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RESEARCH

Performance of the PATHOS score in predicting in-hospital mortality in patients aged 65 years and older admitted to the intensive care unit from the emergency department

Acil servisten yoğun bakım ünitesine yatırılan 65 yaş ve üzeri hastalarda hastane içi mortaliteyi tahmin etmede PATHOS skorunun performansı

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Abstract

Purpose: The aim of this study was to investigate the performance of the platelets, age, troponin, heart rate, oxygenation, and systolic blood pressure (PATHOS) score in predicting in-hospital mortality among patients aged 65 years and older admitted to the intensive care unit (ICU) from the emergency department (ED).

Materials and Methods: This single-center, retrospective observational study included patients aged 65 years and older who presented to the ED and were admitted to the ICU between 2018 and 2024. The PATHOS score was calculated using routine vital signs and blood parameters obtained at ED admission. The patients were divided into two groups: survivors and non-survivors. The predictive power of the PATHOS score for in-hospital mortality was evaluated by comparing these groups.

Results: The study included a total of 1,131 patients. The number of survivors was 889 (78.6%), while that of non-survivors was 242 (21.4%). Multivariate logistic regression analysis revealed that the PATHOS score (odds ratio [OR]: 3.80, 95% confidence interval [CI]: 3.07–4.70, p<0.001) independently predicted in-hospital mortality. According to the receiver operating characteristic analysis, the area under the curve of the PATHOS score was 0.827 (0.804–0.849). A PATHOS score greater than 2 predicted in-hospital mortality with a specificity of 75.9% and a sensitivity of 77.6%.

Conclusion: The PATHOS score may serve as a valuable tool for predicting in-hospital mortality in geriatric patients admitted to the ICU from the ED. By effectively identifying critically ill elderly patients, this score may facilitate timely ICU transfers and contribute to the more efficient use of limited resources.

Keywords:. Emergency department, geriatric patient, mortality, PATHOS score

Öz

Amaç: Bu çalışmanın amacı, acil servisten (AS) yoğun bakım ünitesine (YBÜ) yatırılan 65 yaş ve üzeri hastalarda hastane içi mortaliteyi tahmin etmede PATHOS (trombositler, yaş, troponin, kalp hızı, oksijenasyon ve sistolik kan basıncı) skorunun etkinliğini araştırmaktır.

Gereç ve Yöntem: Bu tek merkezli, retrospektif gözlemsel çalışmaya 2018 ile 2024 tarihleri arasında AS'ye başvuran ve YBÜ'ye yatırılan 65 yaş ve üzeri hastalar dahil edildi. Hastaların PATHOS skoru AS'ye kabulünde alınan rutin vital bulgular ve kan parametrelerinden hesaplandı. Hastalar yaşayanlar ve ölenler olmak üzere iki gruba ayrıldı. Gruplar arasında PATHOS skorunun hastane içi mortaliteyi öngörebilme gücü değerlendirildi.

Bulgular: Çalışmaya 1131 hasta dahil edildi. Hayatta kalanların sayısı 889 (78.6%), ölenlerin sayısı ise 242 (21.4%) idi. Çok değişkenli lojistik regresyon analizi, PATHOS skorunun (olasılık oranı [OR]: 3.80, %95 güven aralığı [GA]: 3.07-4.70, p<0.001) hastane içi mortaliteyi bağımsız olarak öngördüğünü göstermiştir. Alıcı işlem karakteristik (ROC) analizinde PATHOS skorunun eğri altında kalan alanı (AUC) 0.827 (0.804-.0849) olarak tespit edildi. PATHOS skoru 2'nin üzerinde olmasının hastane içi mortaliteyi %75.9 özgüllük ve %77.6 duyarlılıkla öngördüğünü saptadık.

Sonuç: PATHOS skoru, AS'den YBÜ'ye kabul edilen geriatrik hastalarda hastane içi mortaliteyi tahmin etmede değerli bir araç olarak kullanılabilir. Bu skor, kritik durumdaki yaşlı hastaları etkili bir şekilde belirleyerek YBÜ'ye zamanında transferi kolaylaştırabilir ve sınırlı kaynakların daha verimli kullanılmasına katkı sağlayabilir.

Anahtar kelimeler: Acil servis, geriatrik hasta, mortalite, PATHOS skoru

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INTRODUCTION

The aging global population has become an increasingly significant public health issue[1]. The rapid growth of the elderly population poses major challenges to healthcare systems, particularly in managing age-related diseases and conditions. The increasing burden of geriatric care in emergency settings calls for the development of innovative strategies to optimize patient outcomes. Geriatric patient care differs from that of other adult populations due to the frequent use of medications that may mask critical symptoms and the high prevalence of comorbidities[2]. These age-related challenges often result in atypical presentations of diseases, complicating both diagnosis and treatment. These factors emphasize the importance of rapid and accurate decision-making processes in managing elderly patients in the emergency department (ED). In addition, delays in transferring patients from the ED to the intensive care unit (ICU) are associated with an increase in in-hospital mortality[3]. Early detection of clinical deterioration and timely transfer to the ICU are critical for improving outcomes in critically ill elderly patients. Therefore, there is a pressing need for practical and reliable risk prediction models for patients presenting to the ED.

Various early warning scoring systems have been developed to identify critically ill patients and facilitate early interventions. In the literature, scoring systems such as the Manchester Triage System (MTS), Emergency Severity Index (ESI), Canadian Triage and Acuity Scale (CTAS), and National Early Warning Score (NEWS) are used in geriatric triage, while the Simplified Acute Physiology Score (SAPS II), Mortality Probability Model (MPM II), and Acute Physiology and Chronic Health Evaluation (APACHE II) are applied in ICUs to assess elderly patients[4-7]. However, there is still a lack of a validated and reliable scoring system that can effectively predict the prognosis of elderly patients. Most existing systems tend to focus on general adult populations and fail to address the unique physiological changes and vulnerabilities in older patients. Age-related declines in physiological reserves and impairments in organ function limit the accuracy of existing scoring systems. Thus, a simple and user-friendly scoring system incorporating both vital signs and blood parameters is required to determine the prognosis of elderly patients in EDs. This scoring model should also be designed to be easily applied in busy clinical settings, such as the ED, to facilitate real-time decision-making. The hypothesis of this study is that the PATHOS score is a more accurate and practical tool for predicting in-hospital mortality in elderly patients, compared to existing scoring systems, by addressing their age-related physiological changes and aiding real-time decision-making in emergency settings. Accordingly, this study aimed to evaluate the prognostic power of the platelets, age, troponin, heart rate, oxygenation, and systolic blood pressure (PATHOS) score in predicting in-hospital mortality among patients aged 65 years and older admitted to the ICU from the ED.

MATERIALS AND METHODS

Sample

This retrospective, single-center observational study was conducted in the ED of a tertiary hospital. Patients aged 65 years and older who presented to the ED and were admitted to the ICU between January 1, 2018, and January 1, 2024, were included. Ethical approval was obtained from the Aksaray University Health Sciences Ethics Committee (Decision No: 2024/022, dated 04.04.2024), and the study was conducted in accordance with the principles of the Helsinki Declaration. The researchers collected data retrospectively, and thus, the requirement for informed consent was waived.

We retrospectively evaluated 1,468 patients admitted to the ICU from the ED at our hospital. Patients with incomplete medical records (n = 84), those transferred to another hospital during follow-up (n = 9), those who underwent cardiopulmonary resuscitation (n = 24), those with acute coronary syndrome (n = 39), those requiring surgical intervention (n = 74), and those with a history of intoxication (n = 2) or trauma (n = 105) were excluded. The final study group consisted of 1,131 patients aged 65 years and older.

Data collection

All patient data were obtained from the hospital's electronic medical records and patient files. All stages of the study were carried out by two experienced emergency medicine specialists, each with at least 10 years of clinical experience. The reliability of the records was ensured through the hospital's electronic recording system and cross-checking methods. All patients included in the study received standard

treatment protocols in accordance with international guidelines. To ensure data reliability and protect patient privacy, all information was kept confidential and not shared anywhere. Age, gender, vital signs at presentation, Glasgow Coma Scale (GCS) scores, comorbidities, blood results at ED admission, and patient outcomes (discharge or death) were recorded. Blood samples routinely collected at the time of ED admission were used for analyses. The PATHOS score was calculated based on routine vital signs and blood parameters evaluated at ED admission [8]. The PATHOS score consists of six parameters, each evaluated with +1 point: 1) platelet count <100 or >400 ×10^3/μL, 2) age >80 years, 3) troponin level above the cut-off, 4) heart rate (HR) >100 beats per minute, 5) SpO_2 <90%, and 6) systolic blood pressure (SBP) <100 mmHg. Platelet counts were analyzed using the Mindray BC-6000 automated hematology analyzer, and troponin levels were analyzed with the Beckman Coulter AU5800 autoanalyzer. The patients were categorized into two groups: survivors and non-survivors. The predictive power of the PATHOS score for in-hospital mortality was evaluated by comparing the groups. In-hospital mortality among patients admitted to the ICU from the ED was the primary outcome measure

Statistical analysis

Based on previous studies[9], in-hospital mortality rates in the geriatric population range from 10% to 76%. Assuming the rate in our region is 35%, the estimated rate was calculated by taking 5% lower and 5% higher than the actual population rate. Under these conditions, with 80% power, a 96% confidence interval, and an α=0.03 error margin, the minimum sample size required for this study was calculated to be 1,061 patients. Statistical analyses were conducted using SPSS version 22.0 software.

Continuous variables were presented as median (interquartile range: 25th and 75th percentiles) or mean ± standard deviation, whereas categorical data were represented as frequencies and percentages. The chi-square test or Fisher's exact test was employed to assess differences in categorical variables. The distribution of the data's normality was assessed using histograms, probability plots, and the Kolmogorov-Smirnov test. Groups were compared regarding continuous variables using the Student's t-test or Mann-Whitney U test, based on the distribution of the data.

Univariate logistic regression analysis was undertaken to assess the relationship between clinical variables and in-hospital mortality. To identify independent predictors of mortality, a multivariate logistic regression analysis was applied to the significant variables identified in the univariate analysis.

We calculated odds ratios (ORs) along with their 95% confidence intervals (CIs). The receiver operating characteristic (ROC) analysis was utilized to assess the predictive performance of the PATHOS score for in-hospital mortality. The area under the curve (AUC) was measured, and a p-value of <0.05 was regarded as statistically significant.

RESULTS

The study included a total of 1,131 patients, of whom 581 (51.4%) were male, with a mean age of 77.8 ± 7.0 years. The distribution of age groups was as follows: 394 patients (34.8%) in the 65–74 age group, 523 patients (46.2%) in the 75–84 age group, and 214 patients (18.9%) in the ≥85 age group. The in-hospital mortality rate among the included patients was 21.4%. Age, GCS score, SBP, diastolic blood pressure, oxygen saturation heart rate, mean arterial pressure, coronary artery disease, malignancy, Charlson Comorbidity Index (CCI), platelet count, cardiac troponin, and the PATHOS score demonstrated significant statistical differences between the groups of survivors and non-survivors. (Table 1).

The effect of statistically significant parameters on mortality was evaluated using logistic regression analysis. According to the results, age ≥ 85 years (OR: 1.71, 95% CI: 1.09–3.68, p = 0.019), GCS score (OR: 0.60, 95% CI: 0.44–0.87, p < 0.001), PATHOS score (OR: 3.80, 95% CI: 3.07–4.70, p < 0.001), and CCI (OR: 1.44, 95% CI: 1.26-2.05, p<0.001) were related to in-hospital mortality (Table 2).

The predictive value of the PATHOS score for in-hospital mortality was assessed using ROC analysis, revealing an AUC value of 0.827 (0.804–0.849). A PATHOS score greater than 2 effectively predicted in-hospital mortality with a specificity of 75.9% and a sensitivity of 77.6% (Figure 1).

Table 1. Baseline characteristics of patients according to survival status

Variable	Survival status		
	Survivors (n = 889)	Non-survivors (n = 242)	P value
Age (years)	77.5 ± 7.0	79.2 ± 6.8	<0.001
Age group			
65–74 years	335 (37.7%)	59 (24.4%)	<0.001
75–84 years	401 (45.1%)	122 (50.4%)	
≥85 years	153 (17.2%)	61 (25.2%)	
Gender (male)	454 (51.1%)	127 (52.5%)	0.697
Vital signs at admission			
Systolic BP (mmHg)	123 (100-149)	100 (90-110)	<0.001
Diastolic BP (mmHg)	80 (61-94)	61 (55-80)	<0.001
MAP	95 ± 20	79 ± 17	<0.001
HR (beats/min)	98 ± 17	102 ± 18	0.006
Body temperature (°C)	37.0 ± 0.5	37.0 ± 0.4	0.070
Oxygen saturation (%)	93.1 ± 3.4	92.8 ± 3.6	<0.001
GCS score at admission	13 ± 1	11 ± 2	<0.001
Comorbidities	313 (49.5%)	101 (48.8%)	
Hypertension	448 (50.4%)	127 (52.5%)	0.565
Diabetes mellitus	272 (30.6%)	86 (35.5%)	0.143
Coronary artery disease	110 (12.4%)	44 (18.2%)	0.020
Heart failure	194 (21.8%)	56 (23.1%)	0.661
Cerebrovascular disease	78 (8.8%)	21 (8.7%)	0.963
COPD	281 (31.6%)	82 (33.9%)	0.501
Chronic kidney disease	100 (11.2%)	33 (13.6%)	0.307
Chronic liver disease	22 (2.5%)	11 (4.5%)	0.090
Alzheimer's disease/dementia	73 (8.2%)	27 (11.2%)	0.152
Malignancy	12 (1.3%)	24 (9.9%)	<0.001
Charlson comorbidity index	2.0 ± 1.2	3.0 ± 1.8	<0.001
Laboratory parameters			
White blood cell, $\times 10^9$/L	10.5 ± 3.9	11.0 ± 3.5	0.064
Hemoglobin, g/dL	12.9 ± 1.2	12.5 ± 2.0	0.106
Platelet count, $\times 10^9$/L	245 ± 37	237 ± 47	0.005
Cardiac troponin, ng/mL	8.1 ± 4.0	11.0 ± 9.8	0.012
PATHOS score	1.89 ± 1.00	3.25 ± 0.95	<0.001

Median and 25–75th percentiles, BP: blood pressure, HR: heart rate, RR: respiratory rate, MAP: mean arterial pressure, GCS: Glasgow Coma Scale, ED: emergency department, COPD: chronic obstructive pulmonary disease, PATHOS: platelets, age, troponin, heart rate, oxygenation, and systolic blood pressure

Table 2. Univariate and multivariate analyses of predictive factors for in-hospital mortality

Variables	Univariable logistic regression				Multivariable logistic regression		
	OR	95% CI	p value		OR	95% CI	P value
Gender	0.94	0.71–2.25	0.697		1.24	0.84–2.83	0.259
Age ≥ 85 years	1.59	1.13–3.24	0.007		1.71	1.09–3.68	0.019
GCS score at admission	0.58	0.43–0.83	<0.001		0.60	0.44–0.87	<0.001
Coronary artery disease	1.57	1.07–3.30	0.020		1.46	0.87–2.75	0.151
Malignancy	5.04	2.96–8.34	<0.001		2.21	0.82–5.94	0.113
Charlson comorbidity index	1.53	1.39–2.19	<0.001		1.44	1.26–2.05	<0.001
PATHOS score	3.77	3.13–4.84	<0.001		3.80	3.07–4.70	<0.001

CI: confidence interval; OR: odds ratio, GCS: Glasgow Coma Scale, PATHOS: platelets, age, troponin, heart rate, oxygenation, and systolic blood pressure

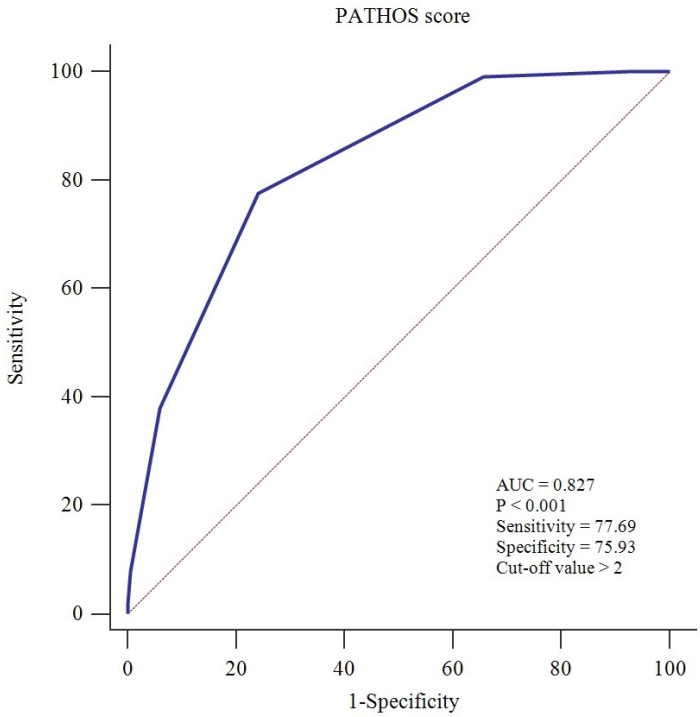

Figure 1. Receiver operating characteristic curve of the PATHOS score in predicting in-hospital mortality in geriatric patients admitted to the intensive care unit from the emergency department.

DISCUSSION

To our knowledge, this is the first study to investigate the association between the PATHOS score and in-hospital mortality in patients aged 65 years and older. In this study, a significant relationship was found between the PATHOS score and in-hospital mortality among individuals aged 65 and over admitted to the ICU after evaluation in the ED. In our study, the AUC value for predicting in-hospital mortality using the PATHOS score was calculated to be 0.827. Patients with a PATHOS score greater than 2 were found to have a 3.8 times higher risk of in-hospital mortality compared to those with lower scores. The PATHOS score had 75.9% specificity and 77.6% sensitivity in predicting in-hospital mortality, as demonstrated by the ROC analysis.

In the literature, it has been reported that approximately 25% of patients admitted to the ED are elderly, and this proportion is increasing[10]. This rise in the elderly population also leads to an increase in the proportion of critically ill elderly patients requiring ICU admission. Therefore, rapidly identifying critical conditions in elderly patients in the ED is very important. Prognostic scoring systems designed for ICU settings, such as APACHE II, MPM II, SAPS II, and the logistic organ dysfunction system, have limitations in terms of their application in the ED. These systems require a broad range of laboratory and physiological data, which may not always be rapidly available in the ED due to time constraints and the need for rapid intervention. Furthermore, the complexity of these models and their focus on ICU patients often fail to capture the rapidly changing clinical conditions of patients presenting to the ED. Consequently, there is an increasing need for reliable and simple scoring systems to predict the prognosis of elderly patients.

Various risk scoring systems are widely used to ensure the accurate evaluation of elderly patients in the ED. The MTS has been associated with the length of ED stay, hospital admission, and in-hospital

mortality. However, the ability of MTS to predict in-hospital mortality has been reported to be lower in elderly patients compared to those under 65 years of age[11]. The ESI has been linked to hospital admission, ICU admission, and mortality. However, despite being effective in predicting hospital admissions for elderly patients, the performance of the ESI in predicting 30-day mortality has been found to be low[12-14]. The CTAS has demonstrated a strong correlation with the severity of illness in elderly patients, including mortality and hospital admission rates[15]. The NEWS2, which evaluates vital signs and consciousness levels, has been reported to be statistically significant in predicting 30-day mortality and ICU admission, although its accuracy has been found to be low[13]. Another research has suggested that NEWS2 may play a limited role in clinical decision-making[16]. These findings indicate the need for more comprehensive information when determining the prognosis of elderly patients. Recent studies have demonstrated that the PATHOS score is an effective and simple prognostic instrument for estimating in-hospital mortality among patients diagnosed with acute pulmonary embolism in the ED[17,18]. The validity of the PATHOS score, developed in 2023, was assessed in a cohort of 1,358 patients diagnosed with PE who admitted to the ED. The AUC value of the PATHOS score was 0.827 in the derivation cohort and 0.74 in the validation cohort. In the analysis of all patients, the optimal cutoff value was identified as >2. At this threshold, the sensitivity was 60%, specificity was 81%, positive predictive value was 30%, and negative predictive value was 94%[16]. In another study, the PATHOS score cut-off value for predicting in-hospital mortality was identified as >2, with a sensitivity of 70.8%, a specificity of 71.3%, a positive predictive value of 41.2%, and a negative predictive value of 81.9%[15]. These studies have shown that the PATHOS score exhibits high accuracy in predicting in-hospital mortality and outperforms other prognostic tools such as the shock index, pulmonary embolism severity index (PESI), and simplified PESI. Our study demonstrated that the PATHOS score could be a reliable indicator for predicting in-hospital mortality in patients aged 65 and older admitted to the ICU from the ED. Using this score, decisions regarding ICU admission can be made more quickly and effectively, allowing timely medical interventions to reduce delays and lower mortality.

This study has several limitations. First, its retrospective design poses a risk of observational bias. Second, it was conducted in a single center. Third, the PATHOS score only considers specific parameters, and other clinical factors were not evaluated. Fourth, the study focused on individuals aged 65 and over transferred to the ICU from the ED, which may limit the generalizability of the results to all elderly patients. Lastly, the PATHOS score is a new score and requires further validation studies.

In conclusion, the rapid increase in the geriatric population has contributed to the growing burden on EDs. Identifying critical patients and providing timely intervention are of vital importance. Given the limited and costly resources of ICUs, using objective tools such as the PATHOS score can allow for the rapid and accurate identification of patients in the ED who require ICU admission. Thus, the effective management of elderly patients in the ED could improve patient outcomes and support the development of strategies to ensure the sustainability of healthcare systems.

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