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ORIGINAL ARTICLE

Risk Factors for Futile Tracheostomy: An Analysis of the NIS Database

Amin Mohamed Ahmed [1] ORCID https://orcid.org/0000-0003-0650-0869,
Abdulaziz A Arishi [1] ORCID https://orcid.org/0000-0002-4769-3583,
Lindsey Loss [1] ORCID https://orcid.org/0000-0002-7563-1996,
Afshin Parsikia [1] ORCID https://orcid.org/0000-0002-0092-4882,
Jorge Ortiz [1] ORCID https://orcid.org/0000-0002-0120-8239.

[1] *Department of Surgery, University of Toledo Medical Center, Toledo, Ohio, United States*

ADDRESS FOR CORRESPONDENCE:

Lindsey Loss, MD

Department of Surgery
University of Toledo Medical Center,
Toledo, Ohio
3065 Arlington Ave #2216
Toledo, OH 43614 United States;

e-mail: lindseyjeanloss@gmail.com

ABSTRACT

INTRODUCTION: Respiratory insufficiency and failure are leading causes of ICU admissions. Advances in medical technology allow prolonging of survival in critical illnesses. Hence, more tracheostomies are being performed. However, we are limited in predicting who may actually benefit. Our goal was to determine prognostic indicators of early mortality after tracheostomy in order to avoid futile procedures.

MATERIAL AND METHODS: We performed a retrospective cohort study utilizing the National Inpatient Sample (NIS) database on all adults who underwent tracheostomy between 2005 and 2015. We defined futile tracheostomy as death within 30 days post tracheostomy during the same hospital admission. Univariate and multivariate testing were performed on the weighted dataset. Odds ratios (OR) were calculated with multivariate logistic regression testing.

RESULTS: 851,020 cases met the inclusion criteria. Rate of futility was 12.4% (n=105,658). Total hospitalization cost was greater in the futile group as compared to non-futile group. On Multivariate testing, male gender, age greater than 65, 3 Elixhauser mortality index categories, Asian/Pacific Islander and other race, self-pay and no charge insurance, septicemia and mechanical ventilation greater than 96 hours were independent risk factors to predict futility. Among these, septicemia was the greatest risk for futility (OR 2.32), followed by Elixhauser mortality index >10 (OR 1.954), and Elixhauser mortality index between 3 and 10 (OR 1.468).

CONCLUSIONS: Between 2005 and 2015, 12.4% of tracheostomies could be considered futile. Targeted efforts are needed to decrease the number of unnecessary procedures in the critically ill. We should consider the identified risk factors to share more informed discussions with patients and families to set better long-term expectations and realistic goals for care.

KEY WORDS: Critical care, tracheostomy, complication, mortality, risk factors.

INTRODUCTION

Respiratory insufficiency and failure are leading causes of ICU admissions [1]. Tracheostomy is indicated after prolonged intubation in order to provide greater comfort, mobility and airway security while decreasing sedative and antipsychotic use [2]. Up to one third of those experiencing prolonged mechanical ventilation, approximately 100,000 people, undergo tracheostomy yearly in the United States [3]. However, it is not without risks [4]. Loss of airway, bleeding, and infection are well known early complications. Tracheal stenosis, tracheomalacia, tracheoarterial fistula, and persistent stoma are established late complications. Despite a perioperative mortality rate of 0.7%, the expectation is of extended survival and eventual placement in rehabilitation facilities [5]. Candidates who are hemodynamically unstable, suffer from bleeding dyscrasias, and are unlikely to survive long term should not be considered for this intervention. Mortality within the thirty-day post-operative period may indicate improper patient selection and inappropriate utilization of resources. Parsikia et Al., reported that hypoalbuminemia and fewer pre-procedure mechanical ventilation days were negative predictors for early mortality and futile operations. However, that analysis only encompassed five hundred patients [5]. Therefore, we sought to capitalize on national data to determine indicators of early mortality after tracheostomy in order to avoid futile procedures.

MATERIAL AND METHODS

Data Collection

We performed a retrospective cohort study utilizing the National Inpatient Sample (NIS) database. The NIS contains information from across the United States, including medical conditions, procedures performed, overall cost of hospitalization, quality of care, and outcomes within 30 days on both inpatient and outpatient surgeries. It is sponsored by the Agency for Healthcare Research and Quality (AHRQ) and was developed for the Healthcare Cost and Utilization Project (HCUP) [6]. It is the largest available inpatient hospital care index in the United States that includes all insurance payers. It encompasses those with Medicare, Medicaid, private insurance, and the uninsured. The data is collected annually and represents over 7 million hospital admissions. The NIS maintains records for each hospital admission. This includes patient demographics, primary payment types, primary and secondary diagnoses, procedures performed, in-hospital mortality, length of hospital stay, and total hospitalization costs. All physicians and individual identifiers are removed from this data set. Approval for institutional review both was not required.

Selection

The International Classification of Disease (ICD), 9th Revision, clinical modifications (ICD-9-CM) and ICD-10 was used to select patients who underwent a tracheostomy procedure. We included individuals over 18 years of age. All diagnoses and procedures were identified by ICD-9-CM and ICD-10 codes. Those with missing or incomplete data were excluded as well as those with negative time to tracheostomy. We divided the analysis into futile tracheostomy and non-futile tracheostomy cohorts. We defined futile tracheostomy as occurrence of death within 30 days or less post-tracheostomy in the same hospital admission of the procedure.

Statistical analysis

All statistical analyses were performed using IBM's Statistical Package for Social Sciences (SPSS), Version 25 (IBM Corp, Armkonk, NY). Continuous variables were presented as a mean in cases of normal distribution or as a median in case of non-normal distribution. Discrete variables were presented as a rate. Adjusted weights to discharge were used for a nationwide estimation number. Continuous variables were compared via t-test or nonparametric test, while discrete variables were compared via Chi-square test. Comorbidities were categorized in 4 Elixhauser mortality index groups. Patients and hospital characteristics as well as associated injuries, complications and outcomes were all statistically significantly different between the two groups. As such, they entered a multivariate logistic regression testing and odds ratios were computed as compared to a reference category (baseline) within the same category. Type I error was set at 0.05 and all p-values indicate two-sided tests.

RESULTS

Demographics

We identified 1,024,493 adults who underwent tracheostomy between 2005 and 2015 in the NIS database (weighted estimate). After applying exclusion criteria, 851,020 records remained for analysis. Of these, 58.6% (n=499,045) were male, 65.5% (n=506,041) were white, 49.2% (n=417,530) had Medicare insurance coverage, and 33.1% (n=274,608) were in the lowest income quartile (Table 1). Of the hospitals, 56.1% (n=474,914) were private not-for-profit, 70.4% (n=595,378) were classified as large bed size, 68.8% (n=581,782) were urban teaching facilities, and 42.8% (n=364,258) were located in the South (Table 1, Table 2).

Table 1. Patient Demographics

	Total (851,020)	%	Futile (105,658)	%	Non-Futile (745,362)	%	P-value
Age>65	371194	43.60%	58513	55.40%	312681	42.00%	<0.001
Age	60.2 (SD 16.6)		65.0 (SD 15.0)		59.5 (SD 16.7)		<0.001
Male	499045	58.60%	60272	57.00%	438773	58.90%	<0.001
Race							
White	506041	65.50%	62749	65.20%	443292	65.00%	0.134
Black	143971	18.50%	16511	17.20%	127460	18.70%	<0.001
Asian or Pacific Islander	20738	2.70%	3059	3.20%	17679	2.60%	<0.001
Hispanic	76070	9.80%	9491	9.90%	66579	9.80%	0.299
Native American	4307	0.60%	465	0.50%	3842	0.60%	0.002
Other	27431	3.50%	3946	4.10%	23485	3.40%	<0.001
Elixhauser Mortality Index							
≤ -1	65599	7.7%	3663	3.5%	61936	8.3%	<0.001
0-2	75739	8.9%	6177	5.8%	69562	9.3%	<0.001
3-10	163655	19.2%	16287	15.4%	147368	19.8%	<0.001
>10	546027	64.2%	79530	75.3%	466497	62.6%	<0.001
Primary Expected Payer							
Medicare	417530	49.20%	61986	58.80%	355544	47.80%	<0.001
Medicaid	140414	16.50%	14163	13.40%	126251	17.00%	<0.001
Private Insurance	214882	25.30%	21273	20.20%	193609	26.00%	<0.001
Self-Pay	40040	4.70%	4612	4.40%	35428	4.80%	<0.001
No charge	4409	0.50%	473	0.40%	3936	0.50%	0.001
Other	31675	3.70%	2916	2.80%	28759	3.90%	<0.001
Median Household Income							
0-25th Quartile	274608	33.20%	33328	32.50%	241280	33.30%	<0.001
26th to 50th Quartile	211830	25.60%	25300	24.60%	186530	25.70%	<0.001
51st to 75th Quartile	184795	22.30%	22815	22.20%	161980	22.30%	0.386
76th to 100th Quartile	156246	18.90%	21203	20.70%	135043	18.60%	<0.001
Charge	267781.0 (148239.0-461041.0)		285534.00 (169552.0- 472237.0)		265026.0 (144942.0 - 459194.7)		<0.001
Length of stay	26.0 (16.0 – 40.0)		26.0 (17.0-35.0)		26.0 (16.0 – 41.0)		<0.001

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Table 2. Hospital Demographics

	Total (851,020)	Percent	Futile (105,658)	Percent	Non-Futile (745,362)	Percent	P-value
Control or Ownership							
Government or Private	161524	19.10%	24038	22.80%	137486	18.60%	<0.001
Private, Not-for-Profit	474914	56.10%	56387	53.60%	418527	56.50%	<0.001
Private	2269	0.30%	387	0.40%	1882	0.30%	<0.001
Private, Investor Owned	93950	11.10%	12735	12.10%	81215	11.00%	<0.001
Public	113150	13.40%	11705	11.10%	101445	13.70%	<0.001
Hospital Bed Size							
Small	61929	7.30%	8415	8.00%	53514	7.20%	<0.001
Medium	188499	22.30%	24141	22.90%	164358	22.20%	<0.001
Large	595378	70.40%	72696	69.10%	522682	70.60%	<0.001
Location and Teaching Status							
Rural	28924	3.40%	4039	3.80%	24885	3.40%	<0.001
Urban Non-Teaching	235101	27.80%	33317	31.70%	201784	27.20%	<0.001
Urban Teaching	581782	68.80%	67896	64.50%	513886	69.40%	<0.001
Region							
Northeast	188430	22.10%	28313	26.80%	160117	21.50%	<0.001
Midwest	143957	16.90%	14243	13.50%	129714	17.40%	<0.001
South	364258	42.80%	43666	41.30%	320592	43.00%	<0.001
West	188430	22.10%	28313	26.80%	160117	21.50%	<0.001

Table 3. Outcomes

	Total (851,020)	Percent	Futile (105,658)	Percent	Non-Futile (745,362)	Percent	P-value
Skull Fracture & Intracranial Injury	49844	5.90%	2691	2.50%	47153	6.30%	<0.001
Cervical Spine Injury	9456	1.10%	623	0.60%	8833	1.20%	<0.001
Tracheostomy Infection	4071	0.50%	300	0.30%	3771	0.50%	<0.001
Mechanical Ventilation >96 Hours	608915	71.60%	85233	80.70%	523682	70.30%	<0.001
Septicemia and Sepsis	317558	37.30%	61970	58.70%	255588	34.30%	<0.001
Vocal Cord Paralysis	4492	0.50%	224	0.20%	4268	0.60%	<0.001

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Table 4. Multivariate Logistic Regression Testing on the Weighted Dataset

	P-value	OR	95% CI for OR	
			Lower	Upper
Male	0.002	1.023	1.008	1.038
Age >65	<0.001	1.429	1.403	1.456
Elixhauser mortality index category				
≤ -1	Reference			
0-2	<0.001	1.332	1.271	1.395
3-10	<0.001	1.468	1.409	1.528
>10	<0.001	1.954	1.881	2.029
Race				
White	Reference			
Black	<0.001	0.927	0.909	0.946
Hispanic	0.346	0.988	0.964	1.013
Asian or Pacific Islander	<0.001	1.086	1.042	1.133
Native American	0.023	0.883	0.794	0.983
Other	<0.001	1.110	1.070	1.152
Primary Expected Payer				
Medicare	Reference			
Medicaid	<0.001	0.952	0.929	0.976
Private Insurance	<0.001	0.945	0.925	0.965
Self-pay	<0.001	1.257	1.210	1.306
No charge	0.006	1.158	1.044	1.285
Other	0.007	0.939	0.897	0.983
Income Quartile				
First Quartile	Reference			
Second Quartile	<0.001	0.962	0.944	0.980
Third Quartile	0.002	0.969	0.950	0.989
Fourth Quartile	0.591	0.994	0.973	1.016
Hosptial Bed size				
Small	Reference			
Medium	0.018	0.966	0.938	0.994
Large	0.031	0.971	0.946	0.997
Hospital Control				
Government or Private	Reference			
Public	<0.001	0.650	0.632	0.667
Private, Not-for-Profit	<0.001	0.652	0.640	0.664
Private, Investor-Owned	<0.001	0.639	0.621	0.657
Private	0.858	0.987	0.857	1.137
Region				
Northeast	Reference			
Midwest	<0.01	0.664	0.648	0.68
South	<0.01	0.853	0.837	0.87
West	<0.01	0.858	0.839	0.878
Location/Teaching Status				
Rural	Reference			
Urban, Non-Teaching	<0.001	0.896	0.859	0.934
Urban, Teaching	<0.001	0.769	0.739	0.801
Associated Conditions				
Septicemia	<0.001	2.320	2.286	2.355
Ventilator >96 hours	<0.001	1.315	1.291	1.34
Skull Fracture and Intracranial Injury	<0.001	0.650	0.622	0.68
Vocal Cord Paralysis	<0.001	0.513	0.443	0.593
Cervical Spine Injury	<0.001	0.753	0.688	0.824
Tracheostomy Infection	<0.001	0.574	0.505	0.652

Outcomes

Futile tracheostomy procedures were more frequent in the elderly. There was a significantly higher number of individuals over age 65 in the futile comparted to the non-futile cohort (55.4% vs. 42.0%, p<0.001). On univariate analysis all patient and hospital characteristic categories were statistically significant, including age greater than 65, gender, race, primary expected payer, median household income, hospital control or ownership, hospital bed size, location, teaching status, and region. Prolonged mechanical ventilation was more frequent in the futile than the non-futile tracheostomy group (80.7% vs. 71.6%, p<0.001). Septicemia was also more common in the futile tracheostomies (58.7% vs. 37.3%, p<0.001). Skull fractures, intracranial injuries, cervical spine injury, tracheostomy infection, and complications of vocal cord paralysis were significantly less common in futile group (Table 3).

On multivariate logistic regression, male gender (OR 1.023, p=0.002), age greater than 65 (OR 1.429, p<0.001), Elixhauser mortality index category 1-4, (OR 1.954, p <0.001 for category 4), Asian or Pacific Islander race (OR 1.086, P <0.001), other race (OR 1.11, p <0.001), self-pay insurance (OR 1.257, p<0.001), no charge insurance (OR 1.158, p 0.006), septicemia (OR 2.32, p < 0.001), and mechanical ventilation >96 hours (OR 1.315, p <0.001) were independent predictors of futility that had an OR greater than baseline reference category (Table 4).

DISCUSSION

Prolonged ICU stay correlates with an increased one-year mortality [7]. Across 2,800 intensive care units, respiratory failure accounted for 14.6% of admissions [1]. The mortality rate in the ICU is higher for the mechanically ventilated [7]. More tracheostomies are being performed as advances in medical ability allow us to prolong critical illness [8]. For example, one third of those mechanically ventilated undergo prolonged mechanical ventilation [3]. It is clear that our ability to predict whom will benefit from tracheostomy is limited [3]. Discussions about placing a tracheostomy should be used as a pivotal moment in care to discuss the overall clinical condition and long- and short-term prognosis. Anticipating survival is challenging, which creates significant distress for providers and families alike. The emotional turmoil of critical illness affects everyone involved [9-11]. Identifying risk factors for early mortality is paramount to facilitate discussions about the goals of treatment.

While our 12.4% 30-day inpatient mortality may appear low for critically ill patients, discussions about placing tracheostomies should be held in the context of expected prolonged survival. Therefore, we argue that a 12.4% futility is high for patients undergoing a procedure that should only be performed in cases with presumed prolonged survival. While other investigators evaluated predictors of one year survival after prolonged mechanical ventilation, we sought to evaluate the risk factors associated with high risk of early mortality, signifying a potentially unnecessary procedure [12].

Our futility rate is supported by another investigation examining futile procedures at the end of life [13]. They found that the average rate of futile treatment at the end of life was 12.1% [13]. There is a clear deficit in the way clinicians are able to address these situations with families [14]. This is an increasingly important topic as our medical advances now allow us to prolong lives that previously would have been impossible. Thus, treatment can not only be a question of is it possible to keep an individual alive but must be more focused around goals of care, quality of life, and healthcare resource utilization. Many reports have examined the impact of futile care, both emotionally and financially [13-15]. It has been established that futile care results in increased hospital spending. However, as providers we need to continue to educate ourselves to be aware of when procedures may not actually improve a patient's quality of life and consider the impact this has on both the individual and family emotionally. One way we may start to do so is by recognizing the risk factors that may be associated with these procedures being futile.

In our investigation, sepsis and septicemia were associated with the highest risk of futile tracheostomy. This is likely due to the pathophysiology of sepsis causing and worsening organ dysfunction, ultimately leading to instability and organ failure [16]. Similarly, Knaus et Al. showed mortality increases with involvement of multiple organ systems [17]. This is in line with our findings that having an Elixhauser mortality index of greater than 10 was an increased risk for futile tracheostomy. The Elixhauser mortality index has been used to group multiple comorbidities and use that information to predict their mortality and readmission rates [18]. Higher scores on these measures have been shown to be correlated with higher rates of readmission and mortality in many populations including surgical patients and those with COPD [18]. These scales include many common comorbid conditions, including liver and renal disease. The prevalence of chronic liver disease is increasing, which is mostly attributed to NASH cirrhosis [19].

Due to this increase, it is a risk factor to keep in mind when evaluating the critically ill. Although we could not evaluate the chronicity of these disease processes or their severity, the increased futility risk with multiple comorbidities was significant. Additionally, individuals older than 65 were also at a significantly higher risk of futile tracheostomy placement. Farfel et Al. established that age greatly increases the risk of in-hospital mortality, especially when they are admitted to the ICU and mechanically ventilated [20]. Additionally, Nicolas et Al. and Vosylius et Al. demonstrated that older age is associated with increased mortality and illness severity in the ICU [21,22]. This is directly in-line with both of our results that age and multiple comorbidities are associated with an increased risk of futile tracheostomy.

Protective Factors

Fewer futile tracheostomy procedures were performed in those admitted with cervical spine injuries and skull fractures or intracranial injuries. This population is known to have decreased ICU length of stay, ventilator days, and decreased ICU and overall hospitalization costs with early tracheostomy [23]. It is possible that those admitted to the ICU due to traumatic insults (fractures, intracranial and cervical spine injuries) experience airway compromise without organ system failure. Therefore, their short-term mortality is decreased, which is consistent with results indicating that traumatic injuries had fewer futile tracheostomy procedures. In contrast to this, Parsikia et Al. did not find a significant difference between futile and non-futile tracheostomies in trauma patients [5]. However, they only reported 49 cases of futile tracheostomies and 369 of non-futile tracheostomies. Of these, only 91 suffered a trauma, which could make a significant difference harder to detect. Additionally, the higher success rate may be due to the different indications that neurological injury may have for tracheostomy placement. Unfortunately, due to the nature of this dataset we were unable to assess neurological function or outcome that may have led to this difference.

Strengths and Limitations

The NIS database is comprehensive and a good representation of the national stature of our healthcare system. We believe this is a valid starting point for further analysis of futile tracheostomies in healthcare. The large sample size and breadth across the country allows our findings to be more generalizable than other single center reports. The database also allowed us to compare between and control for a wide variety of hospital and patient demographics, eliminating many confounding variables.

Many of our limitations were due to the nature of using a national database with fixed information. We were unable to determine the ultimate cause of death or time of death. Therefore, the increased mortality detected could be due to the natural course of disease, change in the goals of care, or a number of other confounding factors. The Sequential Organ Failure Assessment (SOFA) score, which is often used to predict ICU mortality and sepsis severity, was not available to us to quantify the magnitude of organ dysfunction. Further work needs to be completed to stratify the rate of futile tracheostomies by the degree of sepsis. Additionally, laboratory values such as albumin and data to determine the extent of illness experienced were not part of the database. Finally, additional information such as the setting of a medical ICU versus surgical ICU and the training background of the surgeon performing the procedure were unavailable.

CONCLUSIONS

Our current prognostication of the critically ill needs improvement as the rate of futile tracheostomies is still high. Discussions on goals of care between physicians and loved ones is plagued by the subjectivity of expectations. Prolonging critical illness can lead to unnecessary procedures and costs with little change in outcome. Ensuring that decision makers understand the high potential for morbidity and mortality is vital. While a tracheostomy is associated with many benefits, discussion of the procedure should be accompanied by a full informed consent. This includes a thorough explanation of all risks and potential outcomes even if the procedure itself is successful. It is crucial to explain that 12.4% may die within one month of the procedure during their hospitalization.

Clinical Significance

Communicating that the risk of death is higher in certain individuals with ventilator dependence, such as those with sepsis and multiple comorbidities, may help both providers and loved ones arrive at more cognizant decisions. Physicians need to use this information to guide their discussion with families and surrogate decision makers when determining whether or not the benefits of performing a tracheostomy will be futile.

Disclosure statement

The authors did not report any potential conflict of interest.

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