

ORIGINAL RESEARCH

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Life advices in patients with tracheostomy: Rational antibiotic use and cerebro-vascular prophylaxis-physiotherapy

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Abstract

Tracheostomy is life-saving procedure in critical care patients which require long-term mechanical ventilation (MV) and an alternative to endotracheal intubation.(1,2) The factors affecting the survival of tracheostomized patients are not clearly known. The aim of this study was to investigate the factors affecting intensive care unit (ICU) and long-term mortality in the tracheostomized patients due to respiratory failure. A retrospective observational cohort study was planned between January 2016-2019 in tertiary ICU. Each patient underwent percutaneous and surgical tracheostomy was included. Demographic characteristics, diagnoses, causes of tracheostomy, comorbidities, Charlson and APACHE 2 scores, culture antibiogram results, ICU day and mortality (1-3 and 12 months) were recorded. In the analysis of the data, appropriate statistical tests and analyzes were used. 115 of 3620 patients admitted to tertiary ICU and underwent percutaneous and surgical tracheostomy due to respiratory failure between January 2016-2019 were included. 75 (65%) of the patients were male and median age was 68±14 years. Hospital mortality was higher in the group with *Acinetobacter baumannii* growth ($p=0.04$). According to Kaplan-Meier survival analysis, long-term follow-up of *Acinetobacter baumannii* growth did not affect survival ($p=0.938$). Patients with cerebro-vascular accident (CVA) had lower survival in long-term follow-up ($p<0.039$). It was determined that presence of tracheal resistant *Acinetobacter baumannii* increases the ICU mortality in tracheostomized patients and existing CVA as a comorbidity increased the long term mortality. In conclusion, rational antibiotic therapy and CVA prophylaxis-physiotherapy could contribute to short and long term survival in these patient groups.

Keywords: Critical care, stroke, tracheostomy, pneumonia, Respiratory infection

Introduction

Tracheostomy is a frequently performed procedure in patients who are unable to be intubated, had prolonged mechanical ventilation and laryngeal pathology [1]. Tracheostomy shortens the intensive care unit (ICU) stay and reduces the endotracheal intubation-related complications, and furthermore, tracheostomy is an independent factor, which protects patients from ventilator associated pneumonia (VAP) development [2-4]. The risk of ventilator-induced pneumonia was shown to vary between 6% and

26% in patients with tracheostomy [5,6]. Closure of the intensive care unit may be required due to high mortality risk in case of resistant *A. baumannii* infection in ICU [7].

In recent studies, ICU stay was prolonged in tracheostomized patients with ventilatory associated pneumonia (VAP), however mechanical ventilation time and mortality did not differ from the tracheostomized patients without VAP [8-10]. Currently, tracheostomy is a commonly performed procedure in prolonged intubation and the factors that influence the ICU and long-term morbidity and mortality are not clearly known in our country. The present study was conducted to investigate the factors affecting the mortality in the patients that have undergone tracheostomy due to prolonged mechanical ventilation.

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Material and Methods

This retrospective, observational cohort study was conducted in the respiratory ICU of a tertiary hospital between January 2016 and 2019. All patients who had undergone percutaneous and/or surgical tracheostomy in the ICU was included in the study. The inclusion and the exclusion criteria and the patient characteristics have been summarized in Figure 1. The demographic characteristics, diagnoses, tracheostomy indications, co-morbid conditions of the patients, ICU severity score (APACHE 2, Charlson), tracheal aspirate culture antibiogram results, the duration of ICU stay and 1-3-12 month mortality rates were recorded from the death notification system. Ethics committee approval was obtained in accordance with the Helsinki Declaration (Number/date: 069/21.08.2018). The informed consent form was not obtained due to the retrospective design of the study but the patient data was de-identified.

Patients

The patients who had an indication for tracheostomy and undergone percutaneous and/or surgical tracheostomy were included in the study.

Definitions

Acute respiratory failure: Hypoxic respiratory failure was defined as the “ratio of partial arterial oxygen pressure to the oxygen fraction in respiration air (PaO₂/FiO₂) of <300 and an arterial partial carbon dioxide pressure (PaCO₂) of < 45 mmHg; hypercarbic respiratory failure was defined as an arterial partial carbon dioxide pressure (PaCO₂) of > 45 mmHg and the ratio of partial arterial oxygen pressure to oxygen fraction in respiration air (PaO₂/FiO₂) of >300; hypercarbic/hypoxemic respiratory failure was defined as an arterial partial carbon dioxide pressure (PaCO₂) of > 45 mmHg and the ratio of partial arterial oxygen pressure to oxygen fraction in respiration air (PaO₂/FiO₂) of <300 [11,12].

The indications for tracheostomy were: a) failure to wean from the mechanic ventilator, b) the need for prolonged mechanic ventilation due to neurological diseases, c) failure to preserve airway integrity and insufficient clearance of bronchial secretions, and d) presence of laryngeal pathologies (trauma, burn, malignity, subglottic stenosis) [13-16].

Failure to wean from the mechanic ventilator: Failure in spontaneous breathing trial or re-intubation within 48 hours after weaning from the mechanic ventilator [17].

Spontaneous breathing trial: The patient who had spontaneous breathing is weaned from the MV and inhales oxygen through the T-tube. This procedure is applied for 30 min and repeated 24 hours later in case of failure [17].

Failure in spontaneous breathing trial: Clinical assessment and subjective indices: Agitation and anxiety, dyspnea, cyanosis, increased respiration effort and suppressed mental functions [17]. Objective criteria: partial oxygen pressure (PaO₂) of 50-60 mmHg (FiO₂≥50%) or oxygen saturation (SaO₂) of ≤90%. Partial carbon dioxide pressure (PaCO₂) of ≥50 mmHg or >8 mmHg elevation in PaCO₂ value; pH of 7.32 or a ≥0.07 U elevation in pH value; breathing frequency/tidal volume: 105 respiration/min; an increase

in breathing frequency of >35 /min or ≥50% increase in respiration /min; heart beat of >140 bpm or ≥20% elevation in the heart rate; systolic blood pressure (SBP) of >180 mmHg or ≥20% elevation in SBP; systolic blood pressure of <90 mmHg; presence of cardiac arrhythmia [17].

Prolonged mechanical ventilation was defined as need for mechanical ventilation more than 7 days or failure in spontaneous respiration [17].

Procedures: The percutaneous tracheostomy forceps dilation technique (Griggs) or the one-step dilation technique (Ciaglia Blue Rhino) was used according to its availability in the ICU. Percutaneous tracheostomy was performed under guidance of fiberoptic bronchoscopy in all patients [18,19].

Recorded Data

The demographic characteristics of the patients, co-morbidities, causes of acute respiratory failure (pneumonia, acute exacerbation of COPD, bronchiectasis, decompensated congestive heart failure, obesity hypoventilation syndrome, amyotrophic lateral sclerosis), indications for tracheostomy, tracheostomy technique, ICU severity score [Charlson, APACHE II (acute physiologic and chronic health evaluation)], culture-antibiogram results, treatment regimens, ICU stay and the mortality were recorded. The mortality during 1-3 months after ICU stay and long term follow-up were recorded from the death notification system (DNS).

Statistical Analysis

The portable SPSS 20.0 package program was used for the statistical analysis. The demographic and clinical data of the patients were analyzed with the descriptive statistics. The paired groups, the non-parametric continuous variables were evaluated using the Mann-Whitney U test and the data were shown as median, 1st and 3rd quartile values (Q1-Q3). The parametric student t-test was used for the paired groups that showed a normality distribution, and the continuous variables were shown as mean and standard deviation (SD). The chi-square test was used for the paired variables. Numbers and percentages were used when required. The Kaplan-Meier survival test was used for the survival analyses. A p level of <0.05 was accepted as statistically significant.

Results

A total of 115 patients who had undergone percutaneous and/or surgical tracheostomy out of 1930 patients in whom invasive mechanic ventilation was applied after intubation were included in the study. Of the patients, 75 (65%) were males and the median (±SD) age was 68±14 years. Sixty-six (57.4%) patients had undergone percutaneous tracheostomy. The demographic characteristics, hospital stay, the day of tracheostomy and the ICU severity score have been summarized in Table 1.

The hospital mortality was determined as 71.1%, the first month mortality rate was 56% and the long-term mortality rate was 71.9%. Microbial growth was detected in the deep tracheal aspirate (DTA) culture and/or in 52 (45.6%) bronchial lavage cultures. *Acinetobacter baumannii* was detected in 39 (33.9%) cases, *Pseudomonas aeruginosa* was detected in 11 (9.6%)

cases, Klebsiella pneumonia was detected in 5 (4.3%) cases and Escherichia coli was detected in 1 (0.9%) case.

The causes for tracheostomy have been summarized in Table 2.

When DTA and bronchial lavage culture growth were compared with regard to hospital mortality, no difference was determined between the groups in which microbial growth detected or not ($p=0.24$). When the hospital mortality was evaluated according to the type of bacteriae growth in the culture, it was significantly higher in the Acinetobacter baumannii group ($p=0.04$) (Table 3).

Acinetobacter baumannii growth was determined as not to affect the survival in the long term follow-up in the Kaplan-Meier survival analysis ($p=0.938$). Survival of the patients who experienced cerebro-vascular event (CVE) was significantly lower in the long-term follow-up ($p<0.039$) (Figure 2).

Table 1. Demographic features and intensive care data of tracheostomy patients

Cases, n	115
Male, n (%)	75 (65)
Age (year), Mean $\pm$ SD	68 $\pm$ 14
Body mass index (kg/m ²); Median (Q1-Q3)	22 (19-30)
APACHE II, Mean $\pm$ SD	28 $\pm$ 8
Charlson score, Mean $\pm$ SD	5 $\pm$ 1.6
Tracheostomy operation day, Median (Q1-Q3)	12 (8-23)
ICU stay (day), Mean $\pm$ SD	31 $\pm$ 14
Survival time after discharge (day), Median(Q1-Q3)	153 (24-342)
Intensive care admission diagnosis,	
Pneumonia, n (%)	45 (39.3)
Acute exacerbation of COPD, n (%)	36 (31.3)
Bronchiectasis, n (%)	9 (7.8)
Congestive heart failure, n (%)	10 (8.6)
OHS, n (%)	11(9.6)
ALS, n (%)	4 (3.4)
Comorbidities; n (%)	
Hypertension , n (%)	44 (38.3)
Diabetes mellitus, n (%)	31 (27)
Congestive heart failure, n (%)	30 (26.3)
Atrial fibrillation, n (%)	22 (19)
Coronary artery disease, n (%)	19 (16.5)
Cerebrovascular event, n (%)	14 (12.1)
Chronic renal failure, n (%)	13 (11.3)
Extrapulmonary malignancy , n (%)	10 (8.6)
Lung cancer, n(%)	10 (8.6)
Alzheimer diseases, n(%)	9 (7.8)
Sequelae of poliomyelitis, n(%)	3 (2.6)

Abbreviations: SS, Standart deviation; Q1-Q3, 1. and 3. quartile values, APACHE II, Acute physiology and chronic health evaluation; COPD, Chronic obstructive pulmonary disease; OHS, Obesty hypoventilation syndrome; ALS, Amyotrophic lateral sclerosis.

Table 2. Tracheostomy indications

Cases	n (%)
Prolonged mechanical ventilation	61(53)
Degenerative and demyelinating	19 (17)
Sequelae of cerebrovascular event	12 (10.4)
Hypoxic encephalopathy after CPR	11 (9.6)
Post- intubation tracheal stenosis	5 (4)
Dynamic airway collapse	3 (2.6)
CNS malignancy	2 (1.7)
Upper airway stenosis	2 (1.7)

CPR, Cardio-pulmonary resuscitation; CNS, Central nervous system

Table 3. Mortality according to bacterial growth in deep tracheal aspirate and bronchial lavage cultures

	Non-survivor, (%)	Survivor, n(%)	p-value
Acinetobacter baumannii	23 (28.4)	16 (48.5)	0.04
Pseudomonas aeruginosa	10 (12.3)	71 (87.7)	0.13

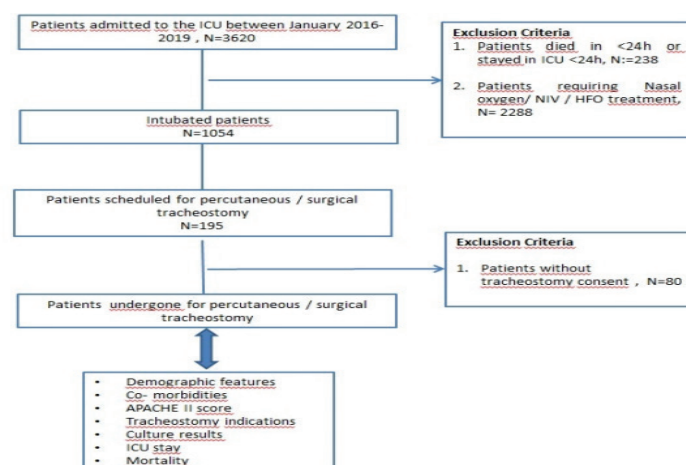


Figure 1. Abbreviations: ICU, intensive care unit; NIV, non-invasive mechanical ventilation; HFO, high flow oxygen therapy; APACHE II score, Acute physiology and chronic health evaluation

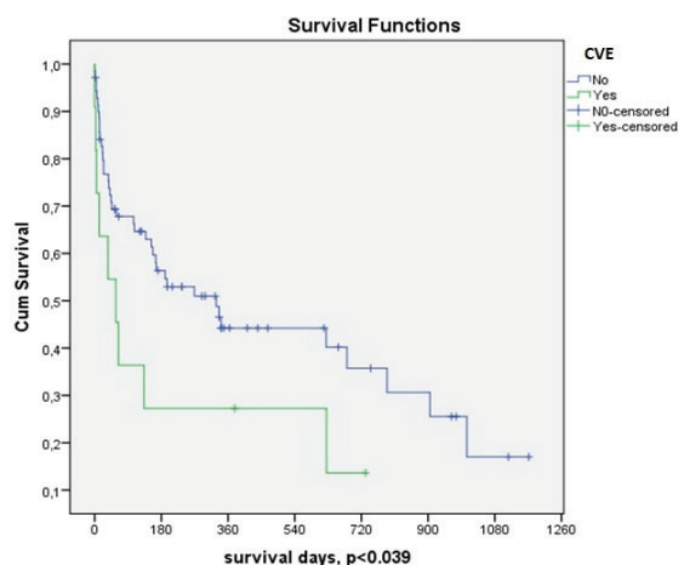


Figure 2. Mortality of tracheostomized patients with CVA (9 deaths among 11 patients) and without CVA (40 deaths among 70 patients) were shown in the long-term Kaplan-meier cumulative survival analysis. Abbreviation: CVE, Cerebrovascular event

Discussion

The present study has revealed that *Acinetobacter baumannii* infection increased the mortality in the ICU, and the presence of a previous CVE increased the long-term mortality in the patients with tracheostomy.

In the study of Tamir et al. which investigated the 30-day morbidity and mortality in 311 patients who had undergone surgical tracheostomy in advanced age, the mortality was found to be higher in the patients with chronic pulmonary disease, prolonged international normalized ratio (INR) and restricted neck extension movement [20]. The present study has revealed that presence of a previous CVE increased the mortality in the long term and the mortality rate was found to be higher in cases with resistant *Acinetobacter baumannii* infection during hospitalization at the ICU. Besides, the small sample size of the study and percutaneous tracheostomy which was a less invasive procedure, might be the reasons for controversial results.

Tamir et al. also reported that the time of tracheostomy did not affect the mortality [20]. Siempon et al. reported that although early tracheostomy did not affect the ICU mortality, it reduced the VAP development, shortened the duration of MV and enabled early mobilization [21]. Morbidity and mortality was found to be high in late tracheostomies (tracheostomies performed after the 14th day of intubation) in a multi-center study investigating 1175 cases who had undergone tracheostomy due to prolonged mechanic ventilation. [22] The effect of the time of tracheostomy procedure on ICU or long-term mortality was not analyzed in our study.

While there are some studies reporting that VAP development increases the mortality in tracheostomized patients [9,10], some others have reported no association [6,23]. This conflicting result might be associated with patient-related factors and co-morbid conditions. Although VAP development was not analyzed in the present study, mortality was found to be similar between the groups, which had microbial growth and no microbial growth in the tracheal aspirate cultures. Besides, the hospital mortality was significantly higher in patients with *Acinetobacter baumannii* growth.

Liu et al. investigated the risk factors for VAP development in patients who had undergone head and neck surgery in which %79 of them had been performed tracheostomy, and reported higher risk in the patients with chronic obstructive pulmonary disease (COPD) [4]. In recent studies, it has been shown that VAP development is higher in patients with COPD [24-27]. Risk factors for increased VAP development in COPD patients were found to be advanced age, COPD-related increased inflammation, corticosteroid use, malnutrition and respiratory muscle weakness [24-27]. Our study did not analyze the reasons for VAP development; however, microbial growth was present in almost half of the tracheal aspirates. Although microbial growth in the tracheal aspirates do not indicate VAP development, it is an important marker for VAP and tracheo-bronchitis together with a consistent clinical condition. The results of the present study are compatible with the other studies in regard to risk factors for VAP development, as COPD is the second leading diagnosis (31.3%)

following pneumonia (39.3%), and microbial growth is present in almost half of the tracheal aspirates.

The present study has some limitations. First, the results may not be generalized as it was a single-center retrospective study. However, we consider that the results may be valuable for similar patient group as the patients were followed-up by the same pulmonologists and intensive care unit physicians.

Conclusion

In conclusion, *Acinetobacter baumannii* infection-related hospital mortality might be reduced through controlling the pathways that contribute to infection development in patients undergoing percutaneous and/or surgical tracheostomy. Rational antibiotic use may reduce *A. Baumannii* growth and therefore cause decrease in hospital mortality and costs. The presence of a previous CVE and related immobilization increase the long term mortality in case of tracheostomy indicates that physical therapy, which is usually avoided in this patient group, may contribute to improvement of the long term survival. Clinicians may need to be more careful for co-morbid conditions in the presence of CVE.

Competing interests

The authors declare that they have no competing interests.

Financial Disclosure

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Ethical approval

Before the study, permissions were obtained from local ethical committee.

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