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ORIGINAL RESEARCH / *ÖZGÜN ARAŞTIRMA*

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A Retrospective Analysis of Hospital and Intensive Care Unit Readmission Causes in Patients Discharged from Intensive Care Units

Yoğun Bakımdan Taburcu Edilen Hastaların Yoğun Bakıma ve Hastaneye Yeniden Başvurularının Geriye Dönük İncelenmesi

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ABSTRACT *Objective:* Intensive care unit (ICU) readmission is a common and unwanted situation. Mortality rates, length of stay in ICU and treatment expenses are also higher in readmitted patients. This study aimed to examine the hospital/ICU readmission rates and risk factors among patients discharged from the ICU.
Materials and Methods: Patients older than 18 years who were hospitalised in the ICU between January 1, 2012 and October 31, 2016 and were re-admitted to the hospital/ICU within 30 days after discharge were retrospectively analysed.
Results: A total of 510 patients met the inclusion criteria, of whom 91 (17.84%) patients were readmitted to the ICU. The average age was higher (p = 0.002) among the readmitted patients. The acute physiology and chronic health evaluation II and sequential organ failure assessment scores at admission and discharge, stability and workload index for transfer (SWIFT) scores at discharge and comorbid disease rates were higher among readmitted patients (p < 0.05 for all). Patients discharged with mechanical ventilation support had higher readmission rates (p = 0.041). In our risk analysis model, factors that increased the risk of readmission were identified as age (odds ratio [OR], 1.02; 95% confidence interval [CI], 1.01–1.03) and presence of renal disease (OR, 5.72; 95% CI, 2.81–11.65) among patient-related reasons.
Conclusion: High acute physiology and chronic health evaluation and SWIFT scores during discharge as well as presence of comorbidities can predict hospital/ICU readmission.
Keywords: SWIFT score, intensive care, readmission, acute physiology and chronic health evaluation II score

ÖZ *Amaç:* Yoğun bakım ünitesine (YBÜ) yeniden başvuru yaygın ve istenmeyen bir durumdur. Mortalite oranları, YBÜ'de kalış süresi ve tedavi giderleri yeniden yatırılan hastalarda daha yüksektir. Bu çalışma, YBÜ'den taburcu edilen hastalarda hastane/YBÜ'ye yeniden başvuru oranlarını ve buna neden olan risk faktörlerinin incelenmesi amaçlanmıştır.
Gereç ve Yöntem: 1 Ocak 2012 and 31 Ekim 2016 tarihleri arasında YBÜ'de yatmış ve taburculuk sonrası hastaneye / YBÜ'ye 30 gün içinde yeniden başvuran 18 yaşından büyük hastalar üzerinde retrospektif bir analiz yapıldı.
Bulgular: Toplam 510 hasta dahil edildi, bunların 91'i (% 17,84) YBÜ'ye yeniden başvurdu. YBÜ'ye ilk başvuru ve taburculuk sırasında hesaplan APACHE II ve SOFA skorları ile taburculuk sırasında hesaplanan Stabilite ve İş Yükü İndeksi (SWIFT) skoru ve komorbid hastalık oranları yeniden başvuran hastalarda daha yüksekti (p< 0,05). Yeniden başvuran hastaların yaş ortalaması daha yüksekti (p = 0.002).Mekanik ventilasyon (MV) desteği ile taburcu edilen hastaların tekrar başvuru oranı daha yüksekti (p = 0,041). Risk analizi modelimizde yaş (olasılık oranı [OR], 1.02;% 95 güven aralığı [CI], 1.01-1.03) ve böbrek hastalığı varlığı (OR, 5.72; 95 % CI, 2.81–11.65) yeniden yatış riskini artıran faktörler olarak belirlendi.
Sonuç: Taburculuk sırasında hesaplanan yüksek akut fizyolojik skorlar ile SWIFT skoru ve komorbid hastalıkların varlığı hastaneye/YBÜ'ye yeniden yatışı öngörebilir.
Anahtar Kelimeler: SWİFT skoru, yoğun bakım, yeniden başvuru, APACHE 2 skoru

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Introduction

Readmission to the intensive care unit (ICU) after prior treatment in the ICU is a common and an unwanted situation (1). Approximately 4%–6.3% of patients discharged from the ICU are known to be readmitted to the same hospital (2). One argument claims that there is a 1.5- to 10-fold increase in mortality rates and a minimum of a 2-fold increase in hospitalisation duration among patients' readmission to the ICU after being discharged compared with those who have not been hospitalised (3).

The ICU team generally determines which patients are ready to be discharged from the ICU (4). These determinations are based on personal/subjective decisions, and the high demand for ICU beds might cause some patients to be prematurely discharged. Due to the concerns regarding the early discharge of patients without (the possibility of developing) permanent solutions to their problems, determining the risk factors for the readmissions of critical patients to the ICU or hospital after being previously discharged is crucial (4). At the same time, determining the patients' risk factors can also contribute to a better evaluation of an appropriate ICU discharge time. The studies conducted in this respect revealed that the most common diagnoses related to readmission to ICU are heart failure, gastrointestinal bleeding, bacterial pneumonia and chronic obstructive pulmonary disease (3). Furthermore, researchers have claimed that factors concerning the patient and initial time as an in-patient such as age, comorbid diseases, physiological anomalies during ICU discharge, haemodialysis, mechanical ventilation (MV) applications and the initial time spent in the ICU might impact the reapplication for ICU admission (5). In addition, other components are involved such as the insufficiency of ICU bed capacities, limited ICU resources and institutional factors like night-weekend transfer influential on ICU reapplications (3, 6).

Some scores used in intensive care are thought to be effective in predicting readmission. Disease severity scores (acute physiology and chronic health evaluation [APACHE] and sequential organ failure assessment [SOFA]) measured during the first application for admission to the ICU and at the time of discharge were found to be higher in patients readmitted to the ICU. Each increase in standard deviation reflected on the readmission risk by 43% (7). The Stability and Workload Index for Transfer (SWIFT) score developed by Gajic et al. (8) was shown as a potential tool for determining readmissions to the ICU.

Within the scope of our study, the main objectives were to examine readmission to the ICU as well as risk factors for readmission by evaluating critical patients sent to the clinic or their homes after their treatments.

Materials and Methods

The study was approved by the medical research ethics board on 28 November 2016 (No. 2016-19/15) from the Uludağ University Faculty of Medicine. No informed consent was obtained from the patients because our research was retrospective and descriptive in nature. The study included adult patients over the age of 18 years who were discharged to the clinic, another ICU or home following their treatment that lasted longer than 24 hours between 1 January 2012 and 31 October 2016 with invasive or noninvasive MV support in the ICU. Our ICU has 19 beds, which accept surgical and medical patients, and is managed by the Department of Anaesthesiology and Reanimation at the Uludağ University Faculty of Medicine. Patient information was retrospectively obtained from archived registry files and hospital information management system.

The exclusion criteria were determined as follows: being under 18 years of age, death, admission to the ICU for less than 24 hours and absence of MV support.

The following data were recorded: demographic information of the patients, ICU admission diagnoses, comorbid diseases, ICU treatments [vasoactive medications, renal replacement, extracorporeal membrane oxygenation (ECMO), plasmapheresis], presence of ICU-sourced diagnosed infections, durations of endotracheal intubation-tracheostomy, length of stay in ICU or hospital, APACHE II and SOFA scores during the initial ICU admission and discharge, need for MV support during discharge, SWIFT scores, time of discharge (working hours, weekdays or weekends outside of working hours) and readmission to the ICU or hospital. The APACHE II and SOFA scores were recalculated for the patients' readmission to the hospital/ICU, and the outcomes of patients (death/discharge) were recorded.

Readmission was defined as admission to the emergency room within 30 days after discharge from the hospital, demand for prompt ICU consultation during treatment at the clinic and unexplained death within 1 week after discharge. Information of the patients who were discharged to home was obtained from the death declaration system of the

Directorate-General for Public Health of the Republic of Turkey Ministry of Health.

Averages, standard deviations, medians, minimum and maximum values, interquartile ranges, frequencies and ratio values were used as the descriptive statistics for the data. The distribution of variables was calculated using the Kolmogorov-Smirnov test, and for the analysis of quantitative independent data, quantitative dependent data and qualitative independent data and in cases in which chi-squared test conditions were not fulfilled, Mann-Whitney U test, Wilcoxon test, chi-squared test and Fischer test were used, respectively. A multiple logistic regression analysis was performed to determine the risks of readmission. The statistical analyses were performed using SPSS 22. A $p < 0.05$ was considered to be statistically significant.

Results

A total of 1,437 patients were admitted to the ICU between 1 January 2012 and 31 October 2016. Of these patients, 615 died despite treatment and 11 were still being treated during the study period. There were 811 patients who were discharged after their treatments. According to the study protocol criteria, 301 patients were excluded, thereby leaving 510 patients to be evaluated (Figure 1).

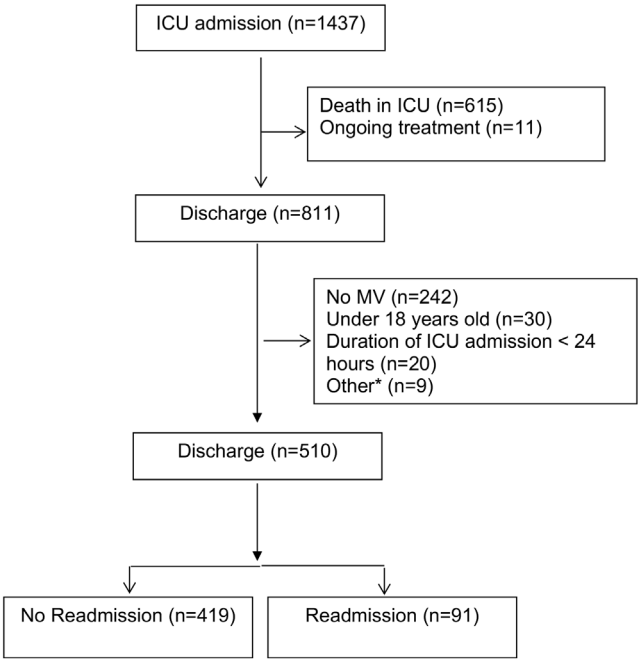

Figure 1. Flow diagram

The demographic data regarding the cases, presence of comorbid diseases, ICU admission diagnoses, airway management, treatments, times and places of discharge and length of stay in the ICU/hospital are shown in Tables 1 and 2.

Included in the study were 194 (38%) female and 316 (62%) male patients. The age average of the patients was calculated as 51.8 years; 70% of the patients had comorbid diseases, of which the most common comorbid diseases were hypertension and cardiac diseases (32.34%).

The most frequent diagnoses for ICU admission among the patients were respiratory system diseases (36.7%), followed by trauma and neurological diseases. Approximately 37.1% of the patients were admitted to the ICU from the hospital ward, 34.3% from the emergency room, 12.2% from the external centre, 12.2% from other ICUs within the hospital and 4.3% from the operating room following urgent surgeries.

In the ICU, 95.7% of the patients had invasive MV support through endotracheal intubation-tracheostomy and 4.3% of the patients had noninvasive MV support. Furthermore, 55.5% of patients underwent one or more of the following treatments: vasoactive medications, renal replacement therapy, ECMO and plasmapheresis. ICU-related infection was detected at least once among 55.5% of the patients.

After their treatments in the ICU, 397 patients were referred to a ward in the hospital, 81 were sent home, 19 were referred to other surgical and medical ICUs within the hospital and 12 were discharged to the external centre. A total of 306 patients were discharged during working hours, whereas 204 patients were discharged during the weekend or outside of working hours.

A total of 91 patients were readmitted to the ICU and hospital after being discharged. The readmission rate was calculated as 17.8%. There were 37 patients readmitted to the emergency room, 26 patients accepted to the ICU, 14 were ICU consultations demanded from clinics, and 14 were unexplained deaths within 1 week.

The age average of patients readmitted to the ICU/hospital was 58.2 years, and they were older than those who were not readmitted ($p = 0.002$). A total of 60 readmitted patients were men, and 31 were women. Sex was not a determining factor in the readmissions ($p > 0.05$). The comorbid disease rate among patients applying for rehospitalisation and readmission to the ICU after being discharged was higher ($p = 0.049$) (Table 3).

Readmitted patients had significantly higher APACHE II and SOFA scores at the first admission and discharge (p = 0.000 for all). The average scores among patients readmitted to the hospital/ICU were as follows: GCS, 10.53; APACHE II, 18.19; and SOFA, 5.83. The SWIFT score during the first discharge from the ICU was found to be significantly higher among readmitted patients (p = 0.01) (Table 4).

When compared with patients who were not readmitted to the hospital/ICU, the length of stay in the ICU and hospital and MV support were significantly longer among the patients who were not readmitted (p = 0.019, p = 0.002, p = 0.018, respectively). The time of first discharge (within and outside of working hours/weekends) was not a contributing factor in readmission (Table 3).

The rates of ICU-related infections and airway management (intubation/tracheostomy) among the readmitted patients were not found to be significantly different in comparison with those who were not readmitted. However, the readmission rate for the hospital/ICU were higher among the patients discharged with MV support (p = 0.041) (Table 5).

The comparison of age, duration of MV support, length of stay in ICU, APACHE and SOFA scores, SWIFT scores, renal disease rates, neurological disease rates, traumas, sepsis/septic shock, vasoactive medication use and RRT made based on the univariate model for the differentiation of readmission showed that all of the parameters were statistically significant with a ratio of $p < 0.05$. The multivariate analysis model for the differentiation of readmission demonstrated that APACHE II and SOFA scores as well as renal disease are independent factors (Table 6).

After excluding the deceased (n = 14), 62 (80.5%)of the readmitted patients were discharged from the ICU, while 15 (19.5%) patients died during their second stay in the ICU.

Table 1. Demographic data and clinical characteristics of cases

Age (Avg.±SD) (Min-Max)	51.8±19.8 (18-93)
Sex (F/M) (n, %)	194 (38.0) / 316 (62.0)
Co-morbid disease (Yes/No) (n, %)	357 (70.0) / 153 (30.0)
ICU admission diagnosis (n, %)	
Respiratory diseases	187 (36.7)
Trauma	93 (18.2)
Neurological diseases	69 (13.5)
Sepsis/Septic shock	55 (10.8)
Post-CPR care	45 (8.8)
Cardiac disease	19 (3.7)
Other	67 (13.1)
Place of ICU admission (n, %)	
Ward	189 (37.1)
Emergency room	175 (34.3)
Postoperative urgent surgery	22 (4.3)
External centre	62 (12.2)
Other ICU	62 (12.2)
Airway (n, %)	
Endotracheal intubation/Tracheostomy	488 (95.7)
Non-invasive MV (n, %)	22 (4.3)
ICU treatments (n, %)	
None	232 (45.5)
Vasoactive medication	213 (41.8)
Renal replacement treatment	117 (22.9)
ECMO	19 (3.7)
Plasmapheresis	31 (6.1)
Place of discharge (n, %)	
Ward	397 (77.8)
Home	81 (15.9)
Other ICU	19 (3.7)
External centre	12 (2.4)
Time of discharge (n, %)	
During working hours	306 (60)
Weekend - Outside working hours	204 (40)
Length of stay in ICU (days) (Avg.±SD) (Min-Max)	31.7±31.9 (2-155)
Length of stay in hospital (days) (Avg.±SD) (Min-Max)	48.6±38.2 (3-212)

Avg: average, SD: standard deviation, F: female, E: male, ICU: intensive care unit, MV: mechanical ventilation, ECMO: extra-corporeal membrane oxygenation, Min: minimum, Max: maximum, CPR: cardiopulmonary resuscitation.

Table 2. Co-morbid diseases of patients

Co-morbid diseases	**n (%)**
Cardiac disease	196 (32.34%)
Endocrine disease	120 (19.80%)
Asthma/COPD	70 (11.55%)
Neurological disease	62 (10.23%)
Renal disease	50 (8.25%)
Malignancy	48 (7.92%)
Psychiatric disease	24 (3.96%)
GIS disease	22 (3.63%)
Rheumatic disease	14 (2.31%)

COPD: Chronic obstructive pulmonary disease, GIS: Gastrointestinal system.

Table 3. Demographic data, co-morbid diseases, ICU admissions, mechanical ventilation and hospital admission durations of patients readmission/no readmission to ICU or hospital.

	No Readmission	Readmission	P
Age (avg±SD)	50.4±19.5	58.2±20.1	0.002
Sex (F/M) (n, %)	163 (38.9) / 256 (61.1)	31 (34.1) / 60 (65.9)	0.457
Co-morbid disease (Y/N) (n, %)	285 (68) / 134 (32)	72 (79.1) / 19 (20.9)	0.049
Length of stay in ICU (day)	30.0±30.8	39.6±35.7	0.019
Duration of MV (day)	26.7±31.0	37.3±36.7	0.018
Length of stay in hospital (day)	46.5±38.3	58.3±36.5	0.002
Time of discharge (n, %)			
During working hours	259 (61.8)	48 (52.7)	0.138
Weekend - Outside working hours	160 (38.2)	43 (47.3)	

Avg: average, SD: standard deviation, F: female, M: male, Y: yes, N: no, ICU: intensive care unit, MV: mechanical ventilation.

Table 4. ICU admission and discharge scores of cases (n: 510)

		No Readmission (n: 419)	Readmission (n: 91)	P
GCS	Admission	8.3±3.9	7.5±3.8	0.109
	Discharge	13.2±2.9	12.8±3.2	0.235
APACHE II	Admission	18.0±6.3	21.9±7.8	<0.001
	Discharge	8.9±5.7	13.1±6.2	<0.001
SOFA	Admission	6.0±4.7	8.1±3.9	<0.001
	Discharge	2.1±1.7	3.3±2.2	<0.001
SWIFT		21.8±12.1	25.9±11.8	0.010

GCS: Glasgow Coma Scale, APACHE II: Acute Physiology and Chronic Health Evaluation, SOFA: Sequential Organ Failure Assessment, SWIFT: Stability and Workload Index for Transfer.

Table 5. Relationship between discharge and ICU related infections, airway management, and mechanical ventilation support (IMV and NIMV).

	No Readmission	Readmission	P
ICU-related infection (Yes/No) (n, %)	225 (53.7) / 194 (46.3)	57 (62.6) / 34 (37.4)	0.150
Airway management (n, %)			
IMV	402 (95.9)	86 (94.5) / 5 (5.5)	0.743
NIMV	17 (4.1)		
Discharged with MV support (Yes/No)	89 (21.2) / 330 (78.8)	29 (31.9) / 62 (68.1)	0.041

ICU: intensive care unit, ETT: endotracheal intubation, NIMV: non-invasive mechanical ventilation, IMV: Invasive mechanical ventilation, MV: mechanical ventilation

Discussion and Conclusion

In our study that examined the readmission to hospital and ICU after ICU discharge, the readmission rate in 30 days after discharge was 17.8%. The readmitted patients were older, and the comorbid disease rates among these patients were higher. They were also supported with MV for more days while staying longer in the hospital. Furthermore, the high initial and second ICU admission and discharge scores (APACHE II, SOFA and SWIFT) and high discharge rate with MV were determined as contributing factors that increased the risk of readmission.

Table 6. Risk analysis for readmission						
	Univariate Model			**Multivariate Model**		
	OR	**95% CI**	**p**	**OR**	**95% CI**	**p**
Age	1.02	1.01 – 1.03	**0.002**	1.02	1.01 – 1.03	**0.016**
Sex	0.82	0.49 – 1.38	0.450			
Co-morbid disease	1.76	0.97 – 3.20	0.062			
Duration of MV	1.01	1.00-1.02	**0.011**			
Length of stay in ICU	1.01	1.00 – 1.01	**0.016**			
Discharged with MV support	0,58	0.34-1.00	0,052			
ICU-related Infection	0.68	0.41 – 1.13	0.135			
GCS	0.94	0.88 – 1.01	0.090			
APACHE	1.09	1.05 – 1.13	**<0.001**	1.06	1.02 – 1.10	**0.007**
SOFA	1.09	1.02 – 1.16	**0.007**	4.28	1.99 – 9.23	**<0.001**
SWIFT	1.03	1.01 – 1.05	**0.008**			
Co-morbid disease						
Cardiac disease	0.92	0.55 – 1.53	0.744			
Endocrine disease	1.66	0.96 – 2.87	0.068			
Respiratory disease	1.24	0.62 – 2.47	0.543			
Neurological disease	0.82	0.37 – 1.82	0.622			
Renal disease	5.72	2.81 – 11.65	**<0.001**	1.02	1.00 – 1.03	**0.027**
Malignancy	1.62	0.75 – 3.47	0.218			
GIS disease	2.41	0.88 – 6.65	0.088			
Psychiatric disease	0.50	0.11 – 2.20	0.357			
Rheumatic disease	0.92	0.20 – 4.28	0.914			
ICU Admission Diagnosis						
Cardiac disease	1.89	0.58 – 6.19	0.294			
Respiratory disease	1.32	0.79 – 2.20	0.293			
Neurological disease	0.38	0.16 – 0.92	**0.032**			
Trauma	0.45	0.21 – 0.99	**0.047**			
Sepsis/Septic shock	2.80	1.32 – 5.93	**0.007**			
Post-resuscitation care	1.74	0.81 – 3.76	0.157			
ICU Treatment						
Vasoactive medication	1.94	1.18 – 3.21	**0.009**			
RRT	3.13	1.85 – 5.31	**<0.001**			
ECMO	0.65	0.14 – 2.92	0.572			
Plasmapheresis	1.16	0.38 – 3.57	0.796			

ICU: Intensive care unit, GCS: Glasgow Coma Scale, APACHE 2: Acute physiologic and chronic health evaluation score, SOFA: Sequential organ failure assessment score, SWIFT: Stability and workload index for transfer, GIS: Gastrointestinal system, RRT: Renal Replacement therapy, ECMO: Extracorporeal membrane oxygenation, MV: Mechanical ventilation

Readmission to the ICU is considered a crucial measure for the safety and the quality of ICUs (6, 9). However, the argument that readmission rates are signs of low-quality health care is controversial because insufficient ICU bed capacity, the occupancy of clinic beds and the absence of sufficient directives for patient transfer are also influential on early discharge and readmission (6).

Woldhek et al. (10) analysed the data of 19,750 patients treated in a period of 14 years in a single-centre retrospective study and revealed that the readmission rate to the same ICU after being discharged was 7%. Another multicentre study examined 263,082 patients, of whom 105 were in the ICU, and the study found that the readmission rate was 6.3% (6). The readmission rate was calculated as 5.7% in a compilation document in which 24 studies published as of February 2014 were quantitatively analysed (1). There is no fixed time interval for readmission. Although the quality standards in Turkey designate this interval as the first 48 hours following the initial discharge from the ICU, studies in the literature consider the first 1–30 days as the time interval for readmission (11). We took 30 day period because we aimed to evaluate the reasons of readmissions in a wider perspective.

The reason why the readmission rates were higher (17.8%) in our study might be that in addition to the admission to the same ICU within 30 days after being discharged, we included readmissions to the emergency room, additional ICU consultations for patients sent to the wards and unexplained death within 1 week. When we exclude the additional readmission criteria and calculate, like other studies, the readmission rate seems to be similar to that of other studies (5.09%).

Many risk factors were proposed for readmission to the ICU after discharge. While patient-related factors such as age, comorbid diseases, ICU treatments and disease severity scores are effective, institutional factors like limited ICU capacity and resources are also significant (3,6,12–14). Elliott et al. (15) found out that patients readmitted to the ICU after being discharged tend to be older than those who are not readmitted. The authors claimed that the ageing process contributes to the rise of comorbid disease and functional disorder incidences and that age, therefore, will continue to be a risk factor for readmission. Another study detected that readmission rates increase up until the age of 80 and decline afterwards (3). We also revealed in our study that age is influential on readmission and that patients reapplying to the ICU are older than those who do not ($p = 0.002$) (Table 3).

Sex has also been proposed as a contributing factor for readmission to the ICU after discharge. Jo et al. (4) found that in their single-centre study conducted in their medical ICU, male patients have a higher risk for readmission. Contradicting this study, many others have demonstrated that sex is not influential on readmission (8, 13, 14). Despite the high rate of male patients among the readmitted patients in our study, no statistical significance was detected.

Comorbid diseases are another risk factor for ICU readmission. Studies comparing readmitted patients and non-readmitted patients have shown that many comorbid diseases pose a risk factor in the former group of patients (3, 6, 12, 15). Hua et al. (12) examined the reasons behind the early and late unplanned hospital readmissions of critical patients, and they reported that metastatic cancer and final stage kidney disease were risk factors for readmission. Another study demonstrated that the presence of diabetes mellitus increased the risk of readmission to the ICU (4). Our study also found that the readmission rate among patients with comorbid diseases was significantly higher than those without comorbid diseases. The most common comorbid diseases were hypertension/other cardiac diseases, endocrine diseases and renal diseases in that order. In addition, we learned that the presence of renal diseases increased the risk of readmission (odds ratio [OR], 5.72; 95% confidence interval [CI] 2.81–11.65).

The location of the patient prior to the initial ICU admission (clinic, another hospital or the emergency room) is asserted to have a relationship with readmission (6, 8, 14, 15). The prospective cohort study including 4,684 patients conducted by Rosenberg et al. (16) detected that patients transferred from another hospital or admitted to the ICU from the hospital ward have higher rates of readmission after discharge compared with patients admitted directly from the emergency room. Another study revealed that readmission rates are higher among patients who are transported to the ICU from the operating room and the emergency room (3). Our study did not find a significant relationship between the initial place of admission to the ICU and readmission. The differences between patient admission policies of hospitals might have affected this outcome. The working procedure of our hospital is as follows: If there are available beds in the ICU, patients are accepted from clinics within the hospital, from other ICUs within the hospital and from the emergency room. There are only two beds reserved for patients in the early postoperative period in our unit.

In ICUs, patients are frequently supported with MV. The choice of airway management depends on a wide range of factors such as the patient's respiratory and neurological function impairment. A retrospective study conducted by Hua et al. (12) evaluated 492,653 critical patients and found

that patients undergoing tracheostomy and MV have higher rehospitalisation rates compared with those not supported with MV. Another study examined deceased patients after being discharged from the ICU and reported that prolonged MV support is correlated with mortality (17). Yet, a study by Woldhek et al. (10) found that patients supported with MV during their stay in the ICU have lower ICU readmission rates. The authors argued that the fact that more than 50% of the patients included in their study had limited disease severity and elective cardiac surgery might have affected this outcome. Our study showed no effect of airway management (endotracheal intubation or tracheostomy) during the initial ICU admission on readmission. However, we found a correlation between prolonged MV support and readmission.

During the stay in the ICU, ECMO treatments are administered in patients with organ failure. The relationship between ICU treatments and readmission is commonly evaluated although the number of studies focusing on renal replacement treatment is higher (3, 4, 6, 10, 12). An examination of a patient's readmission to the medical ICU by Jo et al. (4) revealed that only continuous renal replacement treatment correlated with readmission to the ICU. Similarly, our study found a relationship between renal replacement treatment in the ICU and readmission.

Studies have shown that discharge during the night or outside of working hours is an independent risk factor as far as ICU readmission is concerned (9). Night-time discharge is often thought to be a sign of insufficient bed capacity (18). Our study showed no difference between patients discharged during working hours or outside of working hours/weekends in terms of readmission (Table 3).

It is well recognised that prolonged ICU admission is influential on readmission to ICU/hospital (3, 6, 10, 13, 15). In a multicentred study by Kramer et al. (3), 229,961 critical patients were examined, and 6.1% of these patients were readmitted to the ICU. The authors stated that prolonged admission is influential on the initial ICU application and that the readmission rate is directly proportional to the duration of admission. This might be caused by complications such as ICU-related infections that occur when a patient stays in the ICU for a long time and their treatments. In our study, we also detected a correlation between prolonged length of ICU stay and readmission. However, we did not find a significant relationship between ICU-related infections and readmission.

According to several researchers, readmission to hospital/ICU admission is determined by the patient's physiological state at the end of ICU treatment (16). Studies have demonstrated a relationship between disease severity scores showing the physiological anomaly level at the time of discharge from the ICU and readmission (1, 3, 13, 16, 17). In addition, a meta-analysis examined 11 research studies on this subject and concluded that the time of physiological measurements (admission or discharge) and evaluated scores, regardless of the type of ICU disease severity, increase the risk for readmission to the ICU (7). Certain researchers have claimed that there is a valid point in calculated scores to help differentiate between patients who can be discharged to the ward or to a lower ICU unit and those who require additional ICU treatment (19). Acute physiological scores calculated at the time of discharge from the ICU posed a greater risk for ICU readmission compared with the scores calculated during the initial admission (3). However, the studies used different disease severity scores. In our study, having high disease severity scores (APACHE II, SOFA) at the time of initial admission and discharge is a risk factor for death or readmission after being discharged from the ICU (OR, 1.06; 95% CI, 1.02–1.1; OR, 4.28; 95% CI, 1.99–9.23). This finding is consistent with outcomes in several studies (10, 13, 20).

Using the tools or scores based on objective data might help us decide whether a patient can be safely discharged or whether special supervision after ICU treatment is necessary. The SWIFT score, which is developed to measure the workload within the context of intensive care, can differentiate between the patients who apply to the ICU and those who do not (21). SWIFT scores were employed in a prospective cohort study evaluating patients at a medical-surgical ICU in Europe, and its validity was proven (50% sensitivity, 85% specificity) (20). Being one of these statistical models, the SWIFT score was also calculated in our study based on the data regarding the time of discharge. We observed that the score was significantly higher among the readmitted patients.

As palliative care system is still developing in Turkey, after intensive care treatments, some patients are sent home to continue their treatments using home-type mechanical ventilators. Patients discharged in this manner were found to have higher readmission rates. The inability to use home care services due to short-staffed units and insufficiently

trained patients' relatives might be contributing factors in this respect.

The primary limitation of our study is that we were not able to obtain data on patients who could not be admitted to the ICU after being sent home or discharged to the service and who were referred to another centre due to some type of shortage within the system. Furthermore, as the readmission period was set at 30 days, applications made at different times such as on the 2nd, 3rd or 7th days after discharge were not included in the study. Finally, our results cannot be generalised since the study was conducted within a single centre in a certain period.

In conclusion, on examining patients' readmission to the hospital/ICU after being discharged, we found that the patients' acute physiological problems, comorbid diseases and durations of RRT and MV increased their risk of readmission. As readmission prolongs the length of stay in hospital/ICU, entails moral burdens to the patient and their relatives as well as medical personnel and increases medical costs, we concluded that protocols must be created to determine and prevent the risk factors for readmission.

Ethics

Ethics Committee Approval: The study was approved by the medical research ethics board on 28 November 2016 (No. 2016-19/15) from the Uludağ University Faculty of Medicine.

Informed Consent: No informed consent was obtained from the patients because our research was retrospective and descriptive in nature.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: İ.C., N.K.G., Design: C.U., N.K.G., Data Collection and Process: C.U., İ.C., Analysis or Interpretation: C.U., İ.C., N.K.G., Literature Search: C.U., İ.C., R.İ., F.Ş.K., Writing: C.U., İ.C., N.K.G., R.İ., F.Ş.K.

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