Turkish Journal of Geriatrics
DOI: 10.29400/tjgeri.2024.410
2024; 27(4):371−382

- Mehmet Nuri YAKAR[1]
- Doğukan ŞENBERBER[2]
- Mehmet Meriç ÇOBAN[3]
- Ejder Kamil ÖZTÜRK[4]
- Begüm ERGAN[5]
- Necati GÖKMEN[2]

CORRESPONDANCE

Mehmet Nuri YAKAR
Phone : +902123735000
e-mail : mnuriyakar@gmail.com

Received : Sep 19, 2024
Accepted : Nov 30, 2024

[1] Şişli Hamidiye Etfal Training and Research Hospital, Department of Anesthesiology and Reanimation, Division of Intensive Care, İstanbul, Turkey

[2] Dokuz Eylül University, Faculty of Medicine, Department of Anesthesiology and Reanimation, İzmir, Turkey

[3] İzmir City Hospital, Department of Internal Medicine, Division of Medical Oncology, İzmir, Turkey

[4] Kırklareli Training and Research Hospital, Department of Internal Medicine, Division of Intensive Care, Kırklareli, Turkey

[5] Dokuz Eylül University, Faculty of Medicine, Department of Chest Diseases, Division of Intensive Care, İzmir, Turkey

ORIGINAL ARTICLE

RISK FACTORS FOR 90-DAY MORTALITY IN CRITICALLY ILL ELDERLY PATIENTS UNDERGOING TRACHEOSTOMY

Abstract

Introduction: The ongoing debate surrounding the early and long-term mortality of critically ill elderly patients who undergo tracheostomy remains unresolved.

Materials and Method: The primary aim of this retrospective study is to define independent factors for 90-day mortality in critically ill elderly patients who underwent tracheostomy during their intensive care unit stays between November 1, 2010, and October 31, 2020, in an academic tertiary hospital. The data were analyzed using the Mann-Whitney U, chi-square, and Fisher's exact tests. Logistic regression analysis was performed to identify independent factors associated with 90-day mortality.

Results: A total of 585 elderly patients were included in the study. The 90-day mortality rate was 77.6%, which increased to 89.2% in one year. Vasopressor requirement (odds ratio [OR], 2.61; 95% confidence interval [CI], 1.46–4.57; *p*=0.001), hospital stay prior to intensive care unit admission >14 days (OR, 2.09; 95% CI, 1.18–3.68; *p*=0.011), occurrence of one or more periprocedural complications of tracheostomy procedure (OR, 2.27; 95% CI, 1.07–4.82; *p*=0.033), and patients with a Charlson comorbidity index ≥6 (OR, 1.57; 95% CI, 1.03–2.40; *p*=0.037) were identified as independent factors for 90-day mortality in critically ill elderly patients.

Conclusions: Elderly patients with respiratory failure who undergo tracheostomy procedures frequently require prolonged, complex care during hospitalization and after discharge. Further research is essential to develop predictive models for early and long-term mortality risk and to establish benchmarks for the quality of post-discharge care.

Keywords: Critical Care; Aged; Morbidity: Mortality; Tracheostomy.

INTRODUCTION

The proportion of the population comprising individuals aged 60 and above has been increasing for several decades. According to the World Health Organization, the number of people in this age group is projected to grow by 10% compared to 2015, reaching 22% in 2050 (1). This is also associated with increases in the number of people with severe diseases in the last years of life (2). Consequently, it can be reasonably assumed that the intensive care needs of elderly patients will increase over time.

The treatment and management of elderly patients in critical care settings present a distinctive set of challenges, largely due to functional limitations. Moreover, elderly patients are more susceptible to developing acute respiratory failure (3). Additionally, the rate of emergency department admission for respiratory failure in elderly patients was 48.6% (4). Age has also been identified as an independent factor for prolonged mechanical ventilation (5). Furthermore, elderly patients with chronic respiratory or cardiac disease are likelier to experience weaning failure (6). These factors render elderly patients more susceptible to undergoing a tracheostomy procedure, which also carries risks during and after the procedure, in addition to the risks associated with intensive care unit (ICU) follow-up. Several risk factors were identified with respect to mortality in elderly patients who underwent tracheostomy in the ICU. A previous study demonstrated that mortality in patients who underwent tracheostomy is more closely associated with underlying medical conditions than with complications related to the procedure itself (7). However, mortality due to tracheostomy complications is more prevalent in older age groups than in younger age groups (8,9). Conversely, another study demonstrated that mortality did not differ between age groups in surgical tracheostomy (10). The presence of comorbidities, including cardiac and hepatic disease, was identified as an independent risk factor for mortality in patients admitted to the emergency department due to tracheostomy complications. Furthermore, prolonged hospital stay was associated with an increased risk of mortality in patients with tracheostomy complications (8).

Consequently, we designed the present study to elucidate the undefined factors related to mortality among critically ill elderly individuals who underwent tracheostomy. These factors encompass patient and hospitalization characteristics, laboratory data, ICU follow-up-related major events and therapies, and the periprocedural and long-term complications of tracheostomy procedures.

MATERIALS AND METHODS

Study design, setting, and selection of participants

This retrospective study was conducted in the tertiary-level ICUs of Dokuz Eylül University after ethics committee approval (date: 22.12.2021 and IRB number:2021/38-13). The study included elderly patients (≥65 years) who underwent tracheostomy during their ICU stay between November 1, 2010, and October 31, 2020. Patients with COVID-2019 or related conditions were excluded from the screening process to avoid the potential confounders that could influence the results. This was due to the potential negative impact of the COVID-19 on mortality in the early stages of outbreak, which exceeded the capacity of health resources. Furthermore, the uncertainty of treatment practices for the disease during this period, and the lack of use of a vaccine, contributed to this decision. Patients with data loss and tracheostomy procedures performed as a component of difficult airway management were excluded. The study was conducted in accordance with the ethical standards set forth in the Declaration of Helsinki (11). The requirement for written informed consent was waived since the study was designed retrospectively.

Variables

All data were collected from electronic medical records. Demographic data, comorbidities, and prognostic scores, including the Glasgow coma scale, Charlson comorbidity index (CCI), and acute physiology and chronic health evaluation II (APACHE II) scores, were recorded. The primary reasons for ICU admission and major events during the ICU stay were identified. These included ventilator-associated pneumonia (VAP), acute kidney injury (AKI), new-onset arrhythmia, cardiac injury, delirium, the occurrence of cardiopulmonary resuscitation (CPR), resulting in the return of spontaneous circulation (ROSC), sepsis, deep venous thrombosis and pulmonary embolism. Additionally, the administration of major therapies during the ICU stay, including vasopressor requirements and renal replacement therapy was documented. The duration of hospitalization, in total and prior to ICU admission; the length of intubation duration; and the ICU stay were recorded. Laboratory data, as well as periprocedural and long-term complications associated with the tracheostomy procedure, were also screened.

Definitions

The diagnosis of major events in the ICU was determined following a data evaluation in accordance with the current guidelines. The diagnosis of VAP was based on the definitions outlined in a previous study (12). Kidney disease-improving global outcome guidelines were employed to identify AKI (13). The diagnosis of new-onset arrhythmia was based on a comprehensive evaluation of electrocardiogram and cardiologic examination notes. Cardiac injury was defined as an increase in both HS-sensitive troponin I and troponin T levels above the 99th percentile upper reference limit (14). The presence of delirium was determined by a review of the daily medical records, including data from the confusion assessment method for the intensive care unit and information on the need for medical intervention to control the delirium symptoms. The presence of spontaneous circulation at least 24 hours after CPR was the criterion for ROSC. Sepsis was defined according to the Surviving Sepsis Campaign Guidelines (15). The diagnosis of DVT and PE was based on radiological evidence. The occurrence of bleeding due to tracheostomy procedure was documented in paper charts or operative notes. Desaturation was identified as oxygen saturation ≤93% for longer than one minute.

Outcomes

The primary outcome of this study was to identify independent factors for 90-day mortality among critically ill elderly individuals who underwent tracheostomy during their ICU stay. Secondary outcomes include the determination of patient characteristics, the incidence of periprocedural and long-term complications of tracheostomy, and early and long-term mortality.

Statistical analysis

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) Version 24 (Armonk, NY, IBM Corp., US) statistical software package. Categorical variables were presented as numbers and percentages. Continuous variables were presented as the median and interquartile range. Continuous and categorical variables were compared in the univariate analysis using the Mann–Whitney U test and chi-square or Fisher's exact tests, respectively. A logistic regression analysis was employed to identify independent factors for 90-day mortality among critically ill elderly individuals who underwent a tracheostomy procedure during ICU follow-up. A model was constructed to incorporate the essential clinical variables and significant parameters identified in the univariate analysis. These included patient and hospitalization characteristics, prognostic scores, major events and therapies during the ICU stay, tracheostomy complications, and laboratory data, which were potential confounders. For each independent factor, an adjusted odds ratio (OR) and a confidence interval (CI) with a rate of 95% were stated. Statistical significance was determined by a two-tailed *p*-value of less than 0.05.

RESULTS

General Characteristics

A total of 9,573 patients admitted to the ICU between November 1, 2010, and October 31, 2020, were screened. Of these patients, 774 underwent tracheostomy procedure. A total of 632 elderly patients were included in the analysis. Subsequently, 47 patients were excluded from the study due to data loss (30 patients), lack of arterial blood gas analysis (15 patients), and tracheostomy procedures for the management of a difficult airway (2 patients). Finally, 585 elderly patients were included in the study.

The median age of the patients was 77 (70–86) years, and 59.0% were older elderly (Table 1). A total

Table 1. Patient Characteristics

Characteristics	90-day mortality			*P* value
	All (n = 585)	**Deceased (n = 454)**	**Survived (n = 131)**	
Age, years	77 (70–86)	77 (70–87)	77 (69–86)	0.49
Younger elderly (65–74 years)	240 (41.0)	187 (41.2)	53 (40.5)	0.92
Older elderly (≥75 years)	345 (59.0)	267 (58.8)	78 (59.5)	
Sex, male	333 (56.9)	257 (56.6)	76 (58.0)	0.84
APACHE II score[a]	18 (14–23)	19 (15–23)	17 (14–22)	0.08
CCI[a]	6 (4–7)	6 (5–7)	5 (4–7)	**0.016**
CCI ≥ 6	306 (52.3)	253 (55.7)	53 (40.5)	**0.003**
GCS[a]	9 (6–12)	9 (6–12)	9 (7–12)	0.20
Comorbidities	557 (95.2)	436 (96.0)	121 (92.4)	0.10
Hypertension	356 (60.9)	277 (61.0)	79 (60.3)	0.92
Diabetes mellitus	209 (35.7)	162 (35.7)	47 (35.9)	1.00
Coronary artery disease	165 (28.2)	136 (30.0)	29 (22.1)	0.10
Congestive heart failure	138 (23.6)	109 (24.0)	29 (22.1)	0.73
Malignancy	137 (23.4)	112 (24.7)	25 (19.1)	0.20
Solid organ malignancy	124 (21.2)	102 (22.5)	22 (16.8)	0.18
Hematological malignancy	13 (2.2)	10 (2.2)	3 (2.3)	1.00
COPD	136 (23.2)	114 (25.1)	22 (16.8)	**0.047**
CKD	130 (22.2)	102 (22.5)	28 (21.4)	0.91
Alzheimer's disease	104 (17.8)	75 (16.5)	29 (22.1)	0.15
Cerebrovascular disease	102 (17.4)	74 (16.3)	28 (21.4)	0.19
History of thromboembolism	28 (4.8)	23 (5.1)	5 (3.8)	0.65
Immunosuppression	24 (4.1)	23 (5.1)	1 (0.8)	**0.024**
Chronic liver disease	11 (1.9)	10 (2.2)	1 (0.8)	0.47
Obesity	7 (1.2)	6 (1.3)	1 (0.8)	N/A
Multimorbidity[b]	447 (76.4)	348 (76.6)	99 (75.6)	0.82

All values are expressed as numbers (percentages) or median (interquartile range).
Abbreviations: APACHE II score, Acute Physiology and Chronic Health Evaluation II score; CCI, Charlson comorbidity index; GCS, Glasgow coma scale; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease; N/A, not applicable.
[a]Calculated on the day of ICU admission.
[b]Total number of comorbidities ≥2.

of 56.9% of the patients were male. In the univariate analysis, the median value of the CCI score and the number of patients with a CCI score of six or more were significantly higher in deceased patients than in survivors. Furthermore, deceased patients exhibited significantly higher rates of comorbidities, including chronic obstructive pulmonary disease (COPD) and immunosuppression, than survivors. The total number of comorbidities and multimorbidity were not found to differ significantly among elderly patients in relation to 90-day mortality.

Table 2. Major Events and Therapies During ICU Stay and Hospitalization Characteristics

Characteristics	**90-day mortality**			***P* value**
	All (n = 585)	**Deceased (n = 454)**	**Survived (n = 131)**	
Reason for ICU admission				
Respiratory failure	333 (56.9)	262 (57.7)	71 (54.2)	0.49
Postoperative	143 (24.4)	111 (24.4)	32 (24.4)	1.00
Neurological disease	100 (17.1)	79 (17.4)	21 (16.0)	0.79
Septicemia	69 (11.8)	53 (11.7)	16 (12.2)	0.88
Congestive heart failure	39 (6.7)	30 (6.6)	9 (6.9)	0.85
Multi-trauma	22 (3.8)	17 (3.7)	5 (3.8)	1.00
Other	53 (9.1)	40 (8.8)	13 (9.9)	0.73
Major events during ICU stay				
Vasopressor requirement	523 (89.4)	417 (91.9)	106 (80.9)	**0.001**
Septicemia	523 (89.4)	402 (88.5)	121 (92.4)	0.26
VAP	447 (76.4)	333 (73.3)	114 (87.0)	0.001
AKI	421 (72.0)	333 (73.3)	88 (67.2)	0.19
Cardiac injury	418 (71.5)	317 (69.8)	101 (77.1)	0.12
Renal replacement therapy	267 (45.6)	216 (47.6)	51 (38.9)	0.09
New onset arrhythmia	154 (26.3)	125 (27.5)	29 (22.1)	0.26
Delirium	130 (22.2)	96 (21.1)	34 (26.0)	0.28
CPR resulted in ROSC	88 (15.0)	76 (16.7)	12 (9.2)	**0.037**
DVT	19 (3.2)	15 (3.3)	4 (3.1)	1.00
PTE	6 (1.0)	6 (1.3)	0 (0.0)	0.35
Length of				
Hospital stay, days	48 (31–79)	40 (28–59)	103 (64–145)	< 0.001
ICU stay, days	35 (22–56)	30 (20–44)	79 (37–119)	< 0.001
Hospital stay before ICU admission, days	4 (1–13)	6 (1–14)	2 (1–7)	**< 0.001**
Hospital stay before ICU admission >14 days	128 (21.9)	111 (24.4)	17 (13.0)	**0.006**
Intubation duration, days	15 (10–21)	15 (10–21)	14 (10–21)	0.95

All values are expressed as numbers (percentages) or median (interquartile range).

Abbreviations: ICU, intensive care unit; VAP, ventilator-associated pneumonia; AKI, acute kidney injury; CPR, cardiopulmonary resuscitation; ROSC, return of spontaneous circulation; DVT, deep venous thrombosis; PTE, pulmonary thromboembolism.

Table 3. Laboratory Data of the Patients

Laboratory test[a]	90-day mortality			*P* value
	All (n = 585)	Deceased (n = 454)	Survived (n = 131)	
WBC, x 10^3/μL	12.5 (9.4–16.7)	12.5 (9.4–16.7)	12.5 (9.4–17.0)	0.77
Neutrophil, x 10^3/μL	10.7 (7.9–14.7)	10.6 (7.8–14.7)	10.8 (8.1–14.6)	0.89
Hemoglobin, g/dL	10.0 (8.8–11.4)	9.9 (8.7–11.4)	10.4 (8.9–11.5)	0.10
Lymphocyte, x 10^3/μL	0.8 (0.5–1.2)	0.7 (0.5–1.2)	0.8 (0.6–1.3)	**0.048**
Platelet, x 10^3/μL	212.0 (142.0–286.5)	212.0 (140–285.0)	207.0 (148.0–309.0)	0.42
HS Troponin I, ng/L	0.06 (0.05–0.19)	0.06 (0.05–0.17)	0.07 (0.05–0.23)	0.49
Troponin T	27.0 (12.0–131.7)	30.0 (11.2–129.7)	23.3 (13.2–229.5)	0.54
D-dimer, ug/mL	4.0 (1.9–7.6)	4.0 (2.0–7.8)	3.8 (1.5–6.9)	0.18
BNP, pg/mL	423 (213–957)	466 (217–975)	363 (195–835)	0.19
BUN, mg/dL	36.0 (23.6–53.4)	36.1 (23.7–53.3)	34.0 (23.0–53.8)	0.81
Creatinine, mg/dL	1.20 (0.76–2.08)	1.20 (0.76–2.11)	1.26 (0.76–2.03)	0.95
Total Bilirubin, mg/dL	0.78 (0.56–1.11)	0.78 (0.56–1.10)	0.74 (0.56–1.18)	0.57
AST, U/L	32 (20–62)	31 (21–60)	33 (18–71)	0.91
ALT, U/L	21 (12–44)	20 (11–44)	21 (12–54)	0.56
LDH, U/L	301 (234–414)	304 (236–414)	295 (223–422)	0.45
ALP, U/L	89 (65–133)	91 (66–137)	83 (61–117)	**0.035**
CRP, mg/L	122 (57–197)	123 (58–192)	117 (48–217)	0.87
Procalcitonin, ng/mL	0.86 (0.27–4.66)	0.89 (0.29–4.59)	0.81 (0.20–5.40)	0.40
Arterial gas analysis				
pH	7.39 (7.31–7.45)	7.39 (7.31–7.45)	7.38 (7.31–7.45)	0.88
PCO_2, mmHg	37.0 (31.0–46.4)	37.2 (31.5–46.4)	37.0 (30.6–46.4)	0.44
PaO_2, mmHg	84.0 (66.2–122.5)	84.0 (65.8–124.4)	83.2 (69.0–121.0)	0.68
HCO_3, mEq/L	23.0 (20.0–26.6)	23.1 (20.0–26.4)	23.0 (19.1–27.0)	0.77
Lactate, mmol/L	1.5 (1.0–2.25)	1.4 (1.0–2.3)	1.6 (1.0–2.2)	0.54
SO_2, %	96.5 (92.0–98.8)	96.1 (92.0–98.9)	97.0 (93.0–98.5)	0.89
PaO_2 / FiO_2	208 (155–270)	206 (151–267)	218 (168–300)	0.15

All values are expressed as median (interquartile range).
Abbreviations: WBC, white blood cell; HS Troponin I, high sensitive troponin I; BNP, brain natriuretic peptide; BUN, blood urea nitrogen; AST, aspartate aminotransferase; ALT alanine aminotransferase; LDH, lactate dehydrogenase; ALP, alkaline phosphatase; CRP, C-reactive protein; PCO_2, partial pressure of carbon dioxide; PaO_2, partial pressure of oxygen; SO_2, oxygen saturation; FiO_2, fraction of inspired oxygen
[a]Performed on day of ICU admission.

Hospitalization characteristics, data related to ICU follow-up and laboratory

The most frequent significant reasons for ICU admission were respiratory failure, the need for postoperative follow-up, and neurological diseases (Table 2). The most common major events during ICU stays were vasopressor requirement, septicemia, and VAP. AKI development was observed in 72.0% of the patients, with 45.6% of them requiring RRT. A notable discrepancy was observed between deceased and surviving patients in vasopressor requirements and the need for CPR, resulting in

ROSC during the ICU stay. As anticipated, the length of hospital and ICU stays was notably longer in survivors than in deceased patients. The median length of hospital stays prior to ICU admission was significantly longer among the deceased patients than among the survivors. Moreover, the proportion of patients with a hospital stay prior to ICU admission exceeding 14 days was significantly higher in the group of patients who subsequently died than in those who survived.

Univariate analysis revealed no significant differences between the surviving or deceased participants with respect to most of the laboratory tests (Table 3). However, the median values

Table 4. Periprocedural and Long-Term Complications Related to Tracheostomy

Characteristics	90-day mortality			
	All (n = 585)	Deceased (n = 454)	Survived (n = 131)	*P* value
Tracheostomy method				
Percutaneous	497 (85.0)	382 (81.4)	115 (87.8)	0.33
Surgical	88 (15.0)	72 (15.9)	16 (12.2)	
Periprocedural complications	70 (12.0)	61 (13.4)	9 (6.9)	**0.046**
Atelectasis	27 (4.6)	26 (5.7)	1 (0.8)	**0.016**
Bleeding	21 (3.6)	18 (4.0)	3 (2.3)	0.59
Subcutaneous emphysema	8 (1.4)	8 (1.8)	0 (0.0)	0.21
Desaturation	8 (1.4)	8 (1.8)	0 (0.0)	0.21
Pneumothorax	6 (1.0)	5 (1.1)	1 (0.8)	1.00
Posterior esophageal wall injury	5 (0.9)	5 (1.1)	0 (0.0)	0.59
Tracheal ring injury	5 (0.9)	5 (1.1)	0 (0.0)	0.59
Pneumomediastinum	5 (0.9)	5 (1.1)	0 (0.0)	0.59
Cannula obstruction	4 (0.7)	2 (0.4)	2 (1.5)	0.22
Pulmonary aspiration	4 (0.7)	3 (0.7)	1 (0.8)	1.00
Esophageal damage	3 (0.5)	2 (0.4)	1 (0.8)	0.53
Unintended decannulation	3 (0.5)	3 (0.7)	0 (0.0)	1.00
Bronchospasm	2 (0.3)	1 (0.2)	1 (0.8)	0.40
Cardiac arrest	2 (0.3)	2 (0.4)	0 (0.0)	1.00
Hypercapnia	1 (0.2)	1 (0.2)	0 (0.0)	1.00
Long-term complications	35 (6.0)	19 (4.2)	16 (12.2)	**0.001**
Bleeding	14 (2.4)	11 (2.4)	3 (2.3)	1.00
Dysphagia	8 (1.4)	0 (0.0)	8 (6.1)	**< 0.001**
Stoma infection	6 (1.0)	4 (0.9)	2 (1.5)	0.62
Granulation	4 (0.7)	3 (0.7)	1 (0.8)	1.00
Tracheomalacia	3 (0.5)	0 (0.0)	3 (2.3)	**0.011**
Tracheoesophageal fistula	2 (0.3)	1 (0.2)	1 (0.8)	0.40
Stenosis	1 (0.2)	1 (0.2)	0 (0.0)	1.00

All values are expressed as number (percentages).
Abbreviations: N/A, not applicable.

of absolute lymphocyte count and alkaline phosphatase were slightly higher in the survivors than in the deceased patients.

Complications of tracheostomy

Most participants underwent percutaneous dilatational tracheostomy, which is an invasive procedure whereby a tracheal stoma is created by means of dilation to insert the tracheostomy cannula. (Table 4). There was no significant effect of the type of tracheostomy on 90-day mortality. The most common periprocedural complications were atelectasis, bleeding, subcutaneous emphysema, and desaturation. The results of the univariate analysis indicated that atelectasis following tracheostomy and the presence of at least one or more periprocedural complications were significantly more prevalent in deceased patients than in surviving patients. As anticipated, the overall rates of long-term tracheostomy complications, dysphagia, and tracheomalacia were significantly higher in surviving than in deceased patients.

Independent factors related to 90-day mortality

The in-hospital mortality rate was 83.9%. The 28-day mortality rate was 33.0%, which increased to 67.4% in 60 days, 77.6% in 90 days, 86.8% in six months, and 89.2% in one year.

The results of the logistic regression analysis are presented in Table 5. The analysis indicated that vasopressor requirement (OR, 2.61; 95% CI, 1.46–4.57; *p* = 0.001), hospital stay prior to ICU admission >14 days (OR, 2.09; 95% CI, 1.18–3.68; *p* = 0.011), occurrence of one or more periprocedural complications of tracheostomy (OR, 2.27; 95% CI, 1.07–4.82; *p* = 0.033), and patients with a CCI score ≥6 (OR, 1.57; 95% CI, 1.03–2.40; *p* = 0.037) were independently associated with 90-day mortality in critically ill elderly patients treated in the ICU.

Table 5. Independent Factors for 90-Day Mortality

Factors related to 90-mortality	OR (95% CI)	*P* value
Major events and therapies during ICU stay		
Vasopressor requirement	2.61 (1.46–4.57)	**0.001**
CPR resulting in ROSC	1.85 (0.96–3.58)	0.07
Hospitalization characteristics		
Hospital stay prior to ICU admission >14 days	2.09 (1.18–3.68)	**0.011**
Complications related to tracheostomy procedure		
Occurrence of one or more periprocedural complications	2.27 (1.07–4.82)	**0.033**
Prognostic scores		
Patients with a CCI ≥6	1.57 (1.03–2.40)	**0.037**
Laboratory data		
Lymphocyte count	0.87 (0.74–1.02)	0.09
Comorbidities		
COPD	1.54 (0.90–2.62)	0.11
Age		
Older elderly (≥75 years)	0.97 (0.64–1.48)	0.90

Abbreviations: OR, odds ratio; ICU, intensive care unit; CPR, cardiopulmonary resuscitation; ROSC, return of spontaneous circulation; COPD, chronic obstructive pulmonary disease; CCI, Charlson comorbidity index.

DISCUSSION

The present study, which examined the risk factors for mortality among critically ill elderly individuals who underwent tracheostomy in the ICU, revealed a 28-day mortality rate of 33% and a relatively high mortality rate of 77.6% at 90 days, which increased to 89.2% at one year. The study demonstrated that vasopressor requirements, the length of hospital stay before ICU admission exceeding 14 days, the occurrence of one or more periprocedural tracheostomy complications, and a score of CCI ≥6 were independently associated with 90-day mortality.

Mortality in critically ill elderly patients is associated with multiple factors. The ongoing debates regarding the direct relationship between age and mortality have been almost finalized following the definition of the concept of frailty, which offers insights based on declines in physiologic function and reserve across organ systems. Frail patients have a reduced ability to regain physiological homeostasis after a destabilizing and stressful event. Increased proinflammatory cytokines and chronic inflammation have been shown in this population. In addition, sarcopenia, lower levels of sex steroids, IGF-1, vitamin D and other hormones such as cortisol cause weakness in the musculoskeletal system and impaired mobility. For these reasons, frailty is associated with pathophysiological, social and health care problems that increase the risk of morbidity and mortality (16). Furthermore, frailty is the most common condition leading to death in the last five years of life in patients aged ≥70 years (2). Although age is an unreliable predictor of prognosis, mortality tends to increase with age among the elderly (3,17). In contrast, a study analyzing tracheostomy-related complications reported as a cause of death demonstrated that the base rate of mortality was tenfold higher in children than in adults (18). However, a study comparing elderly and non-elderly patients admitted to the emergency department due to tracheostomy complications revealed that old age is a predictor of death (8). Tamir et al. (9) revealed that the 30-day mortality rate was higher in older patients than in younger patients following surgical tracheostomy procedure. A further study comparing younger (65–74 years-old) and older elderly (≥75 years) patients who underwent tracheostomy indicated that mortality did not differ by age (10). The present study did not determine any increases in mortality with age or significant differences between younger and older elderly individuals. Regrettably, this study did not document whether the patients were frail.

Severity scores have been identified as mortality predictors among elderly individuals (3). In the present study, the CCI score, which predicts long-term mortality by considering the combinations of comorbidities and age, demonstrated a significant difference between deceased and surviving patients. However, the presence of at least one comorbidity or multimorbidity was not associated with 90-day mortality in the univariate analysis. In contrast, a previous meta-analysis comparing elderly patients with and without multimorbidity revealed that the number of comorbidities was related to an increased risk of death (19). In the univariate analysis, comorbidities, immunosuppression, and COPD were associated with 90-day mortality. The mortality risk among elderly patients with COPD who require positive pressure ventilation via tracheostomy in the wards or at home may be attributed to the challenges encountered in managing these patients. As anticipated, individuals of advanced age and immunosuppression are at an elevated risk of developing infectious complications, which may result in mortality. Moreover, Fimognari et al. (4) demonstrated that elderly patients with respiratory failure due to congestive heart failure or COPD have a lower risk of death than those with other causes of respiratory failure. However, in a previous study, comorbidities heart and liver disease were identified as independent factors leading to mortality in patients admitted to the emergency department due to tracheostomy complications (8).

The risk of death for critically ill elderly individuals is directly related to the necessity of major supportive therapies and the occurrence of serious adverse events in the ICU, as well as the primary reason for ICU admission. Notably, the present study identified vasopressor requirements and occurrences of CPR resulting in ROSC as risk factors for 90-day mortality. Previous studies have demonstrated that AKI, metabolic acidosis, sepsis, hypotension (17), vasopressor requirement (3), alteration in mental status (17), the need for mechanical ventilation (3), and respiratory failure (17) are risk factors for mortality in elderly patients. In contrast with the present study, Vallet et al. (3) identified diagnosis at ICU admission as a risk factor for mortality. Moreover, a low functional status and a body mass index comparable to that of frailty have been identified as risk factors for mortality among elderly patients (3,20). A previous study demonstrated that the rate of 30-day mortality in elderly patients after in-hospital cardiac arrest increases incrementally with age (21). The conditions observed in patients who experienced in-hospital cardiac arrest in a location with cardiac monitoring, which is typically provided in an ICU, resulted in improved survival (21). Nevertheless, long-term mortality following in-hospital cardiac arrest appears to be particularly related to the level of neurological disability at the time of discharge (22).

One of the factors that influences mortality in critically ill individuals is the timing of ICU admission. In-hospital mortality in patients hospitalized in the wards for more than 15 days is significantly higher than that of other patients (23). Furthermore, age was identified as a mortality predictor in relation to the length of stay on the wards before ICU admission (23). A further study comparing elderly and non-elderly patients with tracheostomy complications identified that longer hospital stays were associated with in-hospital mortality (8). Similarly, the present study identified that hospital stays before ICU admission exceeding 14 days were predictors of 90-day mortality. Evidently, patients with complex issues requiring therapeutic processes or who are unresponsive to treatment require longer hospital stays. Nevertheless, prolonged hospitalization may contribute to the development of complications, thereby increasing the risk of death.

Previous studies have investigated the relationship between laboratory data and mortality in elderly patients. A few studies have presented novel frailty indexes that include laboratory tests as markers of cellular aging. These indexes have been identified as reliable assessment tools for predicting long-term mortality in elderly individuals (24,25). However, the present study did not identify a specific set of laboratory tests for the prediction of mortality, except for a lower count of lymphocytes in deceased patients than in survivors.

The impact of tracheostomy complications may also be associated with mortality. In a study of adult patients, the overall complication rate was 3.2%, and the in-hospital mortality rate was 19.2% (7). Another study analyzing over 25.5 million reported deaths over a 10-year period stated that the rate of tracheostomy-related deaths was 2.43% (18). In the aforementioned study, tracheostomy-related deaths were likeliest to occur in a hospital setting and in African American children, adults, and Hispanic adults. Another study found no discernible difference in the incidence of intraoperative complications associated with surgical tracheostomy procedure between deceased and surviving patients. Furthermore, the timing of tracheostomy did not appear to influence the incidence of tracheostomy-related complications (9). A large cohort study examining adult patients found that in-hospital mortality is more commonly related to underlying diseases than tracheostomy complications (7). In the present study, the presence of at least one periprocedural complication was a predictor of 90-day mortality. As anticipated, long-term complications, such as tracheomalacia and dysphagia, were more prevalent in survivors than in deceased patients. Additionally, lower educational levels and procedures performed on weekends and at non-teaching hospitals were identified as additional factors associated with complications of tracheostomy-related deaths (7,18).

LIMITATIONS

The present study is subject to limitations. The results are based on retrospective data from a single center, which requires the support of further studies to generalize the findings. Moreover, the necessity of mechanical ventilation and decannulation at discharge may be associated with mortality. However, due to the unavailability of data, we could not consider these conditions. We also did not consider the patients' frailty status.

Nevertheless, this study has several notable strengths. It included a relatively large sample size, allowing for a robust analysis. The determination of long-term mortality in this population constitutes a notable contribution to a specific research field. Furthermore, the study analyzes numerous subsets of mortality-related factors.

CONCLUSION

The management of elderly patients in critical care settings presents a set of challenges, particularly for those with respiratory failure who undergo tracheostomy. Multiple factors influence in-hospital and long-term mortality, and the prediction of mortality remains an unresolved issue. The decision-making process for tracheostomy is especially complex in this context. Moreover, the quality of patient care following discharge significantly determines long-term outcomes. Further studies should be conducted to address the prediction of early and long-term mortality as well as the establishment of benchmarks for the quality of post-discharge care in critically ill elderly patients who undergo tracheostomy.

Funding: The authors declared that this study had received no financial support.

Competing interest: There is no conflict of interest among the authors.

REFERENCES

1. World Health Organization. Global Health and Ageing [e-book] NIH Publication; 2022. [Internet]. Available from: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. Accessed: 05.09.2024.
2. Gill TM, Gahbauer EA, Han L, Allore HG. Trajectories of Disability in the Last Year of Life. N Engl J Med 2010;362(13):1173-1180. (DOI:10.1056/NEJMoa0909087).
3. Vallet H, Schwarz GL, Flaatten H, De Lange DW, Guidet B, Dechartres A. Mortality of Older Patients Admitted to an ICU: A Systematic Review. Crit Care Med 2021;49(2):324-334. (DOI:10.1097/CCM.0000000000004772).
4. Fimognari FL, De Vincentis A, Arone A, Baffa Bellucci F, Ricchio R, Antonelli Incalzi R. Clinical outcomes and phenotypes of respiratory failure in older subjects admitted to an acute care geriatric hospital ward. Intern Emerg Med 2024;19(5):1359-1367. (DOI:10.1007/s11739-024-03625-4).
5. Seneff MG, Zimmerman JE, Knaus WA, Wagner DP, Draper EA. Predicting the duration of mechanical ventilation: The importance of disease and patient characteristics. Chest 1996;110(2):469-479. (DOI:10.1378/chest.110.2.469).
6. Thille AW, Harrois A, Schortgen F, Brun-Buisson C, Brochard L. Outcomes of extubation failure in medical intensive care unit patients. Crit Care Med 2011;39(12):2612-2618. (DOI:10.1097/CCM.0b013e3182282a5a).
7. Shah RK, Lander L, Berry JG, Nussenbaum B, Merati A, Roberson DW. Tracheotomy outcomes and complications: a national perspective. Laryngoscope 2012;122(1):25-29. (DOI:10.1002/lary.21907).
8. Levy L, Smiley A, Latifi R. Mortality Risk Factors in Patients Admitted with the Primary Diagnosis of Tracheostomy Complications: An Analysis of 8026 Patients. Int J Environ Res Public Health 2022;19(15):9031. (DOI:10.3390/ijerph19159031).

9. Tamir SO, Khalaily N, Einav S, Shemesh S, Gluck O, Marom T. 30-Day Morbidity and Mortality Rates in Elderly Subjects Following Surgical Tracheostomy. Respir Care 2018;63(8):1009-1015. (DOI:10.4187/respcare.06002).

10. Engoren MC, Arslanian-Engoren CM. Outcome after tracheostomy for respiratory failure in the elderly. J Intensive Care Med 2005;20(2):104-110. (DOI:10.1177/0885066604273484).

11. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA 2013;310(20):2191-2194. (DOI:10.1001/jama.2013.281053).

12. Kalil AC, Metersky ML, Klompas M, et al. Management of Adults with Hospital-acquired and Ventilator-associated Pneumonia: 2016 Clinical Practice Guidelines by the Infectious Diseases Society of America and the American Thoracic Society. Clin Infect Dis 2016;63(5):e61-e111. (DOI:10.1093/cid/ciw353).

13. Kellum JA, Lameire N, Aspelin P, et al. Kidney disease: improving global outcomes (KDIGO) acute kidney injury work group. KDIGO clinical practice guideline for acute kidney injury. Kidney Int Suppl 2012;2(1):1-138. (DOI:10.1038/kisup.2012.1).

14. Thygesen K, Alpert JS, Jaffe AS, et al. Fourth universal definition of myocardial infarction (2018). J Am Coll Cardiol 2018;72(18):2231-2264. (DOI:10.1016/j.jacc.2018.08.1038).

15. Evans L, Rhodes A, Alhazzani W, et al. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock 2021. Crit Care Med 2021;49(11):e1063-e1143. (DOI:10.1097/CCM.0000000000005337).

16. Chen X, Mao G, Leng SX. Frailty syndrome: an overview. Clin Interv Aging 2014;9:433-441. (DOI:10.2147/CIA.S45300).

17. Alves GC, Silva Júnior GB, Lima RS, et al. Risk factors for death among critically ill elderly patients. Rev Bras Ter Intensiva 2010;22(2):138-143. (DOI:10.1590/S0103-507X2010000200007).

18. Cramer JD, Graboyes EM, Brenner MJ. Mortality associated with tracheostomy complications in the United States: 2007-2016. Laryngoscope 2019;129(3):619-626. (DOI:10.1002/lary.27500).

19. Nunes BP, Flores TR, Mielke GI, Thumé E, Facchini LA. Multimorbidity and mortality in older adults: A systematic review and meta-analysis. Arch Gerontol Geriatr 2016;67:130-138. (DOI:10.1016/j.archger.2016.07.008).

20. Song YH, Cai GY, Xiao YF, Chen XM. Risk factors for mortality in elderly haemodialysis patients: a systematic review and meta-analysis. BMC Nephrol 2020;21(1):377. (DOI:10.1186/s12882-020-02026-x).

21. Hirlekar G, Karlsson T, Aune S, et al. Survival and neurological outcome in the elderly after in-hospital cardiac arrest. Resuscitation 2017;118:101-106. (DOI:10.1016/j.resuscitation.2017.07.013).

22. Chan PS, Nallamothu BK, Krumholz HM, et al. Long-term outcomes in elderly survivors of in-hospital cardiac arrest. N Engl J Med 2013;368(11):1019-1026. (DOI:10.1056/NEJMoa1200657).

23. Goldhill DR, McNarry AF, Hadjianastassiou VG, Tekkis PP. The longer patients are in hospital before Intensive Care admission the higher their mortality. Intensive Care Med 2004;30(10):1908-1913. (DOI:10.1007/s00134-004-2386-2).

24. Klausen HH, Petersen J, Bandholm T, et al. Association between routine laboratory tests and long-term mortality among acutely admitted older medical patients: a cohort study. BMC Geriatr 2017;17(1):62. (DOI:10.1186/s12877-017-0434-3).

25. Howlett SE, Rockwood MR, Mitnitski A, Rockwood K. Standard laboratory tests to identify older adults at increased risk of death. BMC Med 2014;12:171. (DOI:10.1186/s12916-014-0171-9).