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Predictive Ability of Scoring Systems for Mortality in Older Adults in Intensive Care Unit of a University Hospital: A Single-Center Retrospective Cohort Study

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Abstract

Aim: Predicting the prognosis and mortality of older adults in intensive care units (ICUs) is vital. We studied the parameters that affect and predict outcomes in patients over 65 years of age during ICU follow-up.

Study Design: We retrospectively analyzed data from patients aged 65 and older who were followed in Akdeniz University intensive care units between June 2022 and December 2023. Acute Physiology and Chronic Health Evaluation II (APACHE-II) scores measured on the first day, Sequential Organ Failure Assessment (SOFA) scores measured within the first day and on the third day of admission (Delta SOFA) were recorded. The APACHE II and Delta SOFA scores were compared between the survivor and deceased patient groups.

Results: Parameters of 161 patients were determined. The mortality rate was 51.55% after 45 days of follow-up. Existing hematologic malignancy (p=0.028), hospitalization in intensive care units due to sepsis (p=0.007), Delta Sequential Organ Failure Assessment (ΔSOFA), APACHE-II scores (p<0.001 for both), and steroid therapy (p=0.009) were independent risk factors for mortality. A decrease in SOFA and APACHE-II scores increased the likelihood of survival (p<0.001) in older adults followed up in ICUs. The Delta SOFA score was found to be significantly more predictive of mortality than the APACHE-II score.

Conclusions: Delta SOFA and APACHE-II scores during follow-up are associated with predicting mortality. The mortality prediction ability of Delta SOFA fluctuations surpasses that of APACHE-II. These parameters may provide clinical utility in the follow-up of patients, the prediction of prognosis and mortality, and the evaluation of treatment response.

Keywords: Older adults; Intensive care; Prognostic factors; Mortality; Scoring systems.

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Introduction

The World Health Organization classifies individuals aged 65 as young, those between 65 and 85 as young elderly, and those aged 85 and over as advanced elderly. Due to advancements in healthcare and rising living standards, there has been an increase in the population of individuals over the age of 60.[1] Consequently, the world's population is steadily aging.[2] Older adults are frequently admitted to hospitals due to multiple morbidities and associated medical complications. This demographic shift necessitates careful consideration in treatment and management decisions for older adults. People over the age of 80 constitute 17% of patients in intensive care units (ICUs).[3] Concurrently, the follow-up and care of older adults in ICUs are on the rise.[4] Given the critical conditions of older adults hospitalized in ICUs, predicting their prognosis and mortality is vital for enhancing their treatment processes and reducing morbidity and mortality rates. This study aims to identify the factors that influence the prognosis and mortality of patients over the age of 65 during their ICU treatment, utilizing widely recognized scoring systems.

In intensive care medicine, scoring systems are designed to assess the severity of a patient's condition and categorize patient groups based on objective criteria.[5] The Acute Physiology and Chronic Health Evaluation (APACHE-II) score, calculated from data collected on the first day of hospitalization, is utilized to estimate mortality rates; a higher score indicates an increased risk of mortality. The Sequential Organ Failure Assessment (SOFA) score is another widely employed tool that enables the evaluation of patients with organ failures. This score assesses various domains such as neurological status, respiratory and cardiovascular systems, renal and liver pathologies, and blood diseases. It also facilitates the sequential monitoring of patients throughout their stay in the ICU.[6]

Considering the comorbidities and critical conditions of older adults hospitalized in ICUs, predicting their prognosis and mortality, as well as tailoring their treatment accordingly, is of vital importance. The findings from this study and related research can enhance the follow-up treatment processes for critically ill older adults in ICUs, thereby reducing morbidity and mortality rates.

We aimed to analyze the parameters affecting and predicting prognosis and mortality during the intensive care follow-up of patients over 65 years of age.

Materials and Methods

Ethics Committee Approval

This study was conducted in the Internal Medicine ICU of Akdeniz University between June 2022 and December 2023. Approval was obtained from the Akdeniz University Faculty of Medicine Clinical Research Ethics Committee prior to the commencement of the study (Approval Number: KAEK-753, Date: 27.09.2023). The study adhered to the principles outlined in the Declaration of Helsinki.

Method

This retrospective clinical study was based on the collection of retrospective data and characterized by observational research.

Data

Included in the study were patients aged 65 years and older who were admitted to the Akdeniz University ICU and followed for at least 72 hours. Excluded were patients referred to an external center during hospitalization, those under 65 years of age, patients followed in a post-operative ICU, and those for whom any study parameters could not be calculated (e.g., necessary examinations were not performed, data were insufficient). We analyzed only the data from the first hospitalization of patients who had multiple ICU admissions and follow-ups.

We evaluated the intensive care mortality of the patients and their mortality during the 45-day follow-up period post-ICU. Data were sourced from the hospital information system, and discharged patients were contacted by telephone to gather additional information.

Study Population

The data required for this study were sourced from ICU patient follow-up records, the hospital's electronic database, physicians' daily observation notes, nurses' observation notes, examination results, and ward evaluations.

Demographic and clinical data of the patients were analyzed and recorded. Patients were categorized into two groups: survivors and deceased.

The "entry values" for the APACHE II and SOFA scores were determined within the first 24 hours after admission to the ICU. The difference between the patients' SOFA scores on the first and third days was defined as Delta SOFA.

Statistical Analysis

IBM SPSS Statistics 25.0 (IBM Corp., 2017, Armonk, New York, USA) was employed to statistically analyze the data. The Shapiro-Wilk test and the Kolmogorov-Smirnov test were used to assess whether the measurement values were conformed to a normal distribution. Categorical variables were presented as number and percentage (%). Numerical variables were expresses as either mean ± standard deviation (SD) or median [minimum (min) – maximum (max)], where appropriate. The Pearson chi-square test and the Fisher Exact test were applied to compare categorical variables. For numerical data, the independent groups t-test was used for normally distributed independent variables, and the Mann-Whitney U test was used for independent variables that were not normally distributed. The Wilcoxon test was employed to evaluate changes between the median values of repetitive (dependent) variables. Multivariate logistic regression analyses or linear regression analyses were conducted to evaluate the associations of statistically significant variables with endpoints, independent of other factors. The Hosmer-Lemeshow test was used to evaluate the goodness of fit of the models. Survival analysis was conducted using Kaplan-Meier analysis, log-rank test, and Cox regression analysis. The Kaplan-Meier analysis plotted survival curves and assessed differences between groups. The log-rank test was used to statistically evaluate survival differences between groups. Cox regression analysis was used to identify factors influencing survival. In our study, a p-value of less than 0.05 was considered statistically significant.

Table 1. Demographic characteristics and comorbidities of older adults followed in the intensive care unit (ICU) according to survival and mortality status

	Survival (n=78)	Exitus (n=83)	p
Gender (n, %)			
Female	37 (47.4)	29 (34.9)	0.11
Male	41 (52.6)	54 (65.1)	
Age [median, min-max]	74.5 (65-94)	72 (65-94)	0.14
Age Group (year, %)			
65-79 years	54 (69.2)	20 (24.1)	0.34
≥80 years	24 (30.8)	63 (75.9)	
Multimorbidity (n, %)	62 (79.5)	67 (80.7)	0.85
Chronic Disease (n, %)			
Diabetes Mellitus	33 (42.3)	36 (43.4)	0.89
Coronary Artery Disease	28 (35.9)	34 (40.9)	0.51
Lung Disease	14 (17.9)	18 (21.7)	0.55
Liver Disease	2 (2.6)	5 (6.0)	0.44
Kidney Disease	20 (25.6)	11 (13.3)	0.046
Hypertension	51 (65.4)	40 (48.2)	0.028
Solid Organ Malignancy	25 (32.1)	26 (31.3)	0.92
Hematological Malignancy	4 (5.1)	21 (25.3)	<0.001
Neurological Diseases	20 (25.6)	14 (16.9)	0.170
Other	23 (29.5)	22 (26.5)	0.670

The variables were presented as number (%), mean ± standard deviation (SD) or median [min-max].

Results

Data from 161 patients aged 65 and older, who were followed in the ICU, were analyzed. Of these patients, 95 (59.4%) were male. The mortality rate at the end of the study was 83 (51.55%). No significant differences were found between the survivors and deceased patients in terms of gender, age, and multimorbidity (chronic disease burden). The demographic data and comorbidities of the patients who died and those who survived are presented in Table 1.

The factors affecting mortality in the intensive care units were evaluated for the patient groups. Among the reasons for ICU hospitalization, sepsis was the most prevalent in the deceased patient group, affecting 49 (59.0%) patients (p<0.001). In terms of treatments received in the ICU, 64 (77.1%) deceased patients were on steroid therapy, which was significantly higher than that observed in the surviving patients. The replacement rates for platelets, at 28 (33.7%), and erythrocytes, at 42 (50.6%), were higher among those who experienced mortality. While the intubation rate at ICU admission was 16 (19.3%), 58 (69.9%) of the patients who died during ICU follow-up had been intubated.

The ICU length of stay was significantly longer for patients who died (p<0.001). In surviving patients, the APACHE II score was lower, and the decrease in Delta SOFA value was significant (p<0.001). The data are shown in Table 2.

Table 3 displays the independent factors, adjusted for age and sex, affecting older adults followed in the ICU. Among the parameters we examined, the change in the SOFA score increases the risk of mortality by 1.2 times, and the APACHE II score increases it by 1.1 times. The results of the modeling are presented in Table 3.

Age, gender, presence of more than two comorbidities

Table 2. Factors affecting mortality in surviving and deceased patient groups

	Survival (n=78)	Exitus (n=83)	p
Reason for intensive care unit (ICU) hospitalization (n, %)			
Sepsis	21 (26.9)	49 (59.0)	<0.001
Respiratory Distress	28 (35.9)	16 (19.3)	0.018
Gastrointestinal (GI) Bleeding	8 (10.3)	5 (6.0)	0.390
Blurred Consciousness	7 (9.0)	3 (3.6)	0.200
Hemodynamic Instability	5 (6.4)	2 (2.4)	0.270
Subarachnoid Hemorrhage	3 (3.8)	3 (3.6)	1.00
Heart Failure	3 (3.8)	1 (1.2)	0.350
Pulmonary Thromboembolism	2 (2.6)	1 (1.2)	0.610
Other	1 (1.3)	3 (3.6)	0.620
ICU Steroid Treatment	31 (39.7)	64 (77.1)	<0.001
ICU Platelet Replacement	3 (3.8)	28 (33.7)	<0.001
ICU Erythrocyte Replacement	26 (33.3)	42 (50.6)	0.027
Intubation at ICU Entrance	6 (7.7)	16 (19.3)	0.032
Intubation in ICU Follow-up	3 (3.8)	58 (69.9)	<0.001
Culture Growth	22 (28.2)	51 (61.4)	<0.001
Duration of Hospitalization Before ICU, days	0.0 [0.0-98.0]	7.0 [0.0-111.0]	0.001
ICU Hospital Stay, days	4.0 [1.0-9.0]	6.0 [1.0-28.0]	<0.001
Hospitalization Day After ICU	19 [4.0-110.0]	18 [0.0-117.0]	0.150
ΔSOFA	-1.0 [-5.0-3.0]	2.0 [-6.0-10.0]	<0.001
APACHE II	17.0 [9-30]	20 [10-42]	<0.001

The variables were presented as number (%), mean ± SD, or median [min-max].

(multimorbidity), length of stay in the ICU, and admission to intensive care due to sepsis were included in the regression analysis.

In our study, the Delta Sequential Organ Failure Assessment (ΔSOFA) values of the deceased patients were significantly higher than those of the survivors. Survival analyses revealed a statistically significant relationship between the decrease in ΔSOFA scores and the increase in the probability of survival.

Table 3. Factors increasing the risk of 45-day mortality in older patients followed in intensive care units

Adjusted Model	Hazard Ratio	95% CI	p
Age, years	1.01	0.97-1.04	0.68
Gender, male	1.08	0.66-1.76	0.76
Multimorbidity	1.19	0.63-2.26	0.59
Intensive Care Stay, days	0.99	0.96-1.02	0.52
Sepsis	1.47	0.91-2.38	0.12
ΔSOFA	1.23	1.14-1.30	<0.001
APACHE II	1.08	1.04-1.12	<0.001

ΔSOFA represents the difference between the SOFA score on the third day of ICU admission and the admission day. APACHE II is the calculated score at ICU admission.

Kaplan-Meier survival curves (Figure 1) and log-rank analyses (Table 4) for the 45-day mortality of the study groups are presented. The Delta SOFA value predicts mortality more significantly than the first-day APACHE II score (p<0.001 for both).

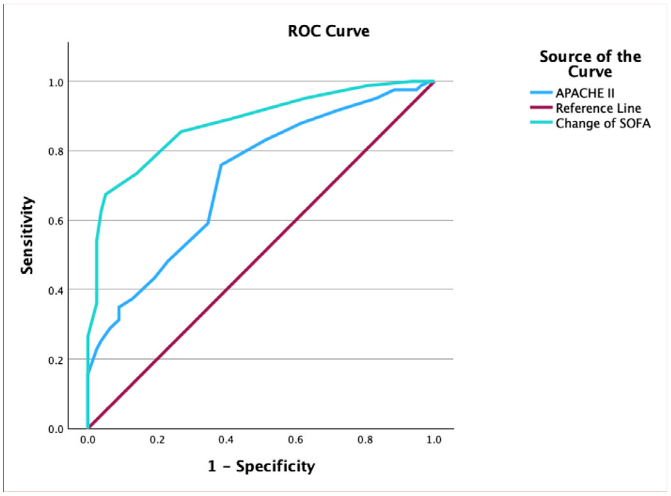

Figure 1. Receiver operating characteristic (ROC) curve of Acute Physiology and Chronic Health Evaluation II (APACHE II) and change in Sequential Organ Failure Assessment (SOFA).

Table 4. Receiver operating characteristic (ROC) analysis of APACHE II and change of SOFA predicting mortality

	Cut-off	Area Under the Curve (AUC)	95% CI (Confidence Interval)	Sensitivity	Specificity	p
APACHE II	17.5	0.72	0.64-0.80	75.9	61.5	<0.001
ΔSOFA	7.5	0.88	0.83-0.93	67.5	94.9	<0.001

ΔSOFA represents the difference between the SOFA score on the third day of ICU admission and the score at admission. APACHE II is calculated at the time of ICU admission.

Discussion

This study assessed the clinical features and outcomes of older adults who were severely ill. The main finding were that Delta SOFA and APACHE values measured at the admission and discharge of elderly patients from intensive care units were independent risk factors for mortality. It was observed that the Delta SOFA value was a more reliable predictor of mortality than the initial APACHE II score on the first day for elderly patients monitored in intensive care.

Literature suggests that age is an important factor in intensive care mortality. However, our investigation found no evidence to support this claim. A study by Fuchs et al.,[7] involving 7,265 patients over 65 years of age who were followed up in ICUs, divided patients into three age groups: 65-74, 75-84, and 85 and over. The 28-day mortality rates for these groups were 20.4%, 28%, and 34.6%, respectively. The study concluded that advanced patient age was a significant risk factor for ICU mortality. Conversely, a retrospective study by Andersen et al.,[8] involving 27,921 patients, indicated that ICU length of stay decreased and mortality rates increased with advancing age.

Our study found higher mortality in patients whose ICU hospitalization diagnosis was sepsis. A prospective multicenter study by Martin-Loeches et al.,[9] which included 1,490 patients, found that mortality due to sepsis was high at advanced ages. Similarly, a study by Nasa et al.[10] found that severe sepsis significantly increased the risk of mortality.

Multiple studies that investigated mortality-related risk factors and prediction in older adults followed up in the ICU have emphasized the importance of considering comorbidities, severity of the disease, and pre-morbid functional status.[11-13] Consistent with the literature, our study found that the presence of hematologic malignancy increased the independent mortality risk 4.2-fold. Intensive care unit mortality rates were higher in patients with hematologic malignancy compared to those without cancer (42% vs. 18%).[14]]

In our study, steroid treatment during ICU follow-up was associated with an increased risk of mortality. According to a study by Venkatesh et al.,[15] hydrocortisone infusion did not improve three-month mortality outcomes compared to placebo in patients with septic shock under mechanical ventilation. Similarly, research by Britt et al.[16] found that corticosteroid use in the ICU was linked to an increased infection rate, prolonged ICU stays, extended use of invasive mechanical ventilators, and higher mortality rates. In our study, the mortality rate was also found to be elevated in patients receiving corticosteroids. Most patients diagnosed with sepsis were treated with corticosteroids, following the latest guidelines. These results may be attributed to the immunosuppressive effects of corticosteroids and their impact on infection rates. Consequently, the use of corticosteroids in ICUs should be closely monitored, and the risk-benefit ratio carefully evaluated.

A higher rate of platelet and erythrocyte replacement was observed in patients who died, although no significant statistical relationship was established between blood transfusions and increased mortality risk. The literature on blood transfusions and outcomes in ICUs shows mixed results. For instance, a two-component prospective observational study by Vincent et al.,[17] involving 1,136 and 3,534 patients, found that higher transfusion rates were associated with increased mortality and longer ICU stays in patients with similar levels of organ dysfunction. However, another multicenter observational study involving 3,147 patients found no significant relationship between blood product transfusion and increased mortality rates in ICU patients.[18] In our study, while the need for replacement was higher in the deceased group, it was not an independent risk factor for mortality. One of the main reasons for this finding was the prevalent hematologic malignancy in deceased patients, necessitating continuous replacement due to the nature of their disease. Based on this result, we conclude that mortality is more dependent on the underlying disease.

Patients receiving treatment in intensive care were evaluated for their need for invasive mechanical ventilation and length of hospital stay. In both parameters, the proportions and numerical values for deceased patients were statistically significantly higher than those for surviving patients. An increased length of stay in the ICU was an independent factor that increased the risk of mortality. In a study by Kır et al.[19] involving 693 patients, those in intensive care were divided into groups under and over 65 years of age. Longer lengths of stay in intensive care, extended hospital stays before intensive care, high APACHE-II scores, and the use of invasive mechanical ventilation were associated with increased intensive care unit mortality.

Reviewing similar studies in the literature regarding scoring systems, Chopra et al.[20] found a significant correlation between survival and mortality at ICU admission, at 48 hours, and with Delta SOFA scores and survival and mortality in a prospective observational study of 100 patients over 60 years old with multiple organ dysfunction followed in the ICU. In a prospective study by Vincent et al.[21] that included 1,449 patients from 40 centers, the most abnormal value for each parameter was recorded in each 24-hour period. High SOFA scores were associated with increased mortality. SOFA scoring is an effective method for assessing organ dysfunction in critically ill patients, and it has been concluded that regular, repeated scoring can predict the patient's course and prognosis. According to a meta-analysis of 87 randomized controlled trials by de Grooth et al.,[22] an increase in the Delta SOFA score (i.e., trajectory from baseline score) was significantly associated with mortality, and this measure was also significantly associated with changes in organ function. No significant association was found between the fixed daily SOFA score and mortality.

Based on these findings, admission SOFA, discharge SOFA, and delta SOFA values are reliable indicators for prognosis and mortality prediction in the follow-up of critically ill older adults in intensive care. In addition, Delta SOFA values can be used as strong markers for evaluating patients' responses to treatment. We believe that the current scoring systems should be used regularly in intensive care and extended to ward patients outside the ICU to potentially predict the likelihood of ICU admission.

In our study, the APACHE-II scores of the deceased patients were significantly higher than those of the survivors, which is consistent with previous research findings.

In a study by Qiao et al.[23] involving 106 ICU patients over 65 years of age, statistically significantly lower SOFA and APACHE-II scores were observed in survivors compared to those who died. The study concluded that APACHE-II and SOFA scores accurately predicted mortality in critically ill older adults, with maximum SOFA and Delta SOFA values being particularly effective in predicting mortality. In research conducted by Czajka et al.[24] with 303 patients followed in intensive care, it was determined that the APACHE-II score was successful in predicting in-hospital mortality, but its reliability was limited for predicting post-discharge mortality. In a retrospective study by Dinkçi et al.[25] involving patients aged 75 and older followed in ICUs, a high APACHE-II score was associated with increased mortality, and factors such as advanced age and prolonged duration of mechanical ventilation also increased mortality risk. It was concluded that high APACHE-II scores are a valuable scoring system in older adults, as in other age groups. According to these findings, admission APACHE-II, discharge APACHE-II, and Delta APACHE-II values may be reliable markers for prognosis and mortality prediction in the follow-up of critically ill older adults in ICUs. Furthermore, these findings suggest that the Delta APACHE-II value may be a potential indicator in assessing patients' treatment responses. In our study, we aimed to enhance the clinical prediction of intensive care prognosis and mortality and to contribute to the interpretation of treatment response and patient follow-up processes by using the APACHE-II scoring system, which has gained increasing importance in intensive care patient follow-ups since its development. Its strength and reliability have been demonstrated in numerous studies across different periods of intensive care follow-up. This scoring is also valuable for establishing a relationship between changes in multiple measured scores and clinical processes.

Limitations

This study has some limitations, primarily that it is retrospective and single-centered. We believe that further research in this area could yield more meaningful results.

Conclusion

The intensive care mortality rate for older adults followed in ICUs is high, with the presence of hematologic malignancy, sepsis, and an increased length of ICU stay being significant risk factors for mortality.

A more specific approach should be adopted in managing risky diseases in older adults. Importantly, the processes of ICU admission and intervention should be restructured to take age into account. It is important to customize intensive care scoring systems to older adults. Assessing measurements and durations and consistently reevaluating them through the treatment process can help detect early indicators of poor or favorable prognoses.

The difference between the entry and third-day values of the SOFA —termed Delta SOFA—is effective in predicting mortality; this value is also more specific than the APACHE II scores. We believe that these values may also be useful in decision-making regarding the discharge of patients from intensive care.

Ethics Committee Approval: Ethics committee approval was obtained from from the Akdeniz University Faculty of Medicine Clinical Research Ethics Committee (Approval Number: KAEK-753, Date: 27.09.2023).

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