ORIGINAL ARTICLE

Medical Journal of Western Black Sea
Batı Karadeniz Tıp Dergisi

Med J West Black Sea 2022;6(3): 358-365
DOI: 10.29058/mjwbs.1117289

Comparison of Patients with Ventilator-Associated Pneumonia Developed in Two Different Intensive Care Units of a Tertiary Hospital

Üçüncü Basamak Bir Hastanenin İki Farklı Yoğun Bakım Ünitesinde Gelişen Ventilatör İlişkili Pnömonili Hastaların Karşılaştırılması

İlken UGUZ[1], Derya KARASU[1], Canan YILMAZ[1], Gül DURMUŞ[2], Ezgi ÜNAL ASAN[3], Şeyda Efsun ÖZGÜNAY[1], Mehmet GAMLI[1]

[1]UHS Bursa Yuksek Ihtisas Training and Research Hospital, Anesthesiology and Reanimation Clinic, Bursa, Turkey
[2]UHS Bursa Yuksek Ihtisas Training and Research Hospital, Infectious Diseases Clinic, Bursa, Turkey,
St.-Marien-Hospital Lünen, Assistenzärztin in Innere Medizin / Gastroenterologie, Germany
[3]Bursa Gemlik State Hospital, Anesthesiology and Reanimation Clinic, Bursa, Turkey

ORCID ID: İlken Uguz 0000-0003-1947-1737, Derya Karasu /0000-0003-1867-9018, Canan Yılmaz 0000- 0002-6626-3626, Gül Durmuş 0000-0002-3021-8831, Ezgi Ünal Asan 0000-0002-7305-7775, Şeyda Efsun Özgünay 0000-0003-1501-9292, Mehmet Gamlı 0000-0002-5618-2734

Cite this article as: Uguz İ et al. Comparison of patients with ventilator-associated pneumonia developed in two different intensive care units of a tertiary hospital. Med J West Black Sea. 2022;6(3):358-365.

Corresponding Author
Derya Karasu

E-mail
drderyatopuz@gmail.com

Received
16.05.2022
Revision
29.08.2022
Accepted
19.10.2022

ABSTRACT

Aim: Our purpose is to compare the characteristics and 30-day mortality of ventilator-associated pneumonia (VAP) patients that developed in two different intensive care units (ICUs) in a tertiary hospital.

Material and Methods: Patients who were over the age of 18 who developed VAP in two different ICUs of our hospital over two years were included in the study. Acute Physiology and Chronic Health Assessment II (APACHE II), Sepsis-Related Organ Failure Assessment (SOFA), Glasgow Coma Score (GCS), Clinical Pulmonary Infection Score (CPIS), infection markers, and 30-day mortality of the patients were evaluated. Physical conditions of Group 1 and Group 2, hand hygiene rates in ICU, nurse education level, and hospitalization rate in intensive care units were compared.

Results: A total of 104 patients, 48 being in Group 1 and 56 being in Group 2, were analyzed. There was no significant difference between the two groups with regards of GKS, SOFA and CPIS scores. Acinetobacter baumanni was the most common agent in both groups. The hospitalization rate was found to be significantly higher in Group 2. 30-day mortality was 45.8% in Group 1 and 48.2% in Group 2. It was found that a one unit increase in the SOFA hospitalization period reduced the risk of 30-day mortality. It was determined that a one unit increase in the age ratio in Group 2 increased the risk of 30-day mortality 1.085 times, and the increase in the mean SOFA score in all patients and Group 1 decreased the length of the hospitalization period.

Conclusion: We found a 30-day mortality rate of 47.1% in patients diagnosed with VAP. An increase in SOFA score increases the risk of 30-day mortality, while a prolonged hospitalization period decreases the risk of mortality.

Keywords: Intensive care unit, Mortality, Ventilator-associated pneumonia

ÖZ

Amaç: Amacımız üçüncü basamak bir hastanede iki farklı yoğun bakım ünitesi (YBÜ)'nde gelişen ventilatör ilişkili pnömoni (VİP) hastalarının özelliklerini ve 30 günlük mortalitelerini karşılaştırmaktır.

Gereç ve Yöntemler: Hastanemizin iki farklı YBÜ'nde iki yıllık süreçte VİP gelişen 18 yaş üstü hastalar çalışmaya dahil edildi. Hastaların Akut Fizyoloji ve Kronik Sağlık Değerlendirmesi II (APACHE II), Sepsis İlişkili Organ Yetmezliği Değerlendirmesi (SOFA), Glasgow Koma Skoru (GKS), Klinik Pulmoner Enfeksiyon Skoru (KPES) ve enfeksiyon belirteçleri ve 30 günlük mortaliteleri değerlendirildi. Grup 1 ve Grup 2'nin fiziksel koşulları, YBÜ'deki el hijyen oranları, hemşire eğitim düzeyi ve yoğun bakım ünitelerinin hasta yatış hızı karşılaştırıldı.

Bulgular: Grup 1'de 48 ve Grup 2'de 56 hasta olmak üzere toplam 104 hastaya analiz yapıldı. İki grup arasında yatış günü, tanı aldığı gün, tanı aldıktan üç, yedi ve 30 gün sonra GKS, SOFA ve KPES skorları açısından anlamlı fark saptanmadı. Her iki grupta da en çok *Acinetobacter baumanni* etkeni tespit edildi. Hasta yatış hızı Grup 2'de anlamlı yüksek saptandı. 30 günlük mortalite Grup 1'de %45,8 ve Grup 2'de %48,2 olarak saptandı. SOFA ortalama skorundaki bir birimlik artışın 30 günlük mortalite riskini 2,214 kat artırdığı, yatış süresindeki artışın 30 günlük mortalite riskini azalttığı saptandı (OR=0,891). Grup 2'de yaş oranının bir birimlik artışı 30 günlük mortalite riskini 1,085 kat arttırdığı, tüm hastalarda ve Grup 1'de SOFA ortalama skorundaki artışın yatış süresini azalttığı saptandı.

Sonuç: VİP tanısı alan hastalarda 30 günlük mortaliteyi %47,1 olarak saptadık. SOFA skorundaki artış 30 günlük mortalite riskini artırırken yatış süresindeki uzama mortalite riskini azaltmaktadır.

Anahtar Sözcükler: Yoğun bakım, Mortalite, Ventilatör ilişkili pnömoni

INTRODUCTION

Ventilator-associated pneumonia (VAP) is a nosocomial infection with high mortality and morbidity rate, which occurs at the earliest 48 hours after intubation in patients with invasive mechanical ventilator (MV) support without pneumonia during intubation. It develops in approximately 8-28% of intubated patients (1,2). The care conditions of the intensive care unit (ICU), number of beds, hospitalization rate, duration of ventilator support therapy, and underlying diseases affect the frequency of VAP. Devices used in oropharyngeal colonization, the ineffectiveness of the upper respiratory tract and other defense systems connected to the endotracheal tube, decrease in cough reflex, decrease in macrophage functions, deterioration of ciliary functions, hypoxia, uremia, malnutrition, ventilation and perfusion imbalance, inadequate endotracheal aspirations and devices used in ventilator therapy are part of VAP pathogenesis. Other infection entry routes are considered as a hematogenous spread, inhalation of infected aerosols, and exogenous spread from extra-pulmonary foci of infection (1,2).

The development of VAP prolongs the duration of mechanical ventilation and therefore the length of stay in the intensive care unit. This also increases the cost. Therefore, VAP is an important problem in hospitals. Factors affecting the high rates of healthcare-associated infections in intensive care are the low number of workers and the high number of patients in ICU, the lack of knowledge of the health personnel, the failure to comply with the isolation procedures and asepsis, the lack of attention to hand hygiene, sterilization and disinfection (3).

This study aims to compare the characteristics and 30-day mortality of VAP patients who developed in two different ICUs of a tertiary hospital.

MATERIAL and METHODS

Our study is a prospective observational study conducted in the ICUs of the Anesthesiology and Reanimation Clinic of a tertiary hospital between January 2018 and January 2020 following the principles of the Declaration of Helsinki, after the approval of the local ethics committee (numbered 2017-11/27) and informed consent from the relatives of the patients.

Two ICUs with 17 beds and 21 beds belonging to the Anesthesia Clinic in our hospital were divided into two groups as Group 1 and Group 2. Group 1 has 17 beds in 200 m², Group 2 has 21 beds in 300 m², and both intensive care units have a sink for every six beds. Group 1 has four isolation rooms, each 8.36 m², and Group 2 has three isolation rooms, each 17 m². Three anesthesiologists and an assistant doctor work in Group 1 during working hours; In Group 2, three anesthesiologists and two assistant doctors work during working hours. Out of working hours, an anesthesiologist and three assistant doctors work for both groups. In both groups, a nurse cares for two patients during working hours, and a nurse cares for three patients outside working hours.

Adult patients over the age of 18 who received MV support and developed VAP after being followed for more than 48 hours after intubation were included in the study. The definition of VAP was accepted as pneumonia that developed no earlier than 48 hours after intubation in cases with invasive MV support who did not have pneumonia during intubation. Patients who were hospitalized with pneumonia, had growth in the tracheal aspirate culture taken in the first 24 hours, had mechanical ventilator duration less than 48 hours, underwent non-invasive MV and died within 48 hours after the diagnosis of VAP were excluded from the study.

Demographic information of patients, intensive care treatments (reintubation status, vasoactive drug use, renal replacement therapies, sedative drug use, immunosuppressive use, feeding route, proton pump inhibitor use, presence of central, urinary or intracerebral pressure catheter, endotracheal intubation, tracheostomy status, cuff pressure values), history of abdominal or thoracic surgery, Acute

Physiology and Chronic Health Assessment II (APACHE II), Sepsis-Related Organ Failure Assessment (SOFA), Glasgow Coma Score (GCS), Clinical Pulmonary Infection Score (CPIS) were recorded.

Oral care of the patients was done regularly by nurses. Cuff pressures were measured regularly with a cuff meter every morning. Cuff pressure was maintained between 20-30 cmH_2O. For APACHE II, the patient's age, physiological variables, GCS and chronic health status scores were used. GCS, and SOFA score, CPIS value, fever, white blood cell, CRP, and procalcitonin values were recorded on the third, seventh, and 30th days after the diagnosis of VAP. For CPIS, CPIS score was calculated using tracheal secretion, fever, leukocytes, infiltration, oxygenation, and microbiological data on chest X-ray. The SOFA score was calculated by evaluating six organ systems (respiratory, cardiovascular, central nervous system, renal, coagulation, and liver). The duration of each patient's stay in the intensive care unit, the time from hospitalization to the diagnosis of VAP, and the duration of MV were recorded as days. The final status of the patients after 30 days was evaluated as discharge, transfer to the ward, still hospitalized, and death status. Reproductive factors of the patient were followed up. The physical conditions of Group 1 and Group 2, hand hygiene rates in the ICU, the level of nurse education and the number of patients per nurse-personnel, and the hospitalization rate of the ICUs were recorded. Five basic indications that make hand hygiene necessary for healthcare professionals are defined as before contact with the patient, before aseptic handling, after the risk of exposure to body fluids, after patient contact, after contact with the patient environment (4). The rate of compliance with hand hygiene was calculated by the infectious diseases nurse with the formula "Compliance (%) = (Actions/Indication)x100". The hospitalization rate shows how many patients use a bed per month. The hospitalization rate was calculated as the number of people (discharged + deceased)/(number of beds).

Statistical Analysis

As a result of the pilot study, SOFA measurements (standard deviation=1.2) were obtained for Group 1 (mean=5.2) and Group 2 (mean=5.9) patients. As a result of the power analysis, it was determined as a total of 90 people, whereas there were 45 subjects in each group, with 80% power at 5% significance level and an effect size of 0.60. More subjects were included in the study in case some patients were excluded from the study. The Shapiro-Wilk test was used to examine whether the data showed normal distribution. Descriptive statistics are expressed as mean and standard deviation or median (minimum-maximum) for quantitative data, and frequency and percentage for qualitative data. Mann-Whitney U test was used for the comparison of two groups for normally distributed data, t-test was used for comparisons of two groups for data that were not normally distributed. Pearson Chi-square test, Fisher's Exact Chi-square test, and Fisher-Freeman-Halton test were used to analyze categorical data. Binary logistic regression analysis was applied to examine the factors affecting mortality. In addition, multiple linear regression analysis was applied to examine the factors affecting the estimation of the hospitalization period. The signifi-cance level was determined as $\alpha=0.05$.

RESULTS

While the number of patients in Group 1 was 860 and the number of patients developing VAP was 54 (6.27%) at the time of the study, the number of patients hospitalized in Group 2 was 1940 and the number of patients developing VAP was 65 (3.35%). Fifteen patients were excluded from the study because they died within 48 hours of being diagnosed with VAP. In our study, statistical analysis was performed in a total of 104 patients, whereas there were 48 patients in Group 1 and 56 patients in Group 2.

When the demographic data of the patients were examined, no statistically significant difference was found between the groups (Table 1). Infection markers of the two groups

Table 1: Demographic information of patients.

	Group 1 (n=48)	Group 2 (n=56)	p
Age, years	63±18	62±18	0.586
Gender, n (%)			0.114
Female	15 (31.3)	26 (46.4)	
Male	33 (68.8)	30 (53.6)	
BMI, kg/m²	26.56±4.89	27.09±4.45	0.268
APACHE II score	29.17±7.06	26.84±6.24	0.077
Comorbidity, n (%)			
Diabetes mellitus	11 (22.9)	18 (32.1)	0.296
Hypertension	14 (29.2)	24 (42.9)	0.148
COPD	9 (18.8)	8 (14.3)	0.539
Chronic renal failure	4 (8.3)	3 (5.4)	0.546
Heart failure	7 (14.6)	6 (10.7)	0.552
Cerebrovascular accident	3 (6.3)	5 (8.9)	0.609
Reason for hospitalization, n (%)			
Respiratory causes	17 (35.4)	17 (30.4)	0.154
Cardiac causes	8 (16.7)	6 (10.7)	
Neurological causes	13 (27.1)	15 (26.8)	
Trauma	2 (4.2)	4 (7.1)	
Nephrological causes	1 (2.1)	1 (1.8)	
Postoperative causes	3 (6.3)	13 (23.2)	
Intoxication	1 (2.1)	0	
Endocrinological causes	2 (4.2)	0	
Gastroenterological causes	1 (2.1)	0	

BMI: Body Mass Index, **APACHE II:** Acute Physiology and Chronic Health Assessment II, **COPD:** Chronic Obstructive Pulmonary Disease

are shown in Table 2. No significant difference was found between the two groups in markers other than procalcitonin. Procalcitonin values measured on the day the patients were diagnosed with VAP were found to be significantly higher in Group 2 (p=0.011). There was no significant difference between the two groups in terms of GCS, SOFA, and CPIS scores on the day of hospitalization, the day of diagnosis, and three, seven, and 30 days after diagnosis (Table 2). It was found that tracheostomy was opened on average 14.76±6.67 days after the patient's hospitalization in Group 1, and 12.60±7.23 days after the patient's admission in Group 2 (p=0.068).

There was no difference in terms of reproducing factors in both groups (p=0.941). The most commonly observed factor was *Acinetobacter baumanni* (Group 1:66.7%, Group 2:65.4%), followed by factors of *Pseudomonas aerugino-*

Table 2: Infection markers and GCS, CPIS, SOFA scores.

	Group 1 (n=48)	Group 2 (n=56)	P
White blood cell, µ/L			
Day of hospitalization	13 956±6 939	13 450±5 698	0.876
Diagnosis day	14 654±6 025	14 192±7 773	0.571
After the diagnosis 3rd day	14 109.79±6 482.92	13 037.04±8 015.23	0.505
After the diagnosis 7th day	13 676.83±7 215.93	11 217.17±6 913	0.054
After the diagnosis 30th day	13 162.17±5 559.61	15 358.33±7 044.19	0.470
C-Reactive Protein, mg/L			
Day of hospitalization	73±68	77±76	0.917
Diagnosis day	113.70±69.61	120.99±76	0.769
After the diagnosis 3rd day	104.82±66.14	104.56±70.02	0.843
After the diagnosis 7th day	11.46±86.12	81.14±50.64	0.156
After the diagnosis 30th day	102.78±78.10	118.53±86.51	0.665
Procalcitonin, ng/ml			
Day of hospitalization	0.15±013	0.15±0.24	0.225
Diagnosis day	16.73±25.21	34.24±33.92	**0.011**
After the diagnosis 3rd day	10.56±19.68	17.61±24.66	0.132
After the diagnosis 7th day	5.96±12.01	8.01±12.33	0.640
After the diagnosis 30th day	0.09±1.21	1.08±1.11	0.773
Fever, °C			
Day of hospitalization	36.63±0.42	36.75±0.39	0.106
Diagnosis day	37.3±0.61	37.41±0.52	0.827
After the diagnosis 3rd day	36.8±0.56	36.89±0.53	0.692
After the diagnosis 7th day	36.53±0.50	36.75±0.60	0.695
After the diagnosis 30th day	36.19±0.35	36.22±0.35	0.979
Glasgow Coma Score			
Day of hospitalization	6.23±3.64	6.50±3.61	0.572
Diagnosis day	6.71±2.64	6.54±2.64	0.756
After the diagnosis 3rd day	6.40±2.71	6.98±2.70	0.714
After the diagnosis 7th day	7.20±2.94	7.54±2.64	0.831
After the diagnosis 30th day	7.57±2.90	7.94±2.80	0.398
CPIS			
Day of hospitalization	2.42±1.51	2.68±1.54	0.386
Diagnosis day	6.33±1.33	6.41±1.29	0.772
After the diagnosis 3rd day	5.60±1.75	5.70±1.50	0.630
After the diagnosis 7th day	4.95±2.07	5.11±2.10	0.575
After the diagnosis 30th day	3.83±1.97	4.39±1.91	0.811
SOFA score			
Day of hospitalization	6±2	6±2	0.681
Diagnosis day	6.04±1.56	6.05±1.27	0.405
After the diagnosis 3rd day	5.77±1.49	5.89±1.55	0.165
After the diagnosis 7th day	5.46±1.38	5.02±1.51	0.516
After the diagnosis 30th day	4.48±1.24	5.06±1.35	0.957

GCS: Glasgow Coma Score, **CPIS:** Clinical Pulmonary Infection Score, **SOFA:** Sepsis-Related Organ Failure Assessment

sa (Group 1:22.9%, Group 2:23.1%) and *Klebsiella pneumoniae* (Group 1:10.4%, Group 2:11.5%). There was no significant difference between the two groups in terms of risk factors for VAP (Table 3). The period of hospitalization was similar between the two groups (Group 1:37.66±14.36 days, Group 2:35.05±16.09 days, p=0.334). VAP diagnosis day was also similar between the two groups (Group 1: 15.33±8.96 days, Group 2: 16.12±11.81 days, p=0.794).

There was no difference between the two groups in terms of hand hygiene rates (Group 1: 75.52±4.10, Group 2: 72.48±7.37, p=0.121), but the hospitalization rate was found to be significantly higher in Group 2 (Group 1: 1.93±0.45, Group 2: 2.87±0.82 %, p<0.001). In 2018, the number of high school graduate nurses was six and the number of university graduate nurses was two for each month in Group 1; In Group 2, the number of high school graduate nurses was nine, and the number of university graduate nurses was one. In 2019, the number of nurses with high school graduates was five and the number of nurses with a university degree was three for each month in Group 1; In Group 2, the number of high school graduate nurses was eight, and the number of university graduate nurses was two. The number of patients per nurse in both groups was two, so no comparison was made.

Table 3: Risk factors for ventilator-associated pneumonia.

	Group 1 (n=48)	Group 2 (n=56)	p
Reintubation status, n (%)	12 (25)	9 (16.1)	0.258
Sedative drug use, n (%)	29 (60.4)	42 (75)	0.111
Feeding route, n (%)			0.684
Enteral	46 (95.8)	51 (91.1)	
Parenteral	0	1 (1.8)	
Enteral + parenteral	2 (4.2)	4 (7.1)	
Feeding tract, n (%)			0.247
Nasogastric tube	48 (100)	53 (94.6)	
Orogastric tube	0	3 (5.4)	
Immunosuppressive use, n (%)	16 (33.3)	18 (32.1)	0.897
Vasoactive drug use, n (%)	27 (56.3)	34 (60.7)	0.645
Presence of central venous catheter, n (%)	36 (75)	45 (80.4)	0.512
Presence of intracerebral pressure catheter, n (%)	4 (8.3)	12 (21.4)	0.065
Proton pump inhibitor use, n (%)	30 (62.5)	31 (55.4)	0.461
Position, n (%)			1.000
Supine	46 (95.8)	53 (94.6)	
Prone	2 (4.2)	3 (5.4)	
History of abdominal or thoracic surgery, n (%)	3 (6.3)	7 (12.5)	0.335
Renal replacement therapies, n (%)	14 (29.2)	12 (21.4)	0.364
Cuff pressure values, cmH_2O	24.35±5.08	22.46±2.68	0.089

There was no difference between the two groups in terms of 30-day mortality. It was 45.8% (n=22) in Group 1 and 48.2% (n=27) in Group 2 (p=0.136). It was 47.1% (n=49) in all patients. In all patients, age, gender, comorbidity, hand hygiene rate, hospitalization rate, mean CPIS value, APACHE II score, mean white blood cell count, CRP mean value, mean procalcitonin value, and MV stay variables does not affect on 30-day mortality, while one unit increase in SOFA mean score increases the risk of 30-day mortality 2.21 times. The increase in the hospitalization period reduces the risk of 30-day mortality (OR=0.891) (Table 4).

Age, gender, comorbidity, hand hygiene rate, hospitalization rate, the mean value of CPIS did not have a significant effect on the hospitalization period in all patients, but an increase in the mean SOFA score decreased the period of hospitalization (p=0.002) (Table 5).

DISCUSSION

Our study was conducted prospectively in 104 patients who developed VAP in two different ICUs of a tertiary hospital. VAP rates were 6.27% in Group 1 and 3.35% in Group 2. There was no significant difference between the two groups in terms of demographic data, VAP development risk factors, and length of stay in ICU. There was no significant difference between the two groups in terms of GCS values, SOFA scores, and CPIS values measured on the day of hospitalization, the day of diagnosis, three days after

Table 4: Factors affecting terms of 30-day mortality in all patients.

	p	OR	%95 Confidence Interval	
			Lower limit	Upper limit
Age	0.236	1.022	0.986	1.061
Gender	0.308	1.885	0.557	6.382
Comorbidity	0.376	0.505	0.111	2.290
Hand hygiene rate	0.454	0.961	0.867	1.066
Hospitalization rate	0.571	1.248	0.580	2.685
Mean CPIS value	0.753	0.919	0.543	1.554
Mean SOFA score	**0.009**	**2.214**	**1.220**	**4.018**
APACHE II score	0.940	0.997	0.915	1.086
Mean White blood cell count	0.069	1.000	1.000	1.000
CRP mean value	0.684	1.003	0.990	1.015
Mean Procalcitonin value	0.550	1.013	0.970	1.058
Mechanical Ventilator stay time	0.403	0.980	0.935	1.027
Period of hospitalization	**0.001**	**0.891**	**0.834**	**0.951**

CPIS: Clinical Pulmonary Infection Score, **SOFA:** Sepsis-Related Organ Failure Assessment, **APACHE II:** Acute Physiology and Chronic Health Assessment II, **CRP:** C-Reactive Protein

Table 5: Factors affecting period of hospitalization in all patients.

	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Standard error	Beta		
(Constant)	28.496	22.419		1.271	0.207
Age	0.028	0.088	0.033	0.324	0.747
Gender	-1.791	3.142	-0.057	-0.570	0.570
Comorbidity	-5.030	4.134	-0.122	-1.217	0.227
Hand hygiene rate	0.373	0.243	0.152	1.536	0.128
Hospitalization rate	0.186	1.871	0.010	0.099	0.921
Mean CPIS value	1.576	1.334	0.118	1.181	0.240
Mean SOFA score	-3.911	1.212	-0.318	-3.226	**0.002**

CPIS: Clinical Pulmonary Infection Score, **SOFA:** Sepsis-Related Organ Failure Assessment

diagnosis, seven days after diagnosis, and 30 days after diagnosis. Procalcitonin values measured on the day of diagnosis were found to be significantly higher in Group 2. The increase in the mean SOFA score in all patients had a significant effect on 30-day mortality. When evaluated overall patients, a one unit increase in the SOFA score increases the risk of mortality 2.21 times. It was found that the increase in SOFA score decreased the hospitalization period in all patients.

Most VAP pathogens are microorganisms with high antibiotic resistance, such as *Pseudomonas species, Acinetobacter species,* MRSA, ESBL, and *Gram-negative bacilli that secrete AmpC B-lactamase* (5). In a multicenter study conducted in Turkey, it was reported that most frequently *Acinetobacter spp* was isolated and that Pseudomonas aeruginosa ranked as second and *Stafilococcus aureus* ranked as third (6). In our study, *Acinetobacter baumanii, Pseudomonas aeruginosa, Klebsiella pneumoniae* were found to be the most common Gram-negative agents in both groups, in line with the literature. In a previous study conducted in our clinic, in which nosocomial infections were examined in patients hospitalized in the ICU for more than 90 days, the incidence of VAP was 33% and the causative agents were *Acinetobacter baumanii, Klebsiella pneumoniae, and Pseudomonas aeruginosa* (32.1%, 25%, 21.4%, respectively) (7).

Gursel et al. included a total of 63 patients in their study, in which they aimed to evaluate the effectiveness of APACHE II, SOFA, and CPIS in determining mortality during VAP episodes in pulmonary patients, and it was observed that the APACHE II, SOFA, and CPIS scores were also significantly higher in patients who died with respect to those who survived (8). In the study in which the mortality was 54%, logistic regression analysis revealed that only APACHE II >16 value out of the three scoring systems was an independent predictor of mortality (8). In our study, the APACHE II score did not affect on 30-day mortality in either group. Among the three scoring systems, CPIS is used for diagnostic purposes, while the others (APACHE II, SOFA) are used to determine prognosis (8). In the study they conducted in relation to VAP cases, Yang and Wang have found that while CPIS value at beginning of VAP in those who died was high, CPIS value at beginning of VAP in those who survived got significantly reduced (9). They observed that mortality was higher in those with CPIS >6 at day five than those with CPIS <6, and the sensitivity and specificity of CPIS in determining mortality were 96.8% and 74.2%. In addition, their results show that CPIS is valuable in the diagnosis of VAP and also contributes to the prediction of mortality (9). Contrary to this study, in our study, the mean value of CPIS did not affect 30-day mortality. In addition in the study, CPIS had a positive correlation with MV period, ICU, and period of hospitalization (9). In our study, age, gender, comorbidity, hospitalization rate, mean CPIS value, and mean SOFA score did not have a significant effect on the duration of MV in all patients, while an increase in hand hygiene rate increased the duration of MV stay. It was found that an increase in the SOFA score among these variables decreased the length of stay in all patients.

In various studies evaluating the length of stay of patients with VAP in intensive care units, different results were obtained reporting the average length of stay between 21 and 76 days (10-12). In our study, the mean hospitalization period of the patients in Group 1 was 37.66±14.36 days (min-max: 10-75 days), and the mean hospitalization period of the patients in Group 2 was 35.05±16.09 days (min-max: 9-85 days) and the values were found to conform with the literature.

In a study in which 178 cases with VAP were evaluated, Mirsaeidi et al. reported that mortality increased significantly in patients with immunosuppression, chronic liver disease, and chronic kidney failure compared to those who did not have these but that no significant relationship was found for diabetes mellitus (DM), cerebrovascular accident (CVA),

Heart failure (HF), and chronic obstructive pulmonary disease (COPD) (13). In another study, kidney failure was found to be significant in terms of mortality (14). There have also been reports that DM increases mortality 2.23 times in cases with VAP (15). In our study, there was no effect of co-morbidities (DM, hypertension, COPD, CVA, HF, CRF) on 30-day mortality between both groups.

Although the mortality rate in ventilator-associated pneumonia cases varies between 30-70%, most of these cases die due to underlying diseases (5). Publications are reporting the mortality of cases with VAP between 31.9 and 68.4% (10,16,17). In our study, the 30-day mortality rate was found to be 45.8% in Group 1 and 48.2% in Group 2, which was similar to the literature. It has been reported that among the clinical factors affecting mortality in the ICU, the long stay in the ICU is not significant in terms of mortality, but the mortality is significantly higher in terms of the length of stay in the MV (18). In our study, it was determined that the length of stay in MV did not have an effect on 30-day mortality in all patients, but an increase in the length of hospitalization reduced the risk of 30-day mortality.

In a review, it was reported that the risk of VAP increased 5.1 times in cases over the age of 60 (19). In another study, they reported that the mean age of patients with and without VAP was very close to each other, and there was no significant difference between the two groups in terms of VAP development, even when the patients were divided into two groups as those under 70 years of age and over (20). In our study, the mean age was around 62, and we found that age did not affect 30-day mortality in patients who developed VAP.

While each patient should be followed by a nurse in high-risk patients, a nurse can follow two patients in low-risk patients and implement infection control and prevention strategies. In a study, it was shown that the incidence of VAP increases when nurse care and number are not sufficient (21). Small area per patient, lack of experienced staff, workload, and imbalance between resources are associated with nosocomial infections (22). It has been shown that the low number of nurses and high workload is directly related to morbidity and mortality (23). While ideal intensive care units should have one nurse per patient, in our unit this ratio is usually one nurse for every two patients. The excess of personnel workload can create problems in the isolation of infected patients. The most important source of the problem for nosocomial infections is the inability of many hospitals to provide healthy conditions in intensive care units. Examples of these conditions are inadequacies in architectural structuring, inability to provide isolation conditions, problems with air conditioning, medical waste and biohazardous materials inpatient rooms in ICU, contaminated treatment areas and common areas, fecal residues in ICU patient toilets. Others are leaks in walls and associated contaminated cabinets, broken flooring, holes in the floor that generate debris and dirty dust, and foreign material in window sills (24). Although the physical conditions of our two intensive care units were different, we did not find any difference in VAP rates, risk factors for VAP, and 30-day mortality. Safdar et al. reported that the main cause of VAP caused by exogenous pathogenic microorganisms in the intensive care environment is the hands of healthcare workers (25). In a study in which infection and colonization rates were significantly reduced by strict adherence to handwashing protocols, it was determined that handwashing rates were below 50% (26). In the educational study conducted by Rosental in Argentina, the relationship between handwashing compliance and VAP rate was evaluated and it was shown that handwashing rate increased from 23% to 64% ($p<0.001$), and the VAP rate decreased from 47 to 27 in 1000 ventilator days ($p<0.001$) (27). In our study hand hygiene rate was found to be higher than 70% in both groups.

The lack of a control group is our main limitation. Our other limitations are that the anesthesia and infectious diseases doctors who care for the intensive care units differ every month, the differences arising from the treatments of the patients and the VAP training of the intensive care workers are not questioned.

CONCLUSION

We found that a one unit increase in the SOFA mean score in all patients increased the risk of 30-day mortality 2.21 times, and an increase in the SOFA mean score significantly decreased the length of stay in all patients. Although there are similar studies in the literature, it is of great importance in the control and treatment of an infection that each intensive care unit analyzes its own data and results and uses them in clinical practice.

Acknowledgment

None.

Author Contributions

Concept: **İlken Uğuz, Derya Karasu, Canan Yılmaz,** Design: **İlken Uğuz, Derya Karasu, Canan Yılmaz, Gül Durmuş,** Data Collection and/or Processing: **İlken Uğuz, Ezgi Ünal Asan, Şeyda Efsun Özgünay, Gül Durmuş,** Writing Manuscript: **İlken Uğuz, Derya Karasu, Canan Yılmaz,** Critical Review: **Mehmet Gamlı.**

Conflicts of Interest

No conflicts of interest declared.

Financial Support

This research was carried out without funding.

Ethical Approval

Uludağ University Ethics Committee (decision no: 2017-11/27, date: 06.07.2017).

Review Process

Extremely peer-reviewed and accepted.

REFERENCES

1. Nair GB and Niederman MS. Ventilator-associated pneumonia: Present understanding and ongoing debates. Intensive Care Med 2015;41:34-48.
2. Chastre J and Fagon JY. Ventilator-associated pneumonia. Am J Respir Crit Care Med 2002;165:867-903.
3. Yüceer S and Demir SG. Prevention of nosocomial infections in intensive care unit and nursing practices. Dicle Med J 2009;36:226-232.
4. WHO Guidelines on Hand Hygiene in Health Care. 15 January 2009 Website https://www.who.int/publications/i/item/9789241597906. [accessed 29 May 2021]
5. American Thoracic Society; Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med 2005;171:388-416.
6. Leblebicioglu H, Rosenthal VD, Arikan OA, Ozgültekin A, Yalcin AN, Koksal I, Usluer G, Sardan YC, Ulusoy S; Turkish Branch of INICC. Device-associated hospital-acquired infection rates in Turkish intensive care units. Findings of the International Nosocomial Infection Control Consortium (INICC). J Hosp Infect 2007;65:251-257.
7. Karasu D, Yılmaz C, Durmuş G, Özer D, Çağlayan Ü, Karaduman İ, Asan A. Evaluation of healthcare-associated infections in critically Ill patients receiving long-term treatment in the intensive care unit. KLİMİK J 2016;29:71-76.
8. Gursel G, Aydogdu M, Ozyilmaz E, Ozis TN. Risk factors for treatment failure in patients with ventilator-associated pneumonia receiving appropriate antibiotic therapy. J Crit Care 2008;23:34-40.
9. Yang GH, Wang GF. Value of the clinical pulmonary infection score for the prognosis of ventilator-associated pneumonia. Chin J Tuberc Respir Dis 2006;29:751-754.
10. Mathai AS, Phillips A, Kaur P, Isaac R. Incidence and attributable costs of ventilator-associated pneumonia (VAP) in a tertiary-level intensive care unit (ICU) in northern India. J Infect Public Health 2015;8:127-135.
11. Kundakcı A, Özkalaycı Ö, Zeyneloglu P, Arslan H, Pirat A. Risk factors for nosocomial infections in a surgical intensive care unit. J Turk Soc Intens Care 2014;12:25-35.
12. Palabıyık O, Öğütlü A, Toptaş Y. Ventilator-Associated Pneumonia and causative microorganisms in intensive care unit: A two year retrospective analysis. J Turk Soc Intens Care 2016;14:80-85.
13. Mirsaeidi M, Peyrani P, Ramirez JA; Improving Medicine through Pathway Assessment of Critical Therapy of Hospital-Acquired Pneumonia (IMPACT-HAP) Investigators. Predicting mortality in patients with ventilator-associated pneumonia: The APACHE II score versus the new IBMP-10 score. Clin Infect Dis 2009;49:72-77.
14. Şengül A, Şengül E, Argun Barış S, Hayırlıoğlu N. Assesment of the factors associated with mortality in ventilator associated pneumonia of multidrug resistance Acinetobacter Baumannii. Kocaeli Med J 2013;2:1-6.
15. Blot S, Koulenti D, Dimopoulos G, Martin C, Komnos A, Krueger WA, Spina G, Armaganidis A, Rello J; EU-VAP Study Investigators. Prevalence, risk factors, and mortality for ventilator-associated pneumonia in middle-aged, old, and very old critically ill patients. Crit Care Med 2014;42:601-609.
16. de Miguel-Díez J, López-de-Andrés A, Hernández-Barrera V, Jiménez-Trujillo I, Méndez-Bailón M, Miguel-Yanes JM, Del Rio-Lopez B, Jiménez-García R. Decreasing incidence and mortality among hospitalized patients suffering a ventilator-associated pneumonia: Analysis of the Spanish national hospital discharge database from 2010 to 2014. Medicine (Baltimore) 2017;96:e7625.
17. Song X, Chen Y, Li X. Differences in incidence and outcome of ventilator associated pneumonia in surgical and medical ICUs in a tertiary hospital in China. Clin Respir J 2014;8:262-268.
18. Rocker G, Cook D, Sjokvist P, Weaver B, Finfer S, McDonald E, Marshall J, Kirby A, Levy M, Dodek P, Heyland D, Guyatt G; Level of Care Study Investigators; Canadian Critical Care Trials Group. Clinician predictions of intensive care unit mortality. Crit Care Med 2004;32:1149-1154.
19. Bonten MJM, Kollef MH, Hall JB. Risk factors for ventilator-associated pneumonia: From epidemiology to patient management. Clin Infect Dis 2004;38:1141-1149.
20. Uslu M, Öztürk DB, Kuşçu K, Aslan V, Gürbüz Y, Tütüncü EE, Şencan İ. Risk factors affecting the development of Ventilator-Associated Pneumonia in patients hospitalized in the intensive care unit. KLİMİK J 2010;23:83-88.
21. Craven DE. Preventing ventilator-associated pneumonia in adults: sowing seeds of change. Chest 2006;130:251- 260.
22. Grisaru-Soen G, Paret G, Yahav D, Boyko V, Lerner-Geva L. Nosocomial infections in pediatric cardiovascular surgery patients: A 4-year survey. Pediatr Crit Care Med 2009;10:202-206.
23. Tarnow-Mordi WO, Hau C, Warden A, and Shearer AJ. Hospital mortality in relation to staff workload: A 4-year study in an adult intensive-care unit. Lancet 2000;356:185-189.
24. Kahveci F. Infection control principles in intensive care unit: International standarts. J Turk Soc Intens Care 2017;5:30-31.
25. Safdar N, Dezfulian C, Collard HR, Saint S. Clinical and economic consequences of ventilator-associated pneumonia: A systematic review. Crit Care Med 2005;33:2184-2193.
26. Bonten MJ. Infection in the intensive care unit: Prevention strategies. Curr Opin Infect Dis 2002;15:401-405.
27. Rosenthal VD, Guzman S, Safdar N. Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina. Am J Infect Control 2005;33:392-397.