SciMedCentral

International Journal of Clinical Anesthesiology

Research Article

Clinical Correlates to One Year Mortality Following Tracheostomy of Adult Intensive Care Patients

Shannon M. Grap[1], Michael Goldenberg[1], Colin Huntley[2], Kane High[1], Margaret M. Wojnar[1], Eric W. Schaefer[1] and Sonia Vaida[1]*

[1]Department of Anesthesiology, Department of Pulmonary and Critical Care Medicine, and Department of Otolaryngology, Pennsylvania State University College of Medicine, USA
[2]Department of Otolaryngology, Thomas Jefferson University, USA

*Corresponding author
Sonia Vaida, Department of Anesthesiology, Penn State and Milton S. Hershey Medical Center, 500 University Drive, P.O. Box 850, Mailcode H187, Hershey, Pennsylvania, 17033, USA, Tel: 717-531-8433; Email: svaida@hmc.psu.edu

Submitted: 09 August 2014
Accepted: 01 November 2014
Published: 03 November 2014
ISSN: 2333-6641

Abstract

Background: Tracheostomy is a common surgical procedure performed in the adult intensive care unit (ICU) population etc. Our objective was to identify characteristics associated with one year mortality in adult ICU patients following tracheostomy placement.

Methods: A retrospective chart review was conducted on adult ICU patients admitted at Penn State Hershey Medical Center between January 2004 and December 2009 (n=193) who had a first time tracheostomy. Using univariate statistical analysis with logistic regression and Bonferonni correction, the significance of individual characteristics to one year mortality following tracheostomy was determined. Statistical significance was considered $p < 0.05$; all p values reported are Bonferonni-corrected values.

Results: Mortality at one year following tracheostomy was 21.2% (41 of 193 patients). A total of nine variables were found to have a statistically significant correlation with patient mortality: one week increase in continuous intravenous sedation length following tracheostomy (p=0.00057), fourteen day increase in total mechanical ventilation length (p=0.00082), hyperglycemia (p=0.00130), continuous intravenous vasopressor medication infusions during tracheostomy (p=0.00222), acute renal failure (p=0.00471), increased age (p=0.00892), continuous intravenous vasopressor medication infusions during ICU stay (p=0.01711), hemodialysis (p=0.02813), and a 10,000 cell/μL increase in peak white blood cell count (p=0.03574).

Conclusions: Clinical factors associated with increased mortality of adult ICU patients one year following tracheostomy were identified. These factors may indicate greater severity of systemic dysfunction in an already critically ill population leading to increased mortality.

INTRODUCTION

Tracheostomy is a common procedure performed on adult patients in the Intensive Care Unit (ICU) setting and is performed in approximately 10% to 12% of patients requiring mechanical ventilation for >24 hours [1,2]. Patients requiring tracheostomy have a higher hospital survival rate than patients ventilated via endotracheal tube alone [3]. However, tracheostomy is not without associated mortality. A 20% mortality of tracheostomy patients was found at 28 days following the initiation of mechanical ventilation [4]. The reported mortality rate in patients one year following tracheostomy is 36% [5]. Shah et al. [6] have reported a 19.2% national in-hospital mortality of patients receiving tracheostomy.Identified risk factors of in-hospital mortality following tracheostomy include: hospital region, non-teaching centers, increased age, and co-existing cardiac conditions [7].

We investigated clinical factors associated with one year mortality in adult ICU patients following tracheostomy. Our primary outcome was mortality at one year following tracheostomy. We sought to identify individual patient

characteristics as clinical factors of mortalityafter tracheostomy in adult ICU patients.

MATERIALS AND METHODS

A retrospective chart review of adult ICU patients having undergone a tracheostomy was conducted. Approval was obtained from the Penn State College of Medicine Institutional Review Board. The need for informed consent was waived due to the retrospective study design. Potential subjects included adult patients admitted to the Penn State Hershey Medical Center ICU between January 1, 2004 to December 31, 2009, who had a tracheostomy procedure during the ICU stay. Patients included in the study were ≥18 years of age and did not have a previous tracheostomy prior to admission. Patients who underwent a tracheostomy in addition to surgical procedure were also included in the study. A total of 247 patient charts were reviewed and included in the collection of patient characteristic data.

Data for categorical and continuous patient characteristics were collected during chart review. Data related to patient characteristics included patient sex, race, and age on ICU admission. Other patient variables specific to ICU admission included: body mass index, traumatic motor vehicle accident, traumatic injury excluding motor vehicle accident, respiratory status (spontaneous ventilation, mechanical ventilation, or respiratory distress requiring intubation without mechanical ventilation), Glasgow Coma Scale score, and the adult ICU location (surgical, medical, neuroscience, or heart and vascular units). Surgical procedures, other than tracheostomy, that were performed during hospitalization were included as variables according to specialty (general/colorectal, orthopedic, neurosurgery, otolaryngology for tumor resection, otolaryngology for traumatic injury, vascular, cardiac, and noncardiacintrathoracic.) A tracheostomy performed in conjunction with another surgical procedure was included as a separate individual variable.

Hyperglycemia was defined as two or more consecutive blood glucose measurements>200 mg/dL, during the hospitalization, independent of insulin administration. Acute renal failure during the ICU stay was defined as a creatinine level >2.0 mg/dL or an increase in creatinine >1.0 mg/dL abovebaseline in chronic kidney disease. Hemodialysis during the ICU admission included both intermittent sessions and continuous renal replacement therapy.

The use of vasopressor medication infusions during both the ICU stay and tracheostomy procedure included the continuous administration of one or more of the following intravenous medications: phenylephrine, norepinephrine, dopamine, dobutamine, and epinephrine. Transfusion of blood products included one or more of the following: packed red blood cells, fresh frozen plasma, or pooled donor platelets. The presence of infection was identified by positive culture result, and included respiratory, urinary, and blood samples. Variables specific to the ICU stay included: nadir white blood cell (WBC) count, peak WBC count, admission hemoglobin level, nadir hemoglobin level, nadir platelet count, peak prothrombin time, peak partial prothrombin time, peak international normalized ratio, lowest Glasgow Coma Scale score, and total length of endotracheal intubation prior to tracheostomy. Also included were: the number of days of weaning attempts to endotracheal extubation, wean to extubation failures requiring reintubation, sedation days prior to tracheostomy, sedation days following tracheostomy, length of mechanical ventilation, and length of ICU stay.

Variables specific to the tracheostomy procedure included: the hospitalization day of tracheostomy placement, surgical service performing tracheostomy, percutaneous or surgical tracheostomy, procedure location (in operating room or ICU bedside), WBC count on procedure day, hemoglobin <8 g/dL on procedure day, pre-procedural antibiotic administration, and vasopressor medication infusion during procedure. The presence of coagulopathy on the day of tracheostomy was defined by one or more of the following values; platelet count <100,000 platelets/μL, prothrombin time >14 seconds, partial prothrombin time >40 seconds, or international normalized ratio >1.2.

The administration of total parenteral nutrition (TPN), provision of enteral feeding, and ability to ambulate at any time during the hospitalization were included as variables. Hospital discharge characteristics included: the hospitalization length, respiratory support status (decannulated, liberated from mechanical ventilation on room air, tracheostomy collar, continuous positive airway pressure, or synchronous intermittent mechanical ventilation). The patient discharge location was included (rehabilitation hospital, long term acute care hospital, skilled nursing facility, other university or community hospital, hospice, or home).

Statistical analysis

The primary intent was to determine if there is an association between the collected patient characteristics and mortality within one year following tracheostomy placement. A total of 59 patients were excluded from the analysis due to missing follow up status or unknown disposition at one year following tracheostomy. The final analysis included 193 patients. Univariate statistical analysis was conducted for both categorical and continuous patient variables using logistic regression models for the outcome of death at one year. For continuous factors, a linear relationship was assumed between the factor and the outcome. This relationship was checked and verified using methods. Only ICU nadir platelet count showed a significant non-linear trend; therefore a quadratic effect, as suggested by the curve-fitting methods, was used for this variable. Odds ratios (OR) and Bonferroni-corrected 95% confidence intervals (CI) for all variables are reported. We assessed 43 variables in total and used the Bonferonni correction to hold the overall type error rate at 5%. Thus, we multiplied eachuncorrected p-value by 43 to obtain the Bonferonni-corrected p-value which is reported. Bonferonni corrected p-values <0.05 were considered significant.SAS system 9.3 software was used to conduct the statistical analysis.

RESULTS

We found a mortality rate of 21.2% (41 out of 193 patients) at one year following tracheostomy.The data for categorical (Tables 1 & 2) and continuous variables (Table 3) are detailed in Tables 1-3.We identified nine patient variables as significantly associated with one year mortality following tracheostomy ($p<0.05$). Table 4 contains the results from the statistical analysis of all 43 variables tested.Estimated odds ratios for

Table 1: Data for categorical and continuous variables before Surgery.

Characteristic Variable	Overall N	Number	Percentage
Sex	193		
Male		133	68.9
Female		60	31.1
Race	193		
Caucasian		180	93.3
Hispanic		6	3.1
African American		5	2.6
Asian		1	0.5
Other		1	0.5
Admission Respiratory Status	192		
Spontaneous Ventilation		147	76.6
Intubated		44	22.9
Respiratory Distress		1	0.5
Admitting ICU	193		
Surgical		183	94.8
Medical		6	3.1
Neuroscience		3	1.6
Heart and Vascular		1	0.5
Lowest GCS Score	189		
15		30	15.8
3 (or 3T)		159	83.7
Surgical Service Performing Tracheostomy	191		
Emergency General Surgery		113	59.2
Otolaryngology		73	38.2
Other		5	2.6
Tracheostomy Type	191		
Open		144	75.4
Percutaneous		47	24.6
Tracheostomy Procedure Location	191		
Operating Room		144	75.4
Bedside		47	24.6
Respiratory Status on Discharge	174		
Spontaneous Ventilation on Room Air		70	36.3
Tracheostomy Collar		46	23.8
Decannulated		44	22.8
Synchronous Intermittent Mechanical Ventilation		8	4.1
Continuous Positive Airway Pressure		6	3.1
Location to Discharge	172		
Rehabilitation Facility		57	29.7
Home		54	28.1
Long Term Acute Care Hospital		48	25.0
Skilled Nursing Facility/Nursing Home		9	4.7
Other University/Community Hospital		4	2.1

Table 2: Data for categorical and continuous variables after Surgery.

Characteristic Variable	Overall N	Yes		No	
		N	%	N	%
Admitting Diagnosis - Traumatic Motor Vehicle Accident	193	62	32.1	131	67.9
Admitting Diagnosis - Non Motor Vehicle Accident Traumatic Injury	193	88	45.6	105	54.4
General/Colorectal Surgery Performed	167	56	33.5	111	66.5
Orthopedic Surgery Performed	167	32	19.2	135	80.8
Otolaryngology Surgery (Tumor) Performed	167	38	22.8	129	77.2
Otolaryngology Surgery (Traumatic) Performed	167	18	10.8	149	89.2
Neurosurgery Performed	167	23	13.8	144	86.2
Vascular Surgery Performed	167	11	6.6	156	93.4
Intrathoracic Non-Cardiac Surgery Performed	167	7	4.2	160	95.8
Cardiac Surgery Performed	167	5	3.0	162	97.0
Acute Renal Failure	192	51	26.6	141	73.4
Vasopressor Medication Infusion(s)	185	49	26.5	136	73.5
Hyperglycemia	191	78	40.8	113	59.2
Infection (positive culture)	187	116	62.0	71	38.0
Blood Product Transfusion	181	83	45.9	98	54.1
TPN Administration	193	52	26.9	141	73.1
Enteral Feeding	193	161	83.4	32	16.6
Hemoglobin <8 g/dL on Procedure Day	178	12	6.7	166	93.3
Coagulopathy on Procedure Day	183	74	40.4	109	59.6
Procedural Antibiotics Administered	190	151	79.5	39	20.5
Vasopressor Infusion(s) During Procedure	188	38	20.2	150	79.8
Surgical Procedure Involving Tracheostomy	193	51	26.4	142	73.6

logistic regression of each variable modeled separately, as well as Bonferonni-corrected 95% confidence intervals and p-values are shown.

Of the variables that significantly correlated with one year mortality following tracheostomy, five demonstrated ORs >4: hemodialysis (OR=5.8), hyperglycemia, continuous vasopressor infusion(s), and vasopressor infusion during the tracheostomy procedure (OR=5.0 for each), and acute renal failure (OR=4.2). The remaining significantly associated variables exhibited ORs between 1.7 and 2.1: age (OR=2.2), a peak WBC count increased by10,000 cells/μL (OR=2.1), total mechanical ventilation increased by 14 days (OR=2.0), and an increase of 1 week for sedation days post-tracheostomy (OR=1.7).

DISCUSSION

We found a one year mortality of 21.2% following tracheostomy in adult ICU patients. This is consistent with previous reports [3-6]. Esteban, et al. [4], demonstrated a one

Table 3 Data for Characteristic Variable.

Characteristic Variable	Overall N	Mean (SD)	Median	Range
Age at admission (years)	193	51 (19)	52	18-97
Admitting Body Mass Index (kg/m^2)	170	28.9 (9.0)	27	14-67
Admitting GCS Score	191	11.8 (5.0)	15	3.0-15.0
Peak WBC Count (thousands of cells/μL)	185	21.1 (9.1)	19.2	7.0-83.9
Nadir WBC Count (thousands of cells /μL)	185	7.7 (3.3 0	7.1	0.2-22.3
Nadir Hemoglobin (g/dL)	185	8.2 (1.8)	7.8	3.9-14.7
ICU Admission Hemoglobin (g/dL)	184	11.8 (2.2)	11.6	5.4-17.4
Nadir Platelet (thousands of cells /μL)	185	120.1 (64.8)	114.0	7.0-319.0
Peak Prothrombin Time (seconds)	153	17.9 (11.6)	13.4	10.4-79.5
Peak International Normalized Ratio	153	1.8 (1.4)	1.3	1.0-13.2
Peak Partial Thromboplastin Time (seconds)	149	59.3 (39.4)	41.0	2.3-150.0
Hospitalization Day of Tracheostomy	193	9.5 (9.3)	7.0	1.0-60.0
Pre-Tracheostomy Sedation Days	189	7.4 (7.0)	6.0	0.0-28.0
Post-Tracheostomy Sedation Days	180	9.1 (13.8)	4.0	0.0-86.0
Wean Attempts Pre-Tracheostomy	184	1.4 (1.1)	1.0	0.0-5.0
Wean to Extubation Failures Pre-Tracheostomy	184	0.6 (0.9)	0.0	0.0-4.0
Total Mechanical Ventilation Days	180	16.0 (17.5)	12.0	0.0-101.0
Total Days of Intubation Pre-Tracheostomy	190	7.2 (7.0)	6.0	0.0-28.0
Total ICU Days	134	31.3 (26.4)	25.0	4.0-207.0
Total Hospitalization Days	174	31.3 (26.4)	25.0	4.0-207.0

Table 4: Results of Statistical Analysis of Patient Variables in Association with One Year Mortality Following Tracheostomy

Characteristic Variable	OR	95% CI*	p-value*
ICU Admission variables			
Age	2.16	1.10-4.23	0.00892
Sex	0.48	0.15-1.59	1.0000
BMI	0.82	0.39-1.72	1.0000
Spontaneous ventilation	1.28	0.31-5.35	1.0000
GCS Score, Increase of 1	1.00	0.89-1.12	1.0000
Hemoglobin level, increase of 1g/dL	0.86	0.67-1.12	1.0000
Diagnosis of trauma (non-MVA)	0.48	0.14-1.60	1.0000
Diagnosis of traumatic MVA	0.44	0.11-1.77	1.0000
Surgical Procedure(s) During Hospitalization (Other than tracheostomy)			
Otolaryngology for tumor resection	0.40	0.06-2.58	1.0000
Otolaryngology for traumatic injury	0.22	0.01-6.49	1.0000
Orthopedic	0.52	0.08-3.37	1.0000
Neurosurgery	1.52	0.28-8.31	1.0000
General surgery/colorectal	1.38	0.37-5.07	1.0000
Hospitalization Stay Variables			
Hyperglycemia	4.98	1.43-17.4	0.00130
TPN administration	2.36	0.71-7.91	0.86612
Enteral feeding	1.20	0.24-5.95	1.00000
Hospitalization day of ambulation, increase of 1 day	0.96	0.90-1.05	1.00000
ICU Stay Variables			
Sedation days pre-tracheostomy; increase of 1 week	1.46	0.84-2.53	1.00000
Sedation days post-tracheostomy; increase of 1 week	1.66	1.14-2.41	0.00057
Total mechanical ventilation days;increase of 14 days	2.02	1.19-3.47	0.00082
Number of wean attempts, increase of 1 day	1.14	0.69-1.91	1.00000
Number of wean to extubation failures; increase of 1 day	1.54	0.86-2.73	0.69485
Acute renal failure	4.24	1.26-14.2	0.00471
Continuous vasopressor infusion(s)	4.96	1.37-18.0	0.00222
Hemodialysis	5.76	1.08-30.7	0.02813
Infection (positive culture results)	2.52	0.65-9.64	1.00000
Peak WBC count; increase of 10,000 cells/μL	2.08	1.02-4.26	0.03574
Nadir WBC count; increase of 1 K/μL	1.00	0.83-1.19	1.00000
Peak PT;increase of 10 seconds	1.46	0.90-2.40	0.48471
Peak INR; increase of 1	1.42	0.89-2.29	0.61134
Peak PTT; increase of 50 seconds	1.50	0.71-3.12	1.00000
Nadir platelet count; 68 vs. 157 (quadratic trend)	1.86	0.73-4.76	1.00000
Nadir hemoglobin level; increase of 1 g/dL	0.80	0.55-1.19	1.00000
Blood product transfusion	0.76	0.23-2.57	1.00000
Lowest GCS Score; 3 (or 3T) vs. 15	2.84	0.36-22.4	1.00000
Tracheostomy Procedure Variables			
Hospitalization day of tracheostomy; increase of 1 day	1.06	0.99-1.12	0.18239
Tracheostomy combined with other surgical procedure	0.58	0.22-1.55	1.00000
Percutaneous tracheostomy (vs. open)	1.42	0.39-5.13	1.00000
Surgical antibiotics prior to tracheostomy	2.12	0.40-11.4	1.00000
Vasopressor infusions during tracheostomy	4.96	1.37-18.0	0.00222
Coagulopathy on day of tracheostomy	1.44	0.45-4.67	1.00000
WBC count on day of tracheostomy; ≥10,000 cells/μL vs. <10,000 cells/μL	1.76	0.47-6.61	1.00000
Emergency general surgery service performing tracheostomy (vs. Otolaryngology and other)	1.82	0.52-6.27	1.00000

*Estimated odds ratios (OR) for logistic regression for each variable modeled separately. Bonferonni-corrected 95% confidence intervals (CI) and p-values are shown. Abbreviations: ICU=Intensive Care Unit, BMI=Body Mass Index, GCS=Glasgow Coma Scale, MVA=Motor Vehicle Accident, TPN=Total Parenteral Nutrition, WBC=White Blood Cell, PT=Prothrombin Time, INR=International Normalized Ratio, PTT=Partial Thromboplastin Time.

year mortality of 36% following hospital discharge and a 28 day mortality of 20% in patients who underwent a tracheostomy.[4] A prospective cohort study of patients receiving mechanical ventilation found a lower overall hospital mortality in patients with a tracheostomy (13.7% mortality) in comparison to those ventilated with an endotracheal tube (26.4% mortality) [3]. findings show that an of one week of continuous intravenous sedation following tracheostomy placement results in higher one year mortality. Deep sedation has been previously correlated with higher ICU mortality within 28 days and increased mortality at six months following ICU discharge [7]. Spontaneous awakening and breathing trials have also been shown to improve overall one year survival in ICU patients, suggesting that decreased sedation time may be beneficial [8].Interestingly, the number of sedation days prior to tracheostomy was not found to be significant to mortality in our study. This may suggest that patients requiring prolonged deep levels of sedation post-tracheostomy have more comorbidities than those patients who do not, thus leading to increased mortality.

We found that a 14 day increase of total mechanical ventilation, with either an endotracheal tube or tracheostomy, was a predictor of one year mortality following tracheostomy (OR=2.0). Previous studies also suggest that mechanical ventilation for an extended period of several weeks is associated with increased patient mortality [9]. However, we did not find that the length of mechanical ventilation with an endotracheal tube prior to tracheostomy was a significant factor of mortality. Consistent with previous reports, we did not find a significant correlation between hospital or ICU patient mortality and timing of tracheostomy placement [10,11].

In this study, hyperglycemia during the ICU stay was found to be a significant risk factor for one year mortality following tracheostomy (OR=5.0). Previous studies have suggested that hyperglycemia is positively associated with poor ICU outcomes [12-15]. ICU patients have an increased risk of developing hyperglycemia, especially with elevated baseline blood glucose levels in both diabetic and non-diabetic patients [16]. Hyperglycemia is correlated with increased organ dysfunction, suggesting detrimental systemic effects leading to increased mortality [15].

Use of vasopressor medication infusions, both during the ICU stay and tracheostomy procedure, was independently associated with one year mortality following tracheostomy in our study. Vasopressor medication use during mechanical ventilation has previously been associated with patient mortality [4]. Shah et al. [6], have reported a higher in-hospital mortality of tracheotomy patients with cardiac conditions, including myocardial infarction, congestive heart failure, and cardiomyopathy.This supports our finding of increased mortality with vasopressor usage during tracheostomy procedure and ICU stay, since the use of vasopressor medication infusions is often due to acute cardiovascular collapse and instability.

We found acute renal failure to be a clinical risk factor of one year mortality following tracheostomy (OR=4.2). Acute renal failure was previously found to be a risk factor for increased ICU patient mortality [14-17]. Previous studies have shown that renal dysfunction is more prevalent in elderly patients requiring mechanical ventilation [5] and elderly tracheostomy patients [18]. New onset renal dysfunction was found to be the most prevalent risk factor for mortality in patients having tracheostomy for respiratory failure [5]. Additionally, we found that hemodialysis during the ICU stay conferred a 5.8 times increased risk of mortality at one year following tracheostomy. Previous research has found a higher mortality among ICU patients requiring hemodialysis for the development of acute renal failure and acute kidney injury, suggesting an increased severity of disease [19,20].

Increased age has been shown to be a significant risk factor for mortality in patients with either mechanical ventilation or tracheostomy [2,4–6,9,18]. Several previous studies have been limited to elderly age groups ≥65 years [5,18]. Our study included ICU patients 18 years of age or older and we also found that increased age (defined as) is a significant risk factor for mortality at one year following tracheostomy. Other studies have found increased age as a risk factor for mortality during mechanical ventilation [4,9] and during a hospital stay during which tracheostomy is performed [6]. Lowest survival rates for patients requiring mechanical ventilation have been reported for patients age >70 years [2]. Previous postulates for increased mortality among the elderly were the presence of more comorbidities and traumatic injuries in comparison to a younger population [18]. However, in our study, the presence of traumatic injuries was not a significant factor for one year mortality following tracheostomy.

A 10,000 cell/μL increase in WBC count during the ICU stay was found to significantly correlate with higher mortality at one year following tracheostomy. Previous authors have shown that the presence of infection in adult ICU patients is a significant risk factor for both increased ICU mortality and overall hospital mortality [21]. Increased ICU mortality has been associated with both leukopenic and exaggerated leukemoid responses (WBC count >25,000cells/μL) [22]. Interestingly, in our study, the presence of infection determined by positive respiratory, urinary, and/or blood cultures was not significant to mortality. This may be due to severe disease marked by a leukemoid response independent of the presence of infection, in which cultures may not have been obtained. We propose that patients with higher peak WBC counts may have more systemic illness causing increased mortality risk.

We have identified several clinical factors associated with one year mortality following tracheostomy in adult ICU patients. These factors may independently represent increased disease severity in an already critically ill patient population. This may contribute to increased mortality in these patients following tracheostomy. Although we have identified these clinical factors in association to mortality following tracheostomy, several of these factors have also been individually correlated to increased ICU patient mortality [14,16,17]. Perhaps the individual factors we have found to be associated with one year mortality following tracheostomy are markers for systemic organ dysfunction and disease severity leading to patient mortality.

We included all adult ICU patients receiving a first time tracheostomy, whereas previous studies have been limited to only those patients with respiratory failure [5,4]or elderly populations [2,18]. We aimed to include all adult age groups in

order to have a patient demographicrepresentative of that found across both surgical and medical ICUs.

A limitation to this study is the retrospective design of the chart review. Although we have identified multiple clinical factors with significant association to one year mortality following tracheostomy, the retrospective design makes it difficult to distinguish if the associations are a direct cause or markers for mortality. Further studies will be necessary to clarify this issue. risk factors associated with post-tracheostomy related mortality may contribute to increased patient safety.

REFERENCES

1. Fischler L, Erhart S, Kleger GR, Frutiger A. Prevalence of tracheostomy in ICU patients. A nation-wide survey in Switzerland. Intensive Care Med. 2000; 26: 1428-1433.
2. Esteban A, Anzueto A, Frutos-Vivar F, Alía I, Ely EW, Brochard L, et al. Outcome of older patients receiving mechanical ventilation. Intensive Care Med. 2004; 30: 639-646.
3. Kollef MH, Ahrens TS, Shannon W. Clinical predictors and outcomes for patients requiring tracheostomy in the intensive care unit. Crit Care Med. 1999; 27: 1714-1720.
4. Esteban A, Anzueto A, Frutos F, Alía I, Brochard L, Stewart TE, et al. Characteristics and outcomes in adult patients receiving mechanical ventilation: a 28-day international study. JAMA. 2002; 287: 345-355.
5. Engoren M, Arslanian-Engoren C, Fenn-Buderer N. Hospital and long-term outcome after tracheostomy for respiratory failure. Chest. 2004; 125: 220-227.
6. Shah RK, Lander L, Berry JG, Nussenbaum B, Merati A, Roberson DW. Tracheotomy outcomes and complications: a national perspective. Laryngoscope. 2012; 122: 25-29.
7. Shehabi Y, Bellomo R, Reade MC, Bailey M, Bass F, Howe B, et al. Early intensive care sedation predicts long-term mortality in ventilated critically ill patients. Am J Respir Crit Care Med. 2012; 186: 724-731.
8. Girard TD, Kress JP, Fuchs BD, Thomason JW, Schweickert WD, Pun BT, et al. Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing Controlled trial): a randomised controlled trial. Lancet. 2008; 371: 126-134.
9. Behrendt CE. Acute respiratory failure in the United States: incidence and 31-day survival. Chest. 2000; 118: 1100-1105.
10. Brook AD, Sherman G, Malen J, Kollef MH. Early versus late tracheostomy in patients who require prolonged mechanical ventilation. Am J Crit Care. 2000; 9: 352-359.
11. Arabi YM, Alhashemi JA, Tamim HM, Esteban A, Haddad SH, Dawood A, et al. The impact of time to tracheostomy on mechanical ventilation duration, length of stay, and mortality in intensive care unit patients. J Crit Care. 2009; 24: 435-440.
12. Finney SJ, Zekveld C, Elia A, Evans TW. Glucose control and mortality in critically ill patients. JAMA. 2003; 290: 2041-2047.
13. Whitcomb BW, Pradhan EK, Pittas AG, Roghmann MC, Perencevich EN. Impact of admission hyperglycemia on hospital mortality in various intensive care unit populations. Crit Care Med. 2005; 33: 2772-2777.
14. Christiansen C, Toft P, Jørgensen HS, Andersen SK, Tønnesen E. Hyperglycaemia and mortality in critically ill patients. A prospective study. Intensive Care Med. 2004; 30: 1685-1688.
15. Krinsley JS. Association between hyperglycemia and increased hospital mortality in a heterogeneous population of critically ill patients. Mayo Clin Proc. 2003; 78: 1471-1478.
16. Cely CM, Arora P, Quartin AA, Kett DH, Schein RM. Relationship of baseline glucose homeostasis to hyperglycemia during medical critical illness. Chest. 2004; 126: 879-887.
17. de Mendonça A, Vincent JL, Suter PM, Moreno R, Dearden NM, Antonelli M, et al. Acute renal failure in the ICU: risk factors and outcome evaluated by the SOFA score. Intensive Care Med. 2000; 26: 915-921.
18. Engoren MC, Arslanian-Engoren CM. Outcome after tracheostomy for respiratory failure in the elderly. J Intensive Care Med. 2005; 20: 104-110.
19. Clermont G, Acker CG, Angus DC, Sirio CA, Pinsky MR, Johnson JP. Renal failure in the ICU: comparison of the impact of acute renal failure and end-stage renal disease on ICU outcomes. Kidney Int. 2002; 62: 986-996.
20. Strijack B, Mojica J, Sood M, Komenda P, Bueti J, Reslerova M, et al. Outcomes of chronic dialysis patients admitted to the intensive care unit. J Am Soc Nephrol. 2009; 20: 2441-2447.
21. Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. JAMA. 2009; 302: 2323-2329.
22. Waheed U, Williams P, Brett S, Baldock G, Soni N. White cell count and intensive care unit outcome. Anaesthesia. 2003; 58: 180-182.

Cite this article

Grap SM, Goldenberg M, Huntley C, High K, Wojnar MM, et al. (2014) Clinical Correlates to One Year Mortality Following Tracheostomy of Adult Intensive Care Patients. Int J Clin Anesthesiol 2(4): 1039.