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Comparison of predictive scoring systems in patients hospitalized in the internal medicine intensive care unit

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ABSTRACT

Aim: Various scoring systems have been developed to predict mortality, disease severity, and length of stay of patients in intensive care units. It is important to demonstrate the validity of these scores in the society in which they are used. This study aims to evaluate the effects of The Acute Physiologic and Chronic Evaluation (APACHE)-II, APACHE-IV, The Simplified Acute Physiologic Score (SAPS), and Mortality Prediction Model (MPM0) scores on mortality in the internal medicine intensive care unit.

Material and Method: The patients who were followed up in an internal medicine intensive care unit between June 2021 and December 2021 in a tertiary hospital in Turkey were included in this study. The scores were calculated at the time they were admitted to the intensive care unit. 115 patients who were followed up in the internal medicine intensive care unit for 6 months were included. The patients were divided into two groups alive or deceased. 52 (45.2%) patients in the survivor group and 63 (54.8%) patients in the deceased group were included. Patients received no study-related medical intervention.

Results: When all four prognostic scoring systems were analyzed according to the median cut-off values, rising values were related to mortality with statistical significance ($p<0.001$). Hosmer-Lemeshow (HL) test p values in the univariate logistic regression model (higher than the others) showed that the APACHE IV had a better calibration than the other scores. However, the H-L p values of all scores were above 0.05.

Conclusion: Although all scoring systems are good predictors of mortality in patients in internal medicine intensive care units, none of them is superior to the other for mortality prediction.

Keywords: APACHE, SAPS, MPMO

INTRODUCTION

Various scoring systems have been developed to predict mortality, disease severity, and length of stay of patients in intensive care units. The purpose of using these scoring systems is to estimate mortality when patients are admitted to the intensive care unit and to consider this during the follow-up period.

These scoring systems were developed by using data obtained from large cohorts who were followed in intensive care units. Automatic calculators are available for each system that come into use after the validation. The three most frequently used scoring systems in general intensive care units are The Acute Physiologic and Chronic Evaluation (APACHE), The Simplified Acute Physiologic Score (SAPS), and Mortality Prediction Model (MPM0) (1-5). The new versions of them are being developed as a result of the updates (6).

The APACHE scoring system includes 129 physiological and laboratory variables of the patients. The worst values of the patient during the first 24 hours of intensive care unit admission are used to calculate the APACHE score (1). The latest version currently used is APACHE-IV, which has been shown to predict mortality better than the previous version (1).

The SAPS is measured by evaluating approximately 20 parameters considering the worst values in the first 24 hours of the patient's admission to the intensive care unit. Although the latest version is SAPS-3, there are also studies suggesting that it overestimates mortality (3,4,7). Therefore, SAPS-2 is still being used in our center.

The MPM0 scoring system evaluates the clinical and physiological data at the time of admission to the intensive care unit. The current version of this system is MPM0-III, and its effectiveness has been demonstrated by calibration and external validation (5).

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Scoring systems best represent the society in which they were developed. For this reason, it is important to perform external validation according to both the center and the region and to demonstrate its reliability in the society in which it is used (3,4). General intensive care units admit patients with diverse diagnoses. Post-operative patients, trauma patients, patients with a diagnosis of acute coronary syndrome and revascularization therapy, patients with acute neurological problems, and general internal medicine diseases may all be followed in general intensive care units. But usually intensive care units are classified according to the patient's diagnoses. This fact may differ from region to region.

This study aims to evaluate the effects of APACHE-II, APACHE-IV, SAPS-2, and MPM0 -III scores on mortality in patients followed by an internal medicine specialist, in a tertiary general intensive care unit in Turkey and to determine which scoring system is better and more reliable for this patient group.

MATERIAL AND METHOD

The study was carried out with the permission of Samsun Research and Training Hospital Non-interventional Clinical Researches Ethics Committee (Date: 25.08.2021, Decision No: GOKA/2021/15/3). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

115 patients who were followed up in an internal medicine intensive care unit between June 2021 and December 2021 in a tertiary hospital in Turkey were included in this study. All patients over the age of 18 who were hospitalized and followed up in the general intensive care unit by an internal medicine specialist were included.

Trauma patients, post-operative patients, hospitalized patients with a neurological diagnosis, and patients who were hospitalized but admitted to the 1st level intensive care unit were excluded from the study. A total of 115 patients who met these criteria during the 6-month follow-up period were included in the study.

The patient's age, gender, comorbidities, medications, and diagnosis of admission to the intensive care unit were reviewed retrospectively from the patient files. The physical examination findings of the patients, arterial blood pressure, heart rate, and laboratory values at the time of admission to the intensive care unit were recorded. The length of stay and whether there was any blood culture positivity during the hospitalization were recorded.

APACHE-II, APACHE-IV, SAPS-2, and MPM0 -III scores were calculated at the time they were admitted to the intensive care unit (8-11). The patients were divided into two groups according to the way they were discharged from the intensive care unit, those who were transferred to the service as alive and those who died. 52 (45.2%) patients in the survivor group and 63 (54.8%) patients in the nonsurvivor group were included.

Hospitalization diagnoses and comorbidities, which caused a significant difference between the two groups, were analyzed.

Statistical Analysis

SPSS program (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) was used for statistical analysis. Normally distributed continuous variables were expressed as mean ± standard deviation, while non-normally distributed continuous variables were expressed as median (lowest-highest). Categorical variables were expressed as n (%). The Chi-square test and Fischer's exact test were used to compare the categorical variables between groups. Kaplan-Meier survival analysis was done to investigate the effect of scoring systems on survival. Logistic regression analysis and Hosmer-Lemeshow (HL) test were done to investigate the effect of scoring systems on mortality.

RESULTS

A total of 115, 57 women and 58 men were included in the study. The mean age of the patients was 70 ± 15 years. The median length of stay in the intensive care unit was 4 (1-71) days. The admission diagnoses of the patients hospitalized in the intensive care unit were as follows: 21 (18.3%) acute renal failure, 22 (19.1%) gastrointestinal bleeding, 15 (13%) pneumonia, 5 (4.3) electrolyte imbalance, 2 (1.7 %) malnutrition, 13 (11.3%) sepsis, 11 (9.6%) respiratory failure, 26 (22.6) other diagnoses.

All-cause intensive care mortality rate was found to be 54.8%. Mortality rates according to the admission diagnosis were as follows: acute renal failure 23.8%, sepsis 20.6%, pneumonia 20.6%, gastrointestinal bleeding 11.1%, respiratory failure 6.3%, electrolyte imbalance 3.2%, malnutrition 3.2%, and other diagnoses 11.1%.

Demographic and clinical characteristics of the study population are given in **Table 1**. There was no statistically significant difference between the survivor and the nonsurvivor group in terms of gender. The mean age of the nonsurvivors was statistically greater than that of the survivors. It was determined that all 4 mortality scores were statistically higher in the nonsurvivors. In terms of hospitalization diagnoses, gastrointestinal bleeding and other diagnoses were statistically more frequent in survivors while pneumonia and sepsis were more common in nonsurvivors. The frequencies of acute renal failure, electrolyte imbalance, malnutrition, and respiratory failure were statistically similar between

the two groups. When evaluated in terms of comorbid conditions, the frequency of malignancy was statistically higher in nonsurvivors. There was no statistically significant difference between the two groups in terms of other comorbidities.

Table 1. Demographic and clinical characteristics of the study

	Survivors (n: 52)	Nonsurvivors (n: 63)	p
Male sex, n (%)	30 (58)	28 (44)	0.157
Age (years)	64 ± 17	74 ± 11	0.001
Length of ICU stay (days)	3.5 (1-71)	6 (1-66)	0.275
APACHE II score	35.6 (6.6-95.4)	78.6 (14.6-98)	< 0.001
APACHE IV score	17.7 (1.1-77.5)	57.3 (10-95.9)	< 0.001
SAPS II score	10.6 (1.3-83.8)	59.8 (4.7-99.1)	< 0.001
MPM0 III score	19.6 (1.58-88.5)	49 (6-95.7)	< 0.001
Admission Diagnosis			
Acute renal failure, n (%)	6 (11.5)	15 (23.8)	0.090
Gastrointestinal bleeding, n (%)	15 (28.8)	7 (11.1)	0.016
Pneumonia, n (%)	2 (3.8)	13 (20.6)	0.008
Electrolyte imbalance, n (%)	3 (5.8)	2 (3.2)	0.657
Malnutrition, n (%)	0 (0)	2 (3.2)	0.500
Sepsis, n (%)	0 (0)	13 (20.6)	0.001
Respiratory Failure, n (%)	7 (13.5)	4 (6.3)	0.197
Others, n (%)	19 (36.5)	7 (11.1)	0.001
Comorbidities			
Diabetes mellitus, n (%)	21 (40.4)	25 (39.7)	0.939
Chronic renal failure, n (%)	9 (17.3)	16 (25.4)	0.295
COPD, n (%)	6 (11.5)	8 (12.7)	0.850
Congestive heart failure, n (%)	12 (23.1)	21 (33.3)	0.226
Dementia, n (%)	8 (15.4)	16 (25.4)	0.189
Hypertension, n (%)	28 (53.8)	35 (55.6)	0.855
Malignancy, n (%)	3 (5.8)	24 (38.1)	< 0.001

Multiple Logistic Regression

When the effects of APACHE II, APACHE IV, SAPS 2, and MPM0-III scores on mortality were analyzed by multiple logistic regression analysis independent of clinical parameters not used in their score-based algorithms, the OR and 95% CI values were determined as follows. APACHE II: 1.053 and 1.030-1.077 (independent variables: acute renal failure, gender, diabetes mellitus, admission diagnoses excluding dementia), APACHE IV: 1.085 and 1.051-1.114 (independent variables: gender, diabetes mellitus, congestive heart failure, hypertension, dementia, chronic obstructive pulmonary disease), SAPS 2: 1.071 and 1.039-1.104 (independent variables: gender, admission diagnoses excluding acute renal failure and gastrointestinal bleeding, diabetes Mellitus, hypertension, dementia, chronic obstructive pulmonary disease) and MPM0-III: 1.071 and 1.041-1.101 (independent variables: Gender, admission diagnoses excluding acute renal failure and gastrointestinal bleeding, diabetes mellitus, hypertension, dementia, and chronic obstructive pulmonary disease).

Univariate logistic regression analysis, Hosmer-Lemeshow (HL) score results are given in **Table 2**. HL test p values in the univariate logistic regression model (higher than the others) showed that the APACHE IV had a better calibration than the other scores. However, the H-L p values of all scores were above 0.05.

Table 2. Univariate logistic regression analysis, Hosmer-Lemeshow (HL) score results

n: 115	APACHE II	APACHE IV	SAPS II	MPM0-III
Logistic regression				
OR (95% CI)	1.049 (1.031-1.067)	1.071 (1.046-1.097)	1.056	1.057
H-L test				
x^2	12.8	6.6	6.4	10.2
Df	7	8	7	8
P	0.076	0.583	0.495	0.252

DISCUSSION

It has been shown that APACHE-IV, SAPS-3, and MPM0 -III are reliable predictive models to predict mortality, length of stay, and prognosis of patients who were followed in the intensive care unit (12).

Although APACHE-IV is the last version of the APACHE scoring system, APACHE-II is still used in some centers as well as our center (13,14).

However, these scoring systems do not have the same accuracy in every disease group. For this reason, studies are carried out about which scoring system is more reliable in intensive care for special patient groups. For example, in a study on patients hospitalized in the gastroenterology intensive care unit, APACHE-II, SAPS-II, and Sequential Organ Failure Assessment (SOFA) scores were compared, and all three were found to be associated with mortality in this patient group. The system with the most perfect prognostic predictive feature is stated as the SOFA score in this patient group (13). In our study, the frequency of gastrointestinal bleeding as admission diagnosis was 19.1% and the mortality rate of this patient group was 11.1%. This result is greater than the overall mortality score (5.3%) of the previously mentioned study (13). In another study conducted among patients in the neurosurgical intensive care unit APACHE II score had a poor performance to predict hospital mortality (14).

In our study, the cut-off values of SAPS-II and APACHE-II score to predict mortality were 23.0 and 73.0 respectively. In a recent study including 174 patients in the medical

intensive care unit, SAPS II >50.5 and APACHE II >27.5 can predict the risk of mortality in these patients. Patients with an admission diagnosis of sepsis had the highest hospital mortality (15). In our study, the all-cause intensive care mortality rate was 54.8% and higher than the mentioned study. The mortality rate of patients with sepsis was 20.6%. According to the diagnosis of hospitalization, the highest mortality was found in sepsis patients, which was consistent with the results of the related study (15).

In another recent study that includes traumatic brain injury patients, the APACHE II had poor power than the INCNS scoring system to predict mortality in this patient group. The researchers thought that INCNS could be considered a usable prognostic model for Turkish people (16).

Sepsis is a common diagnosis among patients hospitalized in the internal medicine intensive care unit, and in our study, 11.1% of the patients were found to be admitted to the intensive care unit with the diagnosis of sepsis. In a study investigating mortality predictive systems in patients hospitalized in the intensive care unit with the diagnosis of sepsis, it was shown that a high SOFA score and APACHE-II were associated with mortality (17). In another study, in which sepsis patients were included and 140 patients were admitted, high SOFA and quick SOFA scores were found to be risk factors for the severity of the patients and worsening of the prognosis (18).

In a prospective study of 300 patients hospitalized in the cardiac intensive care unit, APACHE-II and SOFA scores were compared and both of those scoring systems were found to be good predictors for mortality. In that study, the APACHE-II score was also related to 6 months mortality (19). There was not any patient with a cardiac admission diagnosis in our study group.

These studies show that the same scoring system may not be valuable for determining intensive care mortality rates in every patient group and community. For this reason, we think that it is important to conduct separate analyzes for intensive care units where certain diagnoses are clustered and followed. In our study, the data of 115 patients, who were hospitalized in the intensive care unit followed only by internal medicine specialists and included the common disease groups followed in the internal diseases intensive care unit in Turkey, were analyzed. Therefore, we think that it will contribute to the literature.

In our study, the frequency of gastrointestinal system (GIS) bleeding (19.1%) and acute kidney injury (18.3%) was found to be high in terms of the diagnosis of intensive care hospitalization. This was followed by pneumonia (13%) and sepsis (11.3%). The number of patients hospitalized due to pneumonia, or respiratory failure was less than that of the patients with the non-pulmonary admission diagnosis (n=26 vs. 89). We think that this situation is related to the fact that there are different intensive care units followed by pulmonology specialists in our center.

Furthermore, this study consists of patients followed during the new coronavirus pandemic period. For this reason, a severe acute respiratory syndrome coronavirus-2 polymerase chain reaction (SARS-CoV-2 PCR) test was performed for all patients before hospitalization in the general intensive care unit, as per the health policy, and the patients who were found negative were admitted to our intensive care unit. Patients with positive SARS-CoV-2 PCR tests and needing intensive care were followed up in different intensive care units and were not included in the study.

It has been shown in previous studies that patients hospitalized with a diagnosis of sepsis have a higher mortality rate (20). In our study, the relationship between admission diagnosis and discharge status was evaluated, and it was observed that the patients hospitalized with a diagnosis of sepsis had significantly higher mortality (p=0.001). It has been shown that patients hospitalized due to GIS bleeding have significantly less mortality (p=0.016).

When the severity of all surviving and deceased patients was evaluated according to the prognostic scoring systems, increased values in all APACHE-II, APACHE-IV, SAPS-2, and MPM0 -III scores were associated with increased mortality. This data is also compatible with the literature (1-3,5).

Internal medicine intensive care units differ from general intensive care units with hospitalized patient characteristics. For this reason, we think that our study will contribute to the literature and provide information to clinicians in the regional internal medicine intensive care unit.

However, our study includes the data of patients who were followed up in a single hospital for 6 months. This is the most important limitation of our study. We think that multicenter studies are needed to generalize the findings.

CONCLUSION

Although APACHE-II, APACHE-IV, SAPS-2, and MPM0-III scores are good predictors of mortality, none of these scoring systems is superior to the other for mortality prediction of patients in internal medicine intensive care units..

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Samsun Research and Training Hospital Non-interventional Clinical Researches Ethics Committee (Date: 25.08.2021, Decision No: GOKA/2021/15/3).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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