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ORIGINAL RESEARCH INTENSIVE CARE

The APACHE-II score and the effect of discharge practices on readmission and mortality in intensive care patients

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ABSTRACT

Background: Two undesirable conditions after discharge from the intensive care unit (ICU) are need of readmission to the ICU and death. Many causative factors have been extensively studied by the researchers in different countries at different periods. We evaluated the effect of APACHE II score on admission and the discharge practices on readmission and mortality.

Methodology: A total of 342 patients were hospitalized in a tertiary ICU between January 2020 and April 2021. We, retrospectively, retrieved their demographic information, and recorded the length of stay in the hospital and ICU, inotropic support, need and duration of mechanical ventilation, units from which the patients were admitted, from which units they were discharged. History of readmission, hospitalization in the ICU, and one-month mortality were also recorded retrospectively.

Results: In our study, no significant difference was found between hospitalization APACHE II scores and post-discharge mortality and readmission rates. It was determined that one-month mortality was significantly higher in the group of patients admitted from the ward. Patients admission to palliative care, and inotropic support was a factor associated with one-month mortality. Prolonged hospital stay was a factor associated with readmission to the ICU.

Conclusion: As prolongation of the time spent in the service of ICU patients may increase ICU mortality, precautions should be taken. Appropriately timed discharge from the medical ward to the ICU and from the ICU to other units will reduce both ICU readmission and mortality.

Abbreviations: APACHE II- Acute Physıology And Chronıc Health Evaluatıon II Score; CRRT- Continuous Renal Replacement Therapy; SOFA- Sequential Organ Failure Evaluation score, CCIS-Charlson Comorbidity Index Score

Keywords: APACHE, Discharge, Intensive care, Mortality, Readmission

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1. INTRODUCTION

Two undesirable conditions after discharge from the intensive care unit (ICU) are re-admission to the ICU and death. The first 48-hour period after discharge was considered the primary time to evaluate the quality of ICU discharge. The shorter the time between discharge and readmission or death, the less 'ready' the patient is considered to be discharged from the ICU.[1]Long-term stay in the ICU is undesirable because of the cost,

increased psychological stress for the patient and their relatives, and increased risk of iatrogenic and nosocomial complications.[2]

Patients awaiting hospitalization in the emergency department may be discharged early or inappropriately from the ICU due to the fact that long-term hospitalization in the ICU increases the cost, and the need for beds for patients who are scheduled for emergency surgery.

In studies 8-10% of patients discharged from the ICU died before being discharged from the hospital or required re-admission to the ICU.[3] In another study, 21 (8.6%) of 244 patients discharged from the ICU died after being discharged from the ICU, and 19 (7.8%) patients were readmitted to the ICU. This study found that the APACHE II score at discharge was effective in predicting post-ICU mortality and ICU readmission.[4]

In the literature review, including 16 articles published between 2010 and 2020, one of the predictors of readmission to intensive care was the APACHE score.[5] Advanced age, diagnosis of admission to ICU, source of admission, APACHE score, continuous renal replacement therapy (CRRT), mechanical ventilation, time to leave the ICU, length of stay in the ICU, and presence of tracheostomy were also associated with readmission to the ICU.[6]

Kramer et al. found in their study that the risk of death in the hospital increased four-fold and the length of hospital stay increased 2.5 times in patients who were re-admitted to the ICU compared to those who did not need re-hospitalization. [7]

Table 1: Demographic characteristics and clinical findings of the patients

Parameters		Result
Age (y)		70.47 ± 13.40
Gender	Female	128 (37.4)
	Male	214 (62.6)
BMI (kg/m^2)		25.27 ± 5.65
The clinic she/he came from	Medical ward	78 (22.8)
	Emergency room	150 (43.9)
	ICU	44 (12.9)
	Outer center	57 (16.7)
	Palliative care service	13 (3.8)
APACHE-II score		22.15 ± 7.02
COPD		229 (67.0)
Malignancy	No	290 (84.8)
	Lung tumor	42 (12.3)
	Other organ tumors	4 (1.2)
	Coexistence of lung and other organ tumor	6 (1.8)
Inotropic support		87(25.4)
CCIS [Median (min-max)]		6.0 (2.0-13.0)
Length of hospital stay (days) [Median (min-max)]		14.0 (1.0-127.0)
Length of stay in ICU (days) [Median (min-max)]		3.0 (1.0-50.0)
Recent status/transfer status to ICU or another clinic	Transfer to service Transfer to outer center	81 (23.7)
	Exit	15 (4.4)
	Discharge	95 27.8)
	Transfer to the 2nd level ICU	1 (0.3)
	Transfer to palliative care service	123 (36.0)
		27 (7.9)
Mechanical ventilation time (days)		6.49 (1-48)
Re-admission to the ICU		45 (13.2)
One-month mortality (%)		37
SOFA [Median (min-max)]		6.0 (4.0-19.0)

BMI: Body Mass Index, COPD: Chronic Obstructive Pulmonary Disease, CCIS: Charlson Comorbidity Index Score, SOFA: Sequential Organ Failure Assessment Score, APACHE: Acute Physiology and Chronic Health Evaluation
Data presented as n (%) or mean ± SD or Median (min-max)

In a study on readmission to the intensive care unit, it was observed that patients who were readmitted to the ICU had a longer average hospital stay and that these patients had higher hospital mortality rates.[8]

As ICU readmission and post-discharge mortality are two important parameters for all patients treated in the ICU, this study aimed to evaluate the effect of hospitalization APACHE scores and discharge practices of patients followed in the ICU on readmission and post-discharge mortality.

2. METHODOLOGY

A total of 342 patients hospitalized in the tertiary anesthesiology ICU between January 2020 and April 2021 were retrospectively reviewed. Age, gender, body mass index, comorbidities, APACHE II score, Sequential Organ Failure Evaluation (SOFA) score, Charlson Comorbidity Index Score (CCIS), length of stay in the hospital and intensive care unit inotropic agent support, mechanical ventilation need and duration of mechanical ventilation, from which unit they came, to

Table 2: Mortality rates

	Mortality rate	P-value
One-month mortality rates by hospital admission of patients		
Inpatient service	45 (57.7)	**< 0.01**
Emergency service	47 (31.3)	
2nd level ICU	21 (47.7)	
Palliative care service	6 (47.2)	
Mortality rates according to the unit to which the patients are transferred		
Inpatient service	12 (14.8)	0.003
2nd level ICU	14 (11.4)	
Palliative care service	9 (33.3)	

Chi-square test. ICU: Intensive Care Unit; Data presented as n (%)

which unit they were discharged, history of readmission to intensive care, and 1-month mortality of the patients were recorded.

To assess the severity of the disease, the APACHE II classification system, calculated according to the clinical and biological data obtained during the first 24 h of their stay in the ICU and their chronic health status, was used.

Those who were discharged from the ICU to a department within the hospital and returned to the ICU during their stay in the hospital were considered to have repeated hospitalizations. Post-ICU death was defined as death that occurred between discharge from the ICU and discharge from the hospital. Patients who died during their first hospitalization in the ICU were excluded from the study.

All analyses were performed using SPSS 25.0 (IBM, USA). The findings of this study were expressed as frequencies and percentages. The Kolmogorov-Smirnov test was used for normality analysis. Numerical variables that do not show a normal distribution are presented as median (minimum-maximum), and those with a normal distribution are presented as mean (standard deviation). Categorical variables were compared using the chi-squared test. Spearman's correlation was used to determine the variables associated with one-month mortality.

3. RESULTS

In this study, which examined 342 patients hospitalized between January 2020 and April 2021, the mean age was 70.47 ± 13.40 years. Of these patients, 128 (37.4%) were females and 214 (62.6%) were males. The mean BMI of the patients was 25.27 ± 5.65, and most of them were normal and overweight patients. Regarding the clinics where they were admitted to the ICU, 78 (22.8%) patients were admitted to the medical ward, 150 (43.9%) patients from the emergency department, 13 (3.8%) from the palliative care service, and 57 (16.7%) from another center. The mean APACHE-II score of the patients was 22.15 ± 7.02, the median CCIS score was 6.0 (2.0-13.0), and the median SOFA score was 6.0 (4.0-19.0). The median length of hospital stay was 14.0 (1.0-127.0), and the median value of hospitalization in the ICU was 3.0 (1.0-50.0). Of these patients, 229 (67%) were diagnosed with Chronic Obstructive Pulmonary Disease. 42 (12.3%) patients had lung malignancy, 6 (1.8%) patients had lung and other organ malignancy, and 4 (1.2%) patients had another malignancy.87(25.4%) of the patients had needed inotropic at least once while being treated in the ICU.The mean duration of mechanical ventilation was found to be 6.49 (1-48) days in those who needed mechanical ventilation.

From the ICU, 81 (23.7%) patients were transferred to the inpatient service, 15 (4.4%) patients were transferred to an external center, 123 (36%) patients were transferred to the second-level ICU, and 27 (7.9%) patients were transferred to the palliative service. The mortality rate after transfer from the ICU admission was 9.2%. The 1-month mortality rate was 37% for all ICU patients, and 45 (13.2%) patients needed to be hospitalized again without leaving the hospital after being discharged from the ICU (Table 1).

Considering the one-month mortality rates of the patients according to the clinic they were admitted to, the mortality rate was found to be significantly higher in

Table 3: The rates of readmission to the intensive care unit

Clinic	ICU readmission	p value
Readmission rate according to the clinic to which the patients were admitted		
Inpatient service	13 (16.7)	0.272
Emergency service	22 (14.7)	
2nd level ICU	5(11.4)	
Palliative care service	2 (15.4)	
Re-admission rates according to the clinic they were transferred to		
Inpatient service	16 (19.8)	0.334
2nd level ICU	18 (14.6)	
Palliative care service	7 (25.9)	

Chi-square test. ICU: Intensive Care Unit; Data presented as n (%)

Table 4: Logistic regression analysis of factors associated with one-month mortality and intensive care unit readmission

Factors	Factors associated with one-month mortality			Factors associated with ICU readmission		
	B	P	OR	B	P	OR
Age	-0.036	0.379	0.964	-0.008	0.802	0.996
Gender	0.774	0.457	2.168	-0.117	0.782	0.868
BMI (kg/m2)	-0.028	0.817	0.972	0.498	0.065	0.969
APACHE II score	0.029	0.122	1.030	0.027	0.484	1.028
Malignancy	-2.445	0.225	0.087	-4.452	0.997	0.007
COPD	0.120	0.916	1.128	0.445	0.414	1.434
Inotropic support	2.831	**0.024**	16.963	0.668	0.056	2.393
CCIS	0.798	0.085	2.220	-0.098	0.619	0.934
Length of hospital stay (days)	-0.044	0.335	0.957	0.063	**< 0.001**	1.064
Length of stay in ICU (days)	-0.083	0.632	0.920	-0.063	0.066	0.927
MV support period (days)	0.124	0.263	1.132	0.027	0.346	1.035
SOFA	0.373	0.292	1.452	-0.215	0.135	0.807

ICU: Intensive Care Unit, BMI: Body Mass Index, COPD: Chronic Obstructive Pulmonary Disease, CCIS: Charlson Comorbidity Index Score, MV: Mechanical Ventilation, SOFA: Sequential Organ Failure Assessment Score

those admitted from the medical ward than in those admitted from the emergency department (P < 0.01) (Table 2).

One-month mortality rates were found to be significantly higher in the patient group transferred to palliative care than in the patients transferred to inpatient service or the 2nd level ICU (P = 0.030). No significant difference was found in terms of one-month mortality rate in patients transferred to the medical ward or to the 2nd level ICU. Mortality rates and comparisons between the groups are shown in Table 2.

When the rates of readmission to the ICU were compared according to the clinic to which they were admitted, no significant difference was found between the group admitted from the emergency service, ICU, and palliative service (P = 0.272) (Table 3).

When the rates of readmission to the ICU were compared according to the clinic to which the patients were transferred, no significant difference was found between the groups (P = 0.334) (Table 3).

Logistic regression analysis revealed that inotropic supplementation was associated with one-month mortality (odds ratio [OR]:16.963, P = 0.024). A positive correlation was found between ICU readmission and the length of hospital stay (OR=1.064, P < 0.001) (Table 4).

4. DISCUSSION

This study confirmed that measures to shorten the time spent in the ward and timely discharge from the ward to the intensive care unit and from the intensive care unit to other units can reduce both readmission to the intensive care unit and mortality.

Patients from many departments were admitted to a tertiary ICU. In a study by Kareliusson et al.[9], 31% of 1067 patients hospitalized in the ICU were admitted to the medical ward, 26% from the emergency room, 23% from the operating room, 9% from another ICU, and 9% from another hospital. Of these patients, 74% were discharged to a medical ward in the hospital, 13% to another ICU, 3% to another hospital, and 1% to their home, and 9% died during their stay in the ICU. In one study, some patients with poor neurological status survived for long periods and required continued care.[10] In our study, according to the clinics where the patients were admitted, 78 (22.8%) patients were admitted from the medical ward, 150 (43.9%) from the emergency service, 13 (3.8%) from the palliative care service, and 57 (16.7%) from another center. According to the clinics to which they were transferred from the ICU, 81 (23.7%) patients were transferred to the inpatient service, 15 (4.4%) were transferred to an external center, 123 (36%) were transferred to the 2nd level ICU, 27 (7.9%) were transferred to the palliative service, and 95 (27.8%) died in the ICU.

In a review study examining 16 studies in North America and Europe, the average ICU readmission rate was 7% (4-14%).[11] In 13 articles examining patients transferred from the intensive care unit to the medical floor, the rate of readmission varies between 1.5% and 13.4%. Differences in readmission rates have been attributed to changes in admission.[12] The 1-month post-discharge mortality rate of 1554 adult patients in 10 tertiary intensive care units in Brazil was 7.9%, with an average.[13] The rates found in our study are similar to those reported in the literature. The one-month mortality rate after transfer from the ICU was 9.2%, and the rate of readmission to the ICU after discharge from the ICU was 13.2%.

In one study, patients admitted to the ICU were more likely to survive discharge from the hospital if they were admitted directly from the emergency room rather than from the ward. Morbi-mortality may increase due to the risk of complications in the wards and delays in the patient's optimal care and transfer to the ICU.[14] In our study, the one-month mortality rate among those admitted from the service was higher than that in those admitted from the emergency department. The time spent in the hospital before the ICU may be a reflection of failure to respond to treatment in general service and/or late referral to the ICU.

Patients who visited the palliative service from the ICU were mostly end-stage care patients. Palliative service provides appropriate treatment and care to terminal patients.[15] In our study, one-month mortality rates according to the clinic to which the patients were transferred were found to be significantly higher in the patient group transferred to palliative care compared to the patients transferred to the inpatient service or the 2nd level ICU. This can be attributed to the fact that the group of patients who were taken to the palliative service consisted of those who did not fully recover and were generally bedridden, who were intended to spend their last period with their relatives in the best possible way.

In a study examining patients readmitted to the intensive care unit, it was observed that the largest number of patients (32.2%) were admitted from the surgery clinic due to respiratory failure.[16] However, in our study, no significant difference was found between the emergency department, medical ward, the 2nd level ICU and palliative service in terms of ICU readmission rates according to the clinic where the patients were admitted and transferred.

There was a good correlation between APACHE II score and mortality.[17] It was concluded that the APACHE II score measured at discharge is an effective factor in predicting post-intensive care mortality and intensive care readmission.[4] The expected mortality rate, according to the APACHE II score, was 25% in those with a score between 15-19, 40% between 20-24, and 55% between 25-29.[18] In our study, the median APACHE-II was 22.15 ± 7.02. The expected mortality rate was between 25 and 55%, and the mortality rate found in this study was within the expected range of 37%. Although APACHE was found to be a predictive factor for readmission in the literature review of 16 articles published between 2010 and 2020, no significant difference was observed in our study.[5] In our hospital, the APACHE II score was measured 24 hours after admission to intensive care. Since this was a retrospective study, there was no APACHE II score calculated at discharge.

COPD patients often require repeated hospitalization for the control of these exacerbations.[19] Respiratory causes are responsible for 57% of readmissions in COPD patients. The most common causes are acute exacerbation (27%), pneumonia (14.2%), and lung cancer (7.1%). Regardless of the reason for readmission in patients with COPD, mortality rates were found to be high in patients readmitted within 30 days after discharge.[20] In our study, 229 (67%) patients had COPD, 42 (12.3%) patients had lung tumors, 6 (1.8%) patients had lung and other organ tumors, and 4 (1.2%) patients had other organ tumors. When the relationship between COPD and malignancy with ICU readmission and mortality was examined, no significant difference was found.

Inotropic and vasopressor agents, which are frequently used in ICUs, can have important side effects, such as arrhythmia, increased myocardial oxygen consumption, myocardial ischemia and metabolic changes.[21] Studies have shown that excessive adrenergic stimulation is detrimental to critical illness.[22] In our study, 87 (25.4) patients received inotropic support treatment at least once during their ICU stay. According to the logistic regression analysis, receiving inotropic support was found to be associated with one-month mortality.

Adverse events following discharge from the intensive care unit to the hospital ward are associated with readmission to the intensive care unit, prolonged hospital stay, and death.[23] In this study, the median length of the hospital stay was recorded as 14.0 (1.0-127.0). Logistic regression analysis, when the variables associated with ICU readmission were examined that the duration of hospitalization was positively associated with ICU readmission. Since our study was retrospective, the time of discharge was unknown. Studies have shown that the rate of readmission and mortality increase after working hours and overnight discharges.[24] Predicting complications that may occur in patients who are transferred from the ICU to the medical ward and taking appropriate interventions can prevent complications in patients transferred from the ICU to the medical ward,

reduce the length of hospital stay, and reduce re-admission to the ICU.

5. LIMITATIONS

Our study had some limitations. This was a single-center retrospective study with limited generalizability. Because it is not known whether the discharges were at night or during the day, night discharges and daytime discharges could not be compared in terms of mortality and readmission.

In this study, which evaluated the effect of the APACHE-II score and discharge practices of patients followed in intensive care on ICU readmission and mortality, no significant effect of the APACHE-II score was detected. We believe that more studies are needed to evaluate the effect of the APACHE II score on post-discharge mortality and readmission. Appropriately timed discharge practices will reduce ICU readmission and mortality following ICU discharge.

6. CONCLUSION

Measures to shorten the time spent in medical wardin patients in need of intensive care will reduce both mortality and the risk of readmission to the intensive care unit. Appropriately timed discharges from the medical ward to the intensive care unit and from the intensive care unit to other units will reduce both intensive care readmission and mortality.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Acknowledgement

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9. Conflict of interest

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

All authors declare that they have participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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