Published in final edited form as:

Laryngoscope. 2014 May ; 124(5): 1118–1122. doi:10.1002/lary.24347.

Predictors of Clinical Outcome After Tracheotomy in Critically Ill Obese Patients

J. Kenneth Byrd, MD, Viran J. Ranasinghe, BS, Kristine E. Day, MD, Bethany J. Wolf, PhD, and Eric J. Lentsch, MD

Department of Otolaryngology (J.K.B.), University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, Department of Otolaryngology–Head and Neck Surgery (V.J.R., E.J.L.), Medical University of South Carolina, Charleston, South Carolina, Department of Surgery (K.E.D.), University of Alabama at Birmingham, Birmingham, Alabama, Department of Public Health Sciences (B.J.W.), Medical University of South Carolina, Charleston, South Carolina, U.S.A

Abstract

Objectives/Hypothesis—To identify patient factors associated with outcomes in critically ill obese patients requiring tracheotomy.

Study Design—Single-institution, retrospective cohort study.

Methods—Charts were reviewed for inpatients admitted to an intensive care unit from 2007 to 2010 with International Classification of Diseases, 9th Revision codes of obesity or morbid obesity and tracheotomy. Variables collected in the dataset include subject age, ethnicity, gender, body mass index, tracheotomy type, patient outcome, chief diagnosis, and medical comorbid conditions. The primary outcomes of interest were tracheotomy type and patient outcome at the time of hospital discharge. Logistic regression models were developed for the probability of each patient outcome using univariate and multivariate models.

Results—One hundred two patients met inclusion criteria. The most common outcome was tracheostomy dependence (49%). Increased mortality was independently significantly associated with pulmonary hypertension ($P=.019$) and African American ethnicity ($P=.045$). Increased tracheostomy dependence was significantly associated with obstructive sleep apnea ($P=.030$). Increased decannulation was significantly associated with percutaneous tracheotomy ($P=.016$) and Caucasian ethnicity ($P<.001$).

© 2014 The American Laryngological, Rhinological and Otolological Society, Inc.

Send correspondence to J. Kenneth Byrd, MD, Department of Otolaryngology, University of Pittsburgh Medical Center, 200 Lothrop Street, Suite 500, Pittsburgh, PA 15213. byrdjk@upmc.edu.

Presented as an oral presentation at the Triological Society Annual Meeting at the Combined Otolaryngology Spring Meeting, Orlando, Florida, U.S.A., April 12–13, 2013.

This work was performed in the Department of Otolaryngology–Head and Neck Surgery (J.K.B., K.E.D., V.J.R., E.J.L.), Medical University of South Carolina, Charleston, South Carolina, and the Department of Public Health Sciences (B.J.W.), Medical University of South Carolina, Charleston, South Carolina, U.S.A.

Dr. Byrd is currently enrolled in a Head and Neck Oncology fellowship at the University of Pittsburgh Medical Center that was awarded the Clinical Robotics Research Grant from Intuitive Surgical, Inc. Intuitive Surgical has no direct financial relationship with any of the authors and does not censor any research performed.

The authors have no other funding, financial relationships, or conflicts of interest to disclose.

Conclusions—Obese patients in the intensive care unit who undergo tracheotomy have a high likelihood of remaining tracheostomy dependent at the time of discharge from the hospital. The factors most commonly found to be significantly associated with poor outcomes were open tracheotomy, African American ethnicity, obstructive sleep apnea, and pulmonary hypertension.

Keywords

Obesity; morbid obesity; tracheotomy; critically ill; intensive care unit; outcome; mortality; decannulation

INTRODUCTION

The obesity epidemic in the United States has been the subject of much discussion over the past 2 decades. Obesity and morbid obesity are defined as having body mass index (BMI) $>30.0 \text{ kg/m}^2$ and 40.0 kg/m^2 , respectively.¹ Given that more than one-third of US adults are obese, physicians must be aware of the health consequences of obesity, including an increased prevalence of comorbid medical illnesses such as hypertension, diabetes, pulmonary hypertension, and heart disease.^{2,3} Moreover, patients who are significantly obese are at increased risk of death compared to normal-weight individuals.⁴ Given the current trends, the negative health effects of obesity could even overshadow declining smoking rates to lower life expectancy in the United States.⁵

Hospitalized obese patients present additional concerns, as the need for admission to the intensive care unit (ICU), mechanical ventilation, and tracheotomy is increasingly associated with higher BMI.⁶ Furthermore, management of the airway can be a significant challenge in these patients due to altered anatomy and a high prevalence of obstructive sleep apnea and obesity hypo-ventilation syndrome.^{1,7} When obese patients require prolonged mechanical ventilation, tracheotomy can be challenging for the surgeon due to increased subcutaneous and submental fat. Due to these anatomical changes, postoperative accidental decannulation is a potentially deadly complication.

Previous studies of tracheotomy in obese and morbidly obese patients have demonstrated that critically ill obese patients have longer ICU stays and a higher rate of postoperative tracheostomy complications, including death.^{8–11} Adverse outcomes have been attributed to decreased baseline pulmonary function with lower lung volumes and decreased compliance.¹² Although studies have examined post-tracheotomy complications in obese patients, there is a lack of data examining patient factors associated with adverse outcomes. Identification of these factors would improve the physician's ability to counsel patients and family members. The primary goal of this study was to identify patient factors associated with outcomes in critically ill obese patients requiring tracheotomy.

MATERIALS AND METHODS

After approval by the institutional review board, a retrospective chart review was performed of all inpatients admitted to an ICU at a single tertiary institution from 2007 to 2010 with International Classification of Diseases, 9th Revision codes for obesity or morbid obesity and tracheotomy. Patients with a principal diagnosis of malignancy or whose tracheotomies

were performed at an outside facility were excluded. Variables collected in the dataset include subject age, ethnicity, gender, BMI (both continuous and dichotomized by BMI <40 vs. BMI ≥ 40), tracheotomy type (open vs. percutaneous), patient outcome (tracheostomy dependence, decannulation, or death), chief diagnosis (neurologic, traumatic, or other), presence of congestive heart failure, diabetes, hypertension, heart disease, pulmonary hypertension, lung disease, obstructive sleep apnea (OSA), and chronic renal insufficiency (CRI).

The primary outcomes of interest were tracheotomy type and patient outcome. χ^2 test and Fisher exact test (when appropriate) were used to test for associations between these primary outcomes and all dichotomous variables. Normality for all continuous variables was examined using the Shapiro-Wilk test. Associations between the primary outcomes and continuous variables were examined using *t* tests or the Mann-Whitney *U* and Kruskal-Wallis tests (where appropriate). Multiple logistic regression models were developed for the probability of each patient outcome. Explanatory variables with a *P* value <.20 in univariate logistic regression models were considered as candidates for multivariate modeling. All *P* values reported in the multivariate models were two sided, and the type I error rate was set at 0.05. All statistical analyses were conducted in SAS version 9.2 (SAS Institute Inc., Cary, NC).

RESULTS

One hundred two patients meeting study criteria were identified. All tracheotomies were performed by surgical services, including otolaryngologists, general surgeons, and neurosurgeons. Tracheotomy was offered to patients if prolonged mechanical ventilation was anticipated (>10–14 days), if upper airway obstruction was significant, or for pulmonary toilet.¹³ The study population was predominantly female (56.9%) and African American (54.9%). The mean age of study participants was 52.8 ± 15.9 years, and the median BMI was 41.95. The average length of stay was 42.1 ± 26.9 days. Seventy-four percent of participants had open tracheotomies, 26% had percutaneous tracheotomies, and two participants were missing information on tracheotomy type. The most common outcome was tracheostomy dependence (49%), with decannulation in 35.3% and death in 15.7% of participants. The study population characteristics are reported in Table I. Three patients had minor bleeding that was conservatively managed, four had episodes of accidental decannulation, two patients had false passages made during the procedure, and the airway was temporarily lost during percutaneous tracheotomy in one patient. No deaths occurred during tracheotomy or due to accidental decannulation, tube occlusion, or bleeding from the surgical site.

Tracheotomy Type

Tracheotomy type was significantly associated with chief diagnosis (*P*=.001). Subjects with a nontrauma and non-neurological diagnosis had 2.7 times the odds of open tracheotomy relative to subjects with trauma diagnoses (*P*=.007, 95% confidence interval [CI]: 1.32–5.56). Subjects with neurological diagnoses had 2.0 times the odds of open tracheotomy relative to subjects with a trauma diagnosis, although the association was not significant (*P*=.

081, 95% CI: 0.92–4.35). There was no difference in the odds of open versus percutaneous tracheotomy between subjects with neurological diagnoses and non-trauma diagnoses. Tracheotomy type was not significantly associated with age, BMI, ethnicity, gender, congestive heart failure, diabetes status, hypertension, heart disease, pulmonary hypertension, lung disease, OSA, or CRI.

Patient Outcome

Patient outcome was found to be significantly associated with ethnicity, tracheotomy type, congestive heart failure, pulmonary hypertension, or OSA. However, patient outcome was not associated with age, BMI, gender, diabetes status, hypertension, heart disease, lung disease, or CRI. Significant univariate associations with each outcome and the final multivariable models are shown in Table II.

Death—In univariate and multivariate models, death was significantly associated with pulmonary hypertension and ethnicity. Subjects who had pulmonary hypertension had 12.5 times the odds of death relative to subjects without pulmonary hypertension controlling for ethnicity and tracheotomy type ($P=.019$, 95% CI: 1.50–90.9). African Americans had 4.31 times the odds of death relative to Caucasians controlling for tracheotomy type and pulmonary hypertension status ($P=.045$, 95% CI: 1.03–17.9). Occurrence of death was not associated with age, BMI, gender, diagnosis, congestive heart failure, hypertension, diabetes, heart disease, lung disease, OSA, or CRI in univariate or multivariate logistic regression models.

Dependence—In univariate models, dependence was found to be associated with tracheotomy type, OSA, and chief diagnosis. Subjects who had open tracheotomies, OSA, or a neurological versus trauma diagnosis had significantly higher odds of dependence. The final logistic regression model included tracheotomy type, OSA, and diagnosis, although only OSA was significant. Subjects with OSA had 3.1 times the odds of dependence relative to subjects without OSA controlling for tracheotomy type and diagnosis ($P=.030$, 95% CI: =1.12–8.33).

Decannulation—In univariate models, decannulation was significantly associated with tracheotomy type, ethnicity, chief diagnosis, congestive heart failure, and OSA. Subjects who had open tracheotomies, neurological diagnosis, congestive heart failure, OSA, BMI >40, or were African American had significantly lower odds of decannulation. The final multivariate logistic regression model included tracheotomy type and ethnicity. Subjects who had a percutaneous tracheotomy had 3.45 times the odds of decannulation relative to subjects who had open tracheotomies controlling for ethnicity ($P=.016$, 95% CI: =1.25–9.09). Caucasians had five times the odds of decannulation relative to African Americans after controlling for tracheotomy type ($P<.001$, 95% CI: 1.92–12.5).

DISCUSSION

Tracheotomy is one of the most common procedures performed in the ICU, and requires rigorous postoperative care and thorough patient and family education to minimize the chances of postoperative morbidity and mortality.¹⁴ Patients who undergo the procedure can

often be decannulated after the acute illness is treated, either as an inpatient or an outpatient, but some patients may require the tracheostomy for a prolonged period of time. The most common outcome in our study was dependence at the time of hospital discharge, in nearly half of the patients. As many patients were discharged to long-term care facilities and/or lost to follow-up, we were unable to determine how many of these patients were decannulated at a later time.

Harris and colleagues³ demonstrated a post-tracheotomy 30-day mortality rate of 29% in obese subjects with a BMI >35, although a statistically significant association was not shown between BMI and mortality rate. In our study, the mortality rate was less than reported in the literature; this may reflect the lack of follow-up after transfer to an outside facility or discharge. None of the mortalities in this study resulted from accidental decannulation as an inpatient, but this is a feared, potentially deadly complication as an outpatient as well.

In this study, African American ethnicity was associated with a lower rate of decannulation and an increased rate of death. This correlation may represent a lack of health care access that causes these patients to have increased and unknown comorbidities, although our analysis attempts to control for these. Another possibility is that African American patients' comorbidities were poorly controlled as outpatients compared to Caucasians; unfortunately, outpatient medical records were unavailable or incomplete for most patients.

Patients with pulmonary hypertension had a higher rate of death compared to patients without pulmonary hypertension; this association is not surprising but warrants further study. Obesity has been investigated as a possible risk factor for pulmonary hypertension based on the prevalence of OSA among obese patients and the causal relationship between OSA and pulmonary hypertension.¹³ Congestive heart failure was associated with a lower rate of decannulation. Obesity has been shown to have a more direct association with heart failure through structural changes attributed to obesity-related cardiomyopathy and comorbid illnesses including hypertension and diabetes.⁹ Taken together, the clinician may advise obese patients with underlying heart disease that they have poorer prognoses.

Subjects with OSA had lower rate of decannulation and higher rate of tracheostomy dependence, not an unexpected outcome given that tracheotomy is a treatment option for severe OSA. Patients with severe OSA may be less likely to meet decannulation criteria prior to discharge because their baseline pulmonary function deficit would cause lower oxygen saturation levels that would necessitate discharge with a tracheostomy tube. Similarly, patients with obesity hypoventilation syndrome may become habituated to improved oxygenation levels through their tracheostomy and would be intolerant to decannulation.

Open tracheotomy was associated with a lower rate of decannulation, which may represent selection bias against sicker or more obese patients that have other factors contributing to their worse outcomes. Additionally, at the institution where the study was performed, patients in the trauma intensive care unit and neurosurgical intensive care unit are more

likely to undergo percutaneous tracheotomy than those in the medical intensive care unit due to service-related preferences.

Overall, the cohort had a low mortality but high rate of tracheostomy dependence. Although the operations were performed by several surgical services, when performed by the otolaryngology team, defatting tracheotomy, skin flaps, and Bjork flaps were sometimes used based on surgeon judgment when appropriate. Additionally, at the institution where the study was performed, a multidisciplinary tracheostomy care team is involved with all patients who undergo tracheotomy, which allows for standardization of postoperative care and education, as described in the American Academy of Otolaryngology–Head and Neck Surgery Clinical Consensus Statement on Tracheostomy Care.¹⁴ We believe that it is especially important for a surgical service that is familiar with tracheostomy care, preferably the one who performed the operation, to be involved in the initial tube change. In addition to preparation with adequate lighting, assistance, and suction equipment, it may be advantageous to have airway exchange catheters, retractors, and other tracheotomy-related equipment available at the bedside for patients with difficult anatomy.

Limitations of this study include its retrospective nature and the lack of patient follow-up after discharge, preventing examination of long-term outcomes, and specifically long-term mortality. Variability in reporting of comorbidities may have also influenced the study; outside records or medical history from the patients and family members may have been incomplete or incorrect for some patients. Additionally, disease severity was not included in comorbidity analysis because this information was inconsistently reported in the medical record, but may have contributed to patient outcomes. Finally, there was lack of a control group of nonobese critically ill patients to use for study comparison.

CONCLUSION

Obese patients in the ICU who undergo tracheotomy have a high likelihood of remaining tracheostomy dependent at the time of discharge from the hospital. The factors most commonly found to be significantly associated with poor outcomes were open tracheotomy, African American ethnicity, OSA, and pulmonary hypertension. African American obese ICU patients have a lower rate of decannulation and an increased risk of death compared to Caucasian patients, which may represent decreased access to outpatient preventative health care. Long-term outpatient follow-up is needed to better counsel patients and family members. We recommend that extra care be taken with post-tracheotomy care and education in these patients, and that the recommendations outlined in the Academy of Otolaryngology–Head and Neck Surgery Clinical Consensus Statement on Tracheostomy Care be followed.

BIBLIOGRAPHY

1. Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. *Arch Intern Med.* 1998; 158:1855–1867. [PubMed: 9759681]
2. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity in the United States, 2009–2010. *NCHS Data Brief.* 2012; (82):1–8.

3. Harris AT, Morell D, Bajaj Y, Martin-Hirsch DP. A discussion of airway and respiratory complications along with general considerations in obese patients. *Int J Clin Pract*. 2010; 64:802–806. [PubMed: 20518954]
4. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *JAMA*. 2013; 309:71–82. [PubMed: 23280227]
5. Stewart ST, Cutler DM, Rosen AB. Forecasting the effects of obesity and smoking on U.S. life expectancy. *N Engl J Med*. 2009; 361:2252–2260. [PubMed: 19955525]
6. Westerly BD, Dabbagh O. Morbidity and mortality characteristics of morbidly obese patients admitted to hospital and intensive care units. *J Crit Care*. 2011; 26:180–185. [PubMed: 21036522]
7. Lopez PP, Stefan B, Schulman CI, Byers PM. Prevalence of sleep apnea in morbidly obese patients who presented for weight loss surgery evaluation: more evidence for routine screening for obstructive sleep apnea before weight loss surgery. *Am Surg*. 2008; 74:834–838. [PubMed: 18807673]
8. Darrat I, Yaremchuk K. Early mortality rate of morbidly obese patients after tracheotomy. *Laryngoscope*. 2008; 118:2125–2128. [PubMed: 19029859]
9. Dela Cruz CS, Matthay RA. Role of obesity in cardiomyopathy and pulmonary hypertension. *Clin Chest Med*. 2009; 30:509–523. ix. [PubMed: 19700049]
10. Dossett LA, Heffernan D, Lightfoot M, et al. Obesity and pulmonary complications in critically injured adults. *Chest*. 2008; 134:974–980. [PubMed: 18719063]
11. El Solh AA, Jaafar W. A comparative study of the complications of surgical tracheostomy in morbidly obese critically ill patients. *Crit Care*. 2007; 11:R3. [PubMed: 17222333]
12. Varon J, Marik P. Management of the obese critically ill patient. *Crit Care Clin*. 2001; 17:187–200. [PubMed: 11219229]
13. Durbin CG Jr. Tracheostomy: why, when, and how? *Respir Care*. 2010; 55:1056–1068. [PubMed: 20667153]
14. Mitchell RB, Hussey HM, Setzen G, et al. Clinical consensus statement: tracheostomy care. *Otolaryngol Head Neck Surg*. 2013; 148:6–20. [PubMed: 22990518]

TABLE I

Characteristics of the Study Population.

Variable	Category	Value
Ethnicity, no. (%)	Caucasian	44 (43.1)
	Hispanic	2 (1.96)
	African American	56 (54.9)
Gender, no. (%)	Male	44 (43.1)
	Female	58 (56.9)
Diagnosis, no. (%)	Neurological	33 (32.4)
	Trauma	9 (8.82)
	Other	60 (58.5)
Tracheotomy type, no. (%)	Open	74 (74.0)
	Percutaneous	26 (26.0)
Outcome, no. (%)	Death	16 (15.7)
	Decannulation	36 (35.3)
	Dependence	50 (49.0)
Congestive heart failure, no. (%)	Yes	15 (14.7)
	No	87 (85.3)
Diabetes, no. (%)	Yes	46 (45.1)
	No	56 (54.9)
Hypertension, no. (%)	Yes	75 (73.5)
	No	27 (26.5)
Heart disease, no. (%)	Yes	25 (24.5)
	No	77 (75.5)
Pulmonary hypertension, no. (%)	Yes	5 (4.90)
	No	97 (95.1)
Lung disease, no. (%)	Yes	9 (8.82)
	No	93 (91.2)
OSA, no. (%)	Yes	27 (26.5)
	No	75 (73.5)
CRI, no. (%)	Yes	10 (9.80)
	No	92 (90.2)
Age, yr	Mean ($\pm$ SD)	52.8 $\pm$ 15.9
	Median	53
Body mass index	Mean ($\pm$ SD)	45.7 $\pm$ 14.3
	Median	41.95

CRI =chronic renal insufficiency; OSA =obstructive sleep apnea; SD =standard deviation.

TABLE II

Univariate and Multivariate Regression Models by Outcome Variable.

Variable	Reference Category	Univariable OR (95% CI)	P Value	Multivariable OR (95% CI)	P Value
Outcome = Death					
Tracheotomy type	Open	1.48 (0.38–5.74)	.568	0.95 (0.23–4.60)	.941
Pulmonary HTN	Yes	10.0 (1.47–50.0)	.018	12.5 (1.49–90.9)	.019
Race	African American	4.13 (1.10–15.6)	.036	4.31 (1.03–17.9)	.045
Outcome = Decannulation					
Tracheotomy type	Percutaneous	3.70 (1.45–9.09)	.006	3.45 (1.25–9.09)	.016
Race	Caucasian	5.00 (1.33–33.3)	<.001	5.00 (1.92–12.5)	<.001
BMI <40	<40	2.42 (1.05–5.56)	.038		
Diagnosis	Trauma vs. neurological	2.33 (1.09–5.00)	.029		
	Trauma vs. other	1.72 (.88–3.45)	.113		
	Other vs. neurological	1.33 (0.52–3.45)	.547		
Congestive heart failure	No	9.42 (1.19–74.9)	.034		
OSA	No	3.10 (1.06–9.08)	.039		
Outcome = Dependence					
Tracheotomy type	Open	2.95 (1.14–7.64)	.026	2.10 (0.74–5.95)	.163
OSA	Yes	3.33 (1.32–8.33)	.012	3.1 (1.12–8.33)	.030
Diagnosis	Neurological vs. trauma	2.45 (1.05–5.73)	.038	2.31 (0.97–5.53)	.060
	Other vs. trauma	1.81 (0.81–4.04)	.15	1.27 (0.53–3.03)	.593
	Neurological vs. other	1.36 (0.58–3.19)	.484	1.82 (0.71–4.67)	.210
Race	African American	2.12 (0.95–4.74)	.068		

BMI =body mass index; CI =confidence interval; HTN =hypertension; OSA =obstructive sleep apnea; OR =odds ratio.