	106 (43%)	55 (41%)	51 (45%)	0.59
COPD	36 (15%)	13 (10%)	23 (20%)	0.02
Hypertension	152 (62%)	82 (62%)	70s (61%)	0.97
Coronary artery	73 (30%)	43 (32%)	30 (26%)	0.30
disease	57 (23%)	28 (21%)	29 (25%)	0.41
Atrial fibrillation	39 (16%)	13 (10%)	26 (23%)	0.005
Heart failure	102 (41%)	56 (42%)	46 (40%)	0.78
Dyslipidemia	33 (13%)	22 (17%)	11 (10%)	0.11
CVA/TIA*	13 (5%)	10 (8%)	3 (3%)	0.09
Dementia	23 (9%)	11 (8%)	12 (11%)	0.54
Cancer	42 (17%)	15 (11%)	27 (24%)	0.01
ESRD				
ICU admission class				0.12
Medical (including	166 (67%)	87 (65%)	79 (69%)	
obstetrical)	37 (15%)	27 (20%)	10 (9%)	
Surgical	44 (18%)	19 (14%)	25 (22%)	
Cardiac surgery				
Vasopressors at time of tracheostomy	61 (25%)	15 (11%)	46 (40%)	< 0.001
Prior failed extubation	102 (41%)	53 (40%)	49 (43%)	0.61
Tracheostomy technique				0.75
Percutaneous (in	173 (70%)	92 (69%)	81 (71%)	
ICU)	74 (30%)	41 (31%)	33 (29%)	
Surgical (in OR)				

All numbers are *n*/group *N* (%)

P values from Wilcoxon rank-sum test or Chi square test

COPD = chronic obstructive pulmonary disease; CVA = cerebrovascular accident; TIA = transient ischemic attack; ESRD = end stage renal disease ; OR = operating room

the prolonged mechanical ventilation group 21 [15–29] days vs. 17 [12–24 days], $P < 0.001$. Similarly, the median duration of mechanical ventilation after tracheostomy was 17.5 days longer for the prolonged ventilation group, 23.5 [13–41] days vs. 6 [1–14] days, $P < 0.001$. Duration of mechanical ventilation before and after tracheostomy for hospital survivors can be found in Table 3.

Decannulation

Overall, 126/154 (82%) of patients were decannulated, 69/87 (79%) in the secretion management group vs. 57/67 (85%) in the prolonged ventilation group ($p = 0.36$) (Table 2).

Length of stay

The secretion management group had a median ICU length of stay that was 20.5 days shorter than the prolonged ventilation group: 31 [21–55] days vs. 51.5 [37–75] days, $P < 0.001$, but a median hospital length of stay that was 21 days longer: 97 [62–155)] days vs. 76 [50–124] days, $P = 0.002$ (Table 2). Length of stay data for hospital survivors can be found in Table 3.

Discharge disposition

Overall, 49/139 (35%) of patients were newly discharged to an institution. Patients in the secretion management group were significantly more likely to require new institutionalization 37/78 (47%) vs. 12/59 (20%), $P = 0.002$.

Missing data

Of note, 40/247 (16.2%) patients (27 in secretion management, 13 in prolonged ventilation) and 80/247 (32.4%) patients (50 in secretion management, 30 in prolonged ventilation) were lost to follow-up at 1- and 3-year mortality respectively. Decannulation status for 6/154 (3.8%) patients (3 in secretion management, 3 prolonged ventilation) and discharge disposition for 24/247 (9.7%) patients (12 in secretion management, 12 in prolonged ventilation) could not be established as they were lost to follow-up.

Discussion

In our cohort, we report a hospital mortality after ICU tracheostomy of 35% which is comparable to the 30–35% previously reported by Liu et al. in their systematic review on early vs. late tracheostomy in ICU [11]. Similarly, our secondary mortality outcomes such as ICU mortality and 1-year mortality were also on par with those reported in other studies [7, 12]. Additionally, over one third of patients undergoing tracheostomy who survived to hospital discharge were then unable to return to their original living arrangements and required new institutionalization despite completing an intensive inpatient rehabilitation program. This is an important patient-centered outcome which has been minimally explored in ICU tracheostomy populations.

In a recent article, Lee et al. explored short- and long-term outcomes exclusively amongst elderly patients undergoing tracheostomy in the ICU of a Canadian university-affiliated hospital. Our work further corroborates and expands on their findings. Our results were comparable with regards to ICU length of stay (41 days vs. 31 days), hospital length of stay (85 days vs. 81 days), as well as ICU mortality (19% vs. 26%). Our cohort, however, experienced lower hospital mortality (35% vs. 45%) and new institutionalization (35% vs. 53%) which may be attributed to our mean cohort age being almost a decade younger than theirs. Additionally, our cohort experienced

Table 2 Patient outcomes

Outcome	All (*N* = 247)	Secretion Management (*N* = 133)	Prolonged Ventilation (*N* = 114)	*P* value
Primary Outcome				
Hospital mortality	86 (35%)	43 (32%)	43 (38%)	0.37
Secondary Outcome				
ICU mortality	47 (19%)	13 (10%)	34 (30%)	< 0.001
28-day mortality	34 (14%)	15 (11%)	19 (17%)	0.22
1-year mortality*	106 (51%) *N* = 207	51 (48%) *N* = 106	55 (54%) *N* = 101	0.36
3-year mortality**	117 (70%) *N* = 167	59 (71%) *N* = 83	58 (69%) *N* = 84	0.77
Duration of ventilation				
Prior to trach (days), median [IQR]	19 [14–26]	17 [12–24]	21 [15–29]	< 0.001
After trach (days), median [IQR]	12 [4–31]	6 [1–14]	23.5 [13–41]	< 0.001
Successful decannulation*** (*n* = 154)	126 (82%) *N* = 137	69 (79%) *N* = 78	57 (85%) *N* = 59	0.36
Length of stay				
ICU (days), median, [IQR]	41 [26–63]	31 [21–55]	51.5 [37–75]	< 0.001
Hospital (days), median, [IQR]	85 [56–136]	97 [62–155]	76 [50–124]	0.002
New institutionalization****	49 (36%) *N* = 137	37 (47%) *N* = 78	12 (20%) *N* = 59	0.002

All numbers are *n*/group *N* (%) unless otherwise specified

P values from Wilcoxon rank-sum test or Chi square test

IQR = interquartile range

*40 patients lost to follow up: 27 in secretion management category and 13 in prolonged ventilation category

**80 patients lost to follow up: 50 in secretion management category and 30 in prolonged ventilation category

***6 patients lost to follow up: 3 in secretion management category and 3 in prolonged ventilation category

****24 patients lost to follow up: 12 in secretion management category and 12 in prolonged ventilation category

a higher successful decannulation incidence (82% vs. 25%) however decannulation status was assessed both as inpatient and outpatient, whereas Lee et al. evaluated this metric only during the hospital stay. Lastly, while our patients were relatively evenly split between the two indications of tracheostomy, 75% of Lee et al.'s cohort were tracheostomized for prolonged ventilation, and they do not report on the different incidence of institutionalization based on tracheostomy indication, a finding that could have important implications for patients and their surrogate decision makers' decision to proceed with tracheostomy and/or their expectations around patients' outcomes. Ultimately our findings corroborate those of Lee et al. and we feel that our data can further contribute to enhancing meaningful discussions as patients undergoing ICU tracheostomy experience challenging clinical courses both during and after their hospitalizations [10].

While timing of tracheostomy, impact of BMI and age on patient outcomes have been extensively studied, there is a paucity of data reporting on how the indication of tracheostomy impacts long-term outcomes [7, 8, 9, 11, 12, 13, 14]. For this reason, we decided to create two pre-specified groups based on tracheostomy indication. The indication for tracheostomy was found to be an important predictor of short- and long-term patient outcomes. Patients receiving a tracheostomy for secretion management were more likely to survive their ICU admission, however, experienced a significantly longer hospital stay and were twice as likely to be discharged to a new institution compared to patients receiving a tracheostomy for prolonged ventilation.

We found that the prolonged ventilation group had significantly higher ICU mortality than the secretion management group, which is consistent with the patient comorbidity profile and acute physiology in this group. This is further supported by our finding that patients in the prolonged ventilation cohort had significantly longer duration of ventilation both prior to and after tracheostomy. Our findings suggest that there may be two distinct and separate patient groups who ultimately require ICU tracheostomy and future work in this field may consider using this classification.

In recent years, there has been growing interest in exploring patient-important outcomes in critical care medicine [15]. A study looking at trends in tracheostomies from 1993 to 2015 found that while hospital mortality decreased over the years, so too did the proportion of patients able to be discharged home directly [13]. In our study, 35% of survivors required new institutionalization which is comparable to the range of 32–81% previously reported in the literature [8, 10, 13, 14, 16, 17]. In general, discharge disposition is a challenging outcome

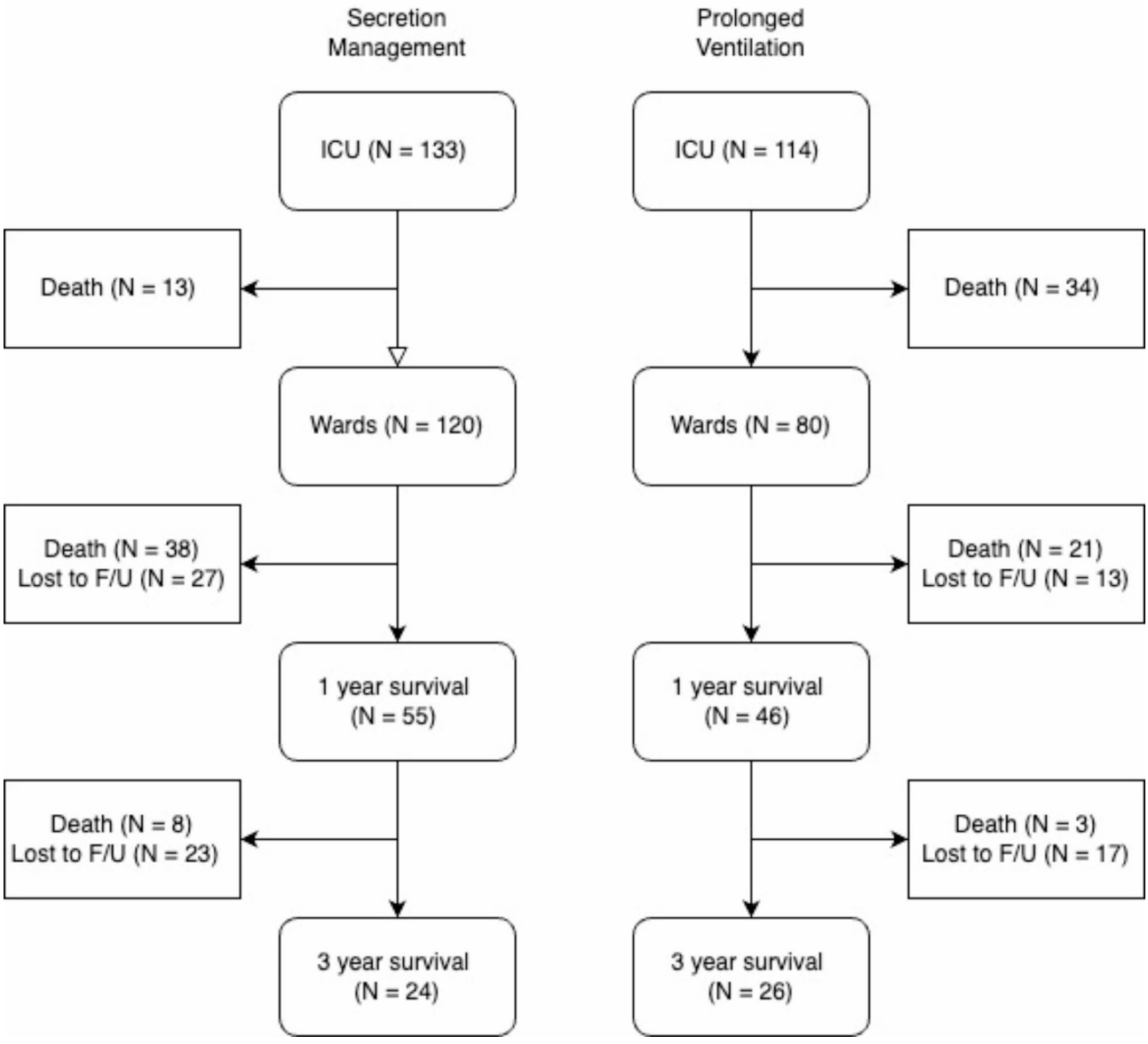

Fig. 2 Flow diagram for mortality

Table 3 Survivor outcomes

	All (*N* = 161)	Secretion Management (*N* = 90)	Prolonged Ventilation (*N* = 71)	*P* value
Duration of ventilation				
Prior to trach (days), median [IQR]	18 [12–25]	16 [12–23]	21 [14.5–29]	0.006
After trach (days), median [IQR]	11 [3–29]	5 [1.25–11.75]	20 [12–41]	< 0.001
Length of stay				
ICU (days), median, [IQR]	40 [25–63]	29.5 [21–55]	51 [36.5–73]	< 0.001
Hospital (days), median, [IQR]	96 [63–143]	109 [79.25–156.5]	77 [50.5–130.5]	< 0.001

to compare between studies, given the heterogeneity of reporting in the literature. Studies often consider discharge to rehabilitation centers or to other acute hospitals as new institutionalization, but in reality, these are temporary interim stays where patients are then discharged home or placed at a long-term care facility after their stay. In our study, we only considered patients who were discharged to a long-term care facility following rehabilitation or hospital transfer as new institutionalization. While previous studies with cohorts based on age, length of ICU stay or obesity found no statistically significant difference in discharge disposition between the cohorts [8, 14, 16], our study found that indication for tracheostomy was a clinically and statistically significant predictor for new institutionalization.

In Montreal where our hospital is based, there are local community service centres run by the provincial healthcare system that provide free and accessible home care services for tracheostomy patients, therefore it is unlikely that the higher incidence of new institutionalization is explained by lack of outpatient resources. The higher incidence of new institutionalization for secretion management patients may be attributed to their underlying medical conditions such as dementia or cognitive disorders, both of which were more common numerically but not statistically in the secretion management group, or new neurological limitations which are known to frequently require long-term institutionalization [18]. This is an important finding as new institutionalization can have a significant negative impact on quality of life, and ultimately may not align with patients' long-term goals. Studies show that institutionalized elderly report a lower quality of life than their community-dwelling counterparts [18]. A study by McDougall et al. found that 27.1% of individuals aged 65 and older living in institutions had clinically significant depression compared to 9.3% of community dwelling adults of the same age [19]. This is further compounded by the fact that critically ill patients who survive to discharge often already experience significant physical and functional impairments [10, 20]. Several studies found that ICU survivors reported lower health-related quality of life (HRQOL) after ICU discharge compared to their pre-admission characteristics-matched and age-matched, healthy counterparts [21, 22, 23]. In light of these findings, future studies should assess HRQOL using a validated tool like the SF36 questionnaire for all patients having undergone a tracheostomy in the ICU. This would ensure adequate assessment and homogenous reporting in the literature of the impact new institutionalization may have on ICU survivors.

Our study's strengths include comprehensive inclusion of all tracheostomies in a university-affiliated hospital with a patient population similar to many North American ICUs, which would allow our findings to be generalizable to similar institutions. There were, however, several limitations to our study. Our cohort was single-center and does admit post-operative cardiac surgery patients, which may limit generalizability. Additionally, we had a number of patients lost to follow-up. All efforts to locate these patients were undertaken, and while we have no reason to believe the loss to follow-up and difference between the two groups was anything other than random, we cannot exclude a resultant potential bias in our conclusions. Furthermore, decision for institutionalization may be influenced by patient's financial or family situation, factors we were unable to ascertain in our cohort design.

To our knowledge, our study is the first to explicitly explore the indication for tracheostomy and its impact on outcomes and new institutionalization for ICU survivors. Patients and surrogate decision makers do not view mortality as the only important metric on which to base decisions impacting patient treatment and care. The patient-centered outcomes that we explored, among others, may therefore provide important information for ICU clinicians to use as part of their discussions with patients and their surrogate decision makers prior to undergoing tracheostomy. The incidence of new institutionalization as well as other patient-centered outcomes should be prospectively explored in future studies of critical care tracheostomy.

Conclusions

Our study explored short- and long-term outcomes after ICU tracheostomy and found that hospital mortality was 35% with no statistically significant difference between the two groups. However, indication for tracheostomy was found to be an important predictor of new institutionalization. Patients receiving a tracheostomy for secretion management experienced a significantly longer hospital stay and were twice as likely to be discharged to a new institution compared to prolonged ventilation patients. Our findings may thus provide important information for intensivists to use as part of their discussions with patients and their surrogate decision makers surrounding tracheostomy, particularly if these findings are confirmed in future investigations.

Abbreviations

ICU	Intensive Care Unit
CIUSSS	Centre Intégré Universitaire en Santé et Services Sociaux

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Author contributions

M.S. provided the patient dataset. D.D.B. and L.M.Z. reviewed the dataset for inclusions and exclusions, conducted chart reviews and wrote the manuscript. B.C.S. performed the statistical analysis and provided editorial guidance. All authors read and approved the final manuscript.

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Data availability

The datasets generated and/or analysed during the current study are not publicly available as patient privacy would be compromised however, they may be made available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Approval for chart review for this project was granted by the Medical/Biomedical Research Ethics Committee (REC) of the CIUSSS West-Central Montreal Research Ethics Board (REB).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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