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An interdisciplinary approach to the management of individuals with tracheostomy

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- Alhashemi, Hashem, guarantor and corresponding author, participated in study design, wrote the proposal, performed the analysis, wrote and reviewed the manuscript.
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Abstract

Background

Study objectives were to identify the proportion of tracheostomy subjects with successful decannulation, time to decannulation after intensive care unit (ICU) discharge, and predictors of long-term tracheostomy based on an interdisciplinary team approach.

Methods

This retrospective cohort study recruited all adult tracheostomy subjects admitted between January 2016 and December 2018. Long-term tracheostomy subjects with recurrent admissions and compromised airway, and subjects with neck tumors obstructing the airway were excluded. Data regarding subjects' demographics, comorbidities, Glasgow Come Score (GCS), feeding, ICU discharge date, decannulation date, and outcome were collected. The interdisciplinary team members included tracheostomy resource nurse, respiratory therapist, speech clinician, Ear, Nose, and Throat (ENT) specialist, and Rehab medicine specialist.

Results

Of the 221 subjects followed during the study period, 16% (36/221) were excluded, and the remaining 84% (185/221) underwent the decannulation protocol. Subjects who failed capping multiple times 114/185 (62%) were labeled long term and did not progress to decannulation. We successfully decannulated 71/185 subjects (38%), and none of them developed decannulation failure. Forty deaths occurred during hospitalization, but none was due to tracheostomy complications. The median time to decannulation after ICU discharge was 47 days. Predictors of long-term tracheostomy were GCS <11 (odds ratio [OR], 5.6; 95% CI, 2.7–12), age ≥65 years

(OR, 4.5; 95% CI, 2–10), comorbidities ≥2 (OR, 4.0; 95% CI, 1.5–11), and female sex (OR, 3.0; 95% CI, 1.3–7.4).

The proportion of subjects with long-term tracheostomy significantly increased with the total number of predictors (Fisher's exact test, $P < 0.001$).

Conclusion

Long-term tracheostomy is a common outcome among tracheostomy patients. Older age, low GCS, female gender, and the number of comorbidities were significant long-term tracheostomy predictors. Further studies to assess outcomes and predictors of tracheostomy subjects are needed.

Key Words: Tracheostomy, Airway, Intensive care units, Teamwork, Decannulation, Care continuity.

Introduction

Tracheostomy is a common procedure performed in critically ill patients.[1] This method has several advantages, including decreased airway resistance, improved secretion clearance, and decreased duration of mechanical ventilation and intensive care unit (ICU) stay.[2] However, tracheostomy is associated with several complications and increased morbidity and mortality.[3] Tracheostomy patients have increased risks of malnutrition, nosocomial infections, pressure sores, and fistulas.[4] Furthermore, these patients place a significant burden on hospital resources and account for the highest levels of hospital reimbursement.[5,6]

There are no data from Saudi Arabia regarding the outcomes of patients undergoing tracheostomy. This study aimed to examine the outcomes of tracheostomy subjects under an interdisciplinary team approach. The objectives were to identify the proportion of subjects with successful decannulation, the time to decannulation after ICU discharge, and predictors of long-term tracheostomy.

Methods

This retrospective cohort study was approved by the Institutional Review Board of the King Abdulla International Medical Research Center. Due to the study's retrospective design, informed consent was not required. All adult tracheostomy subjects admitted between January 2016 and December 2018 were included. Long-term tracheostomy subjects with recurrent admissions and compromised airway, and subjects with neck tumors obstructing the airway were excluded.

An interdisciplinary tracheostomy team followed all subjects. To identify variables that could predict decannulation protocol outcomes, subjects who were successfully capped and decannulated were compared to those who failed capping and did not progress to decannulation. We retrieved data on the subjects' age, sex, comorbidities, Glasgow Coma Score (GCS), feeding, tracheotomy date, ICU discharge date, decannulation date and outcome.[7,8] Comorbidities included diseases commonly encountered in tracheostomy patients (traumatic brain injury, stroke, brain tumors, pneumonia, chronic obstructive pulmonary disease, heart failure, ischemic heart disease, and end-stage renal disease on dialysis).

The interdisciplinary tracheostomy team consisted of a respiratory therapist, a speech and swallowing clinician, an Ear, Nose, and Throat (ENT) specialist, a rehabilitation medicine specialist, and a tracheostomy resource nurse. The respiratory therapist performed daily tube care, the speech and swallowing clinician performed endoscopic airway assessment, clinical and endoscopic swallowing assessments, the ENT specialist diagnosed and managed airway complications, the rehabilitation medicine specialist evaluated the subjects' cognition and medical comorbidities, and the tracheostomy resource nurse ensured that subjects' needs, regarding caregiver education, training, home supply, and equipment, were met. The team was notified as soon as the tracheostomy subjects were discharged from the ICU or admitted to a general unit. Tracheostomy subjects were discussed during weekly clinical rounds, and management decisions were based on the tracheostomy decannulation protocol (Figure 1).[8–10]

Tracheostomy tube with inflated cuff is needed to maintain positive pressure ventilation, however; after extubation cuff deflation is needed to progress towards decannulation. Subjects who were vitally stable underwent suctioning and monitoring before and during the trial of tracheostomy cuff deflation.

On the initial assessment by the tracheostomy team (after ICU discharge), most of the subjects had already deflated cuffs. Dried secretions may obstruct the tracheostomy tube and cause respiratory distress; therefore, air humidification is an essential component of care for tracheostomy patients. Heat moisture exchanger (HME) was used for air humidification for tracheostomy patients in this cohort. In addition, inner tube care was performed (1 to 2 times/shift) for double lumen tracheostomy tubes to prevent tracheostomy tube obstruction due to dried/thick secretions. Subjects who were medically stable, emerged out of coma, had strong cough, and minimal secretions underwent endoscopic airway and swallowing evaluation by the speech and language pathologist. Then, subjects with compromised airway had tracheostomy tube (cuff deflated) change to cuffless non fenestrated. On the other hand, subjects with good airway assessment had tracheostomy tube (cuff deflated) change to a cuffless fenestrated tube and progressed to a capping trail. The endoscopic airway evaluation is an anatomical assessment, and the capping trial is a functional/physiological assessment for the airway. Subsequently, patients who had successful capping progressed to decannulation. Capping failure was defined as respiratory distress and/or the inability to maintain oxygen saturation during a 72 hour trial of tracheostomy tube capping.[11] When subjects failed the capping trial, further capping was delayed, and re-assessment of the decannulation protocol steps regarding suctioning/secretions management, medical stability, tube type/size, and airway assessment for granulomas/obstructive lesions was repeated. If the reason for capping failure remained unknown, a computed tomography for neck and chest was done to rule out subglottic stenosis, tracheal stenosis, tracheomalacia, and/or tracheoesophageal fistula. Tracheostomy subjects who failed repeated capping trials did not progress to decannulation and were labelled long-term tracheostomy.

The objective of swallowing evaluation was to ensure safe feeding, and the recommended feeding modality did not impact decannulation protocol. Tube fed subjects who had successful capping underwent a repeated swallowing evaluation after decannulation because normalization of subglottic pressure, and laryngeal mobility could improve dysphagia.

Decannulation failure was defined as the need for stoma recannulation or oral intubation due to respiratory distress and/or the inability to maintain oxygen saturation 48–96 hours after decannulation.[12,13]

Based on a small pilot study, the proportion of subjects with failed capping was estimated to be approximately 50%. The subjects' electronic medical records were checked for data availability. Sample size calculation was performed using the formula: N = 10 K/P, where K is the number of predictors needed in the model, and P is the smallest proportion among positive or negative cases.[14] The nQuery program was used for sample size sensitivity analysis. After accounting for missing data, the estimated sample size for a power of 80% and a two-sided alpha level of 0.05% was 140 subjects. Data analysis was done using IBM SPSS Statistics Version 26.

Results

The team followed 221 subjects during the study period. Of these, 16% (36/221) were excluded as they were long-term tracheostomy subjects with recurrent admissions (range, two-five times) and compromised airway, and 84% (185/221) underwent the decannulation protocol (Figure 1). We successfully decannulated 71/185 subjects (38%), and none of them developed decannulation failure. The median time to decannulation after ICU discharge was 47 days. Subjects who failed capping multiple times 114/185 (62%) were labeled long term and did not progress to decannulation.

The subjects' characteristics and outcomes are presented in Table 1. Chi-squared and Fisher's exact tests showed that sex, comorbidities, age, GCS, feeding, and mortality were significantly associated with decannulation protocol outcomes. The most prevalent comorbidity was brain injuries (stroke, traumatic brain injuries, brain tumors) 78% (145/185); however, the highest capping failure rates were noted among subjects with ischemic heart disease and/or heart failure 90% (14/15), and those with end-stage renal disease undergoing dialysis 100% (13/13). Using multiple logistic regression, the significant predictors for long-term tracheostomy among subjects (n = 185) were determined to be GCS <11 (odds ratio [OR], 5.6; 95% CI, 2.7–12.0), age ≥ 65 years (OR, 4.5; 95% CI, 2–10), comorbidities ≥ 2 (OR, 4.0; 95% CI, 1.5–11), and female sex (OR, 3.0; 95% CI, 1.3–7.4; Table 2). When subjects were grouped according to the total number of predictors (0, 1, 2, ≥ 3), a significant association was found between the number of predictors per subject and the proportion of subjects with long-term tracheostomy (Fisher's exact test, $P < 0.001$). The proportion of subjects with long-term tracheostomy significantly increased with the total number of predictors (Figure 2).

Subjects who became long-term tracheostomy were discharged after receiving caregiver education and tracheostomy home care supplies. Fifteen subjects were decannulated during follow-up visits in the tracheostomy clinic after hospital discharge. Of the entire cohort, 18% (40/221) had died. However, none had died due to tracheostomy complications. There were four deaths among the excluded 36 long-term tracheostomy subjects (11%) and 36 among the 185 subjects who underwent decannulation protocol (19%). The difference in mortality between them was not statistically significant (Chi-squared test, $P = 0.20$).

Discussion

Tracheostomy patients may have airway, medical, and neurological abnormalities; therefore, multiple disciplines are involved in decannulation. Multidisciplinary and interdisciplinary team approaches are used to manage patients requiring multiple disciplines. In the multidisciplinary approach, team members work independently, while in the interdisciplinary approach, team members work together, collaborate, and communicate effectively to manage the patients.[15,16] A team-based approach when delivering care to tracheostomy patients improves their outcomes.[17] The outcomes reported in this study were achieved using the interdisciplinary team approach, which ensured continuity of care, decreased the burden on individual clinicians, bridged experience gaps among team members, and improved the ability to make airway management decisions.

The rate of successful decannulation varies in the literature from 20-80%, depending on the setting and patient population studied.[17–21] The decannulation failure rate is in the range of 2-5%.[12,13] The reported mortality of tracheostomy patients varied between 20-40%, primarily due to significant associated morbidities.[3,22,23] The time from ICU discharge to decannulation was reported to reflect team performance because total tracheostomy time and length of hospital stay were affected by complications that delayed ICU discharge. Furthermore, length of hospital stay was affected by complications that delayed hospital discharge post-decannulation.[24] The identified predictors (age, GCS, sex, and comorbidities) were also significant in previous studies[9,12,13,17,20,25]; however, our study was the first to combine them into one model.

Moreover, this study was the first to report that subjects with multiple predictors were more likely to have long-term tracheostomy (Figure 2). The ability to identify subjects with multiple predictors for long-tracheostomy is essential for effective utilization of resources, and proper reporting of teams' outcomes. Subsequently, subjects with three or more predictors could be discharged and/or re-evaluated when their GCS or comorbidities had improved.[26]

Although decannulation predictors varied in the literature, they are clinically related. For example, the ability to cough is related to the level of consciousness; the need for suction is related to cough strength; pooling of secretions is related to the degree of dysphagia; oxygenation is related to medical stability and comorbidities.[27] While trying to fit all possible/related predictors into one model is attractive, it is difficult due to reasons like sample size constraints, and multicollinearity. On the other hand, identifying the least number of predictors for an outcome is essential, and more practical/helpful to clinicians. The identified predictors (age, sex, comorbidities, and GCS) had the advantage of being simple and readily available. Other predictors reported in the literature were not included in this study because of the difficulty in measuring cough effectiveness among comatose subjects (peak cough flow and maximum expiratory pressure), the need for special expertise and equipment (endoscopic airway and swallowing evaluation) that may not be available at every center, and the overlap with studied predictors (respiratory failure and comorbidities).[10,11,13,28] Note that, although all medically stable and cognitively able subjects underwent bedside and instrumental swallowing evaluations by the speech and language clinician, only 8% (15/185) could tolerate an oral diet at the time of decannulation (Table 1).

Study Limitations

This study's design was retrospective; however, there were no missing data related to the subjects' outcomes or the assessed predictors. This is related to the electronic nature of the records and the completeness of documentation. Moreover, long-term tracheostomy was not a rare outcome (62%); therefore, the reported odds ratios may have overestimated its risk. Finally, the association between the number of predictors and long-term tracheostomy needs validation in future studies.

Conclusion

Long-term tracheostomy is a common outcome among tracheostomy patients. Older age, low GCS, female gender, and the number of comorbidities were significant long-term tracheostomy predictors. Further studies to assess outcomes and predictors of tracheostomy subjects are needed.

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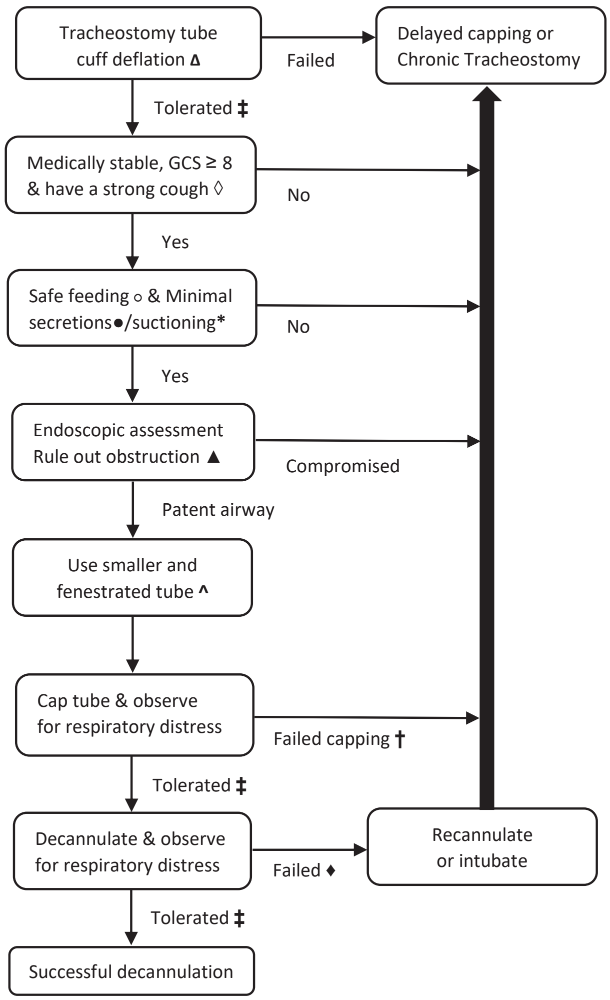
Quick Look

Current Knowledge   A team approach for delivering care to tracheostomy subjects improves their outcomes. Several decannulation predictors have been identified in the literature.
What This Paper Contributes To Our Knowledge   Older age, low GCS, female gender, and the number of comorbidities are significant long-term tracheostomy predictors. The ability to identify subjects with multiple predictors for long-tracheostomy is essential for effective utilization of resources, and proper reporting of teams' outcomes. Subsequently, subjects with three or more predictors could be discharged and/or re-evaluated when their GCS or comorbidities had improved.



∆ Inner tube care & humidification , ‡ Monitor vital signs

◊ Voluntary or evoked cough (in cognitively impaired subjects)

○ Need Swallowing assessment and good mouth hygiene

● May use anticholinergics +/- Salivary glands Botox injection

* Suctioning frequency ≤ 2 times/ 8 hours shift

▲Vocal cord paralysis (**median** position), granuloma, or subglottic stenosis

^ May use a speaking valve but need to monitor vitals signs initially

† Distress or hypoxia during progressive capping for 72 hours

♦ Distress or hypoxia within 96 hours of decannulation

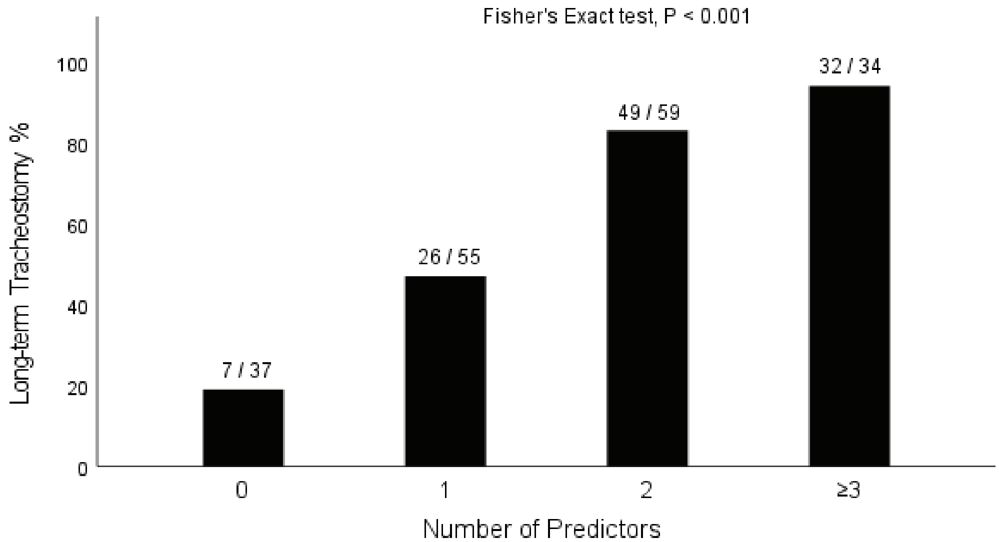

Fisher's Exact test, P < 0.001
Long-term Tracheostomy %
0
20
40
60
80
100
7 / 37
26 / 55
49 / 59
32 / 34
0
1
2
≥3
Number of Predictors

Table 1: Outcomes and characteristics of tracheostomy subjects*

Variables		N	Decannulated (%)	Long term tube (%)	P value
Age	< 65	104	57 (55)	47 (45)	.001
	≥ 65	81	14 (17)	67 (83)	
Sex	Male	139	59 (42)	80 (58)	.05
	Female	46	12 (26)	34 (74)	
GCS^	≥ 11	81	48 (59)	33 (41)	.001
	< 11	104	23 (22)	81 (78)	
Feeding	Oral	18	15 (83)	3 (17)	.001†
	Tube	167	56 (34)	111 (66)	
Morbidities	< 2	138	65 (47)	73 (53)	.001
	≥ 2	47	6 (13)	41 (87)	
Brain	Yes	143	56 (39)	87 (61)	.7
Injury	No	42	15 (36)	27 (64)	
IHD or	Yes	15	1 (7)	14 (93)	.01
HF●	No	170	70 (41)	100 (59)	
COPD or ♦	Yes	41	9 (22)	32 (78)	.01
Pneumonia	No	144	62 (43)	82 (57)	
ESRD on▲	Yes	13	0 (0)	13 (100)	.002
Dialysis	No	172	71 (41)	101 (59)	
Hospital	Yes	36	2 (6)	34 (94)	.001†
Mortality	No	149	69 (46)	80 (54)	
Prolonged	Vent	158	59 (37)	99 (63)	0.5
	◦Others	27	12 (44)	15 (56)	

*Univariate analysis using Chi-Square, † Fisher's Exact test, ^GCS Glasgow coma scale, ●Ischemic heard disease or heart failure, ♦Chronic obstructive pulmonary disease, ▲End stage renal disease, ◦Tracheostomy indications.

Table 2: Predictors of long-term tracheostomy using multiple logistic regression.

	Unadjusted			Adjusted		
Predictors	**OR**	**P value**	**95% C.I**	**OR**	**P value**	**95% C.I**
Sex **Female**	2	.051	1.0-4.4	3	.01	1.3-7.4
Morbidities **≥ 2**	6	.001	2.4-15	4	.007	1.5-11.2
Age **≥ 65**	5.8	.001	3-11.6	4.5	.001	2.1-10
GCS **< 11**	5	.001	2.7-10	5.6	.001	2.7-12