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The laboratory parameters and scoring systems used to predict clinical outcomes in geriatric patients with acute pancreatitis

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Abstract. – OBJECTIVE: Acute pancreatitis (AP) is the leading cause of hospital admissions among gastrointestinal system disorders, and it can resolve independently or lead to life-threatening multiple organ failure. Acute pancreatitis can have a more severe clinical presentation in geriatric patients as compared to younger patients. In this study, we aimed to elucidate the clinical and laboratory characteristics of patients aged 65 and older who presented to the emergency department with a diagnosis of AP and assessed their impact on hospital stay, in-hospital mortality, and cost.

PATIENTS AND METHODS: We reviewed the records of patients aged 65 and older who presented to the emergency department and had lipase levels measured as exceeding three times the upper limit of the reference range during the evaluation. We recorded these patients' vital signs, medical histories, laboratory values, and etiologies. Using these data, we calculated the patients' clinical scores.

RESULTS: We recorded data on 218 patients who met the inclusion criteria. The median age of the patients was 76 (65-113). Of these, 70.6% were females, 54.6% had gallstones, 90.4% (n = 197) were admitted to the general ward from the emergency department, and 7.3% (n = 16) were admitted to the intensive care unit (ICU). In-hospital mortality was 5.63% (n = 12). The Ranson, Glasgow Severity Score (GSS), and Bedside Index for Severity in Acute Pancreatitis (BISAP) scores, as well as lactate, procalcitonin, and the lymphocyte-albumin ratio, were independent predictors of ICU admission and mortality.

CONCLUSIONS: The early diagnosis of AP is essential. When a severe disease course is likely, initiating treatment promptly becomes crucial, especially in patients aged 65 and older. This approach can lead to significant reductions in both complication rates and treatment costs.

Key Words:
Acute pancreatitis, Choledocholithiasis, Emergencies, Geriatrics.

Introduction

Acute pancreatitis (AP) is the leading cause of hospital admissions among gastrointestinal system disorders, and it can resolve independently or lead to life-threatening multiple organ failure due to local and systemic inflammation. Therefore, in patients presenting to the emergency department (ED) with abdominal pain, the rapid diagnosis of AP, the identification of patients at a high risk of progressing to severe AP, and early treatment strategies are crucial factors that can impact the prognosis of the disorder[1].

Acute pancreatitis can lead to a more severe clinical presentation in patients aged 65 and older as compared to younger patients. These patients may present to the ED with non-specific symptoms and delayed onset, and they often have comorbidities. Therefore, it is crucial to prioritize comprehensive and targeted diagnostic procedures and pharmacologic and interventional treatments for this age group[2].

Scoring systems are frequently used in the ED to predict the severity of AP, and age is an essential factor in commonly used scoring systems[3]. The Ranson score, Glasgow Severity Score (GSS), and Bedside Index for Severity in Acute Pancreatitis (BISAP) are scoring systems that use the patient's age as an indicator. In Ranson's criteria, being > 70 years old for "biliary pancreatitis" and > 55 years old for "alcohol and other causes" contribute one point to the score. In the GSS, being > 55 years old, and, in the BISAP, being > 60 years old contributes to the scoring[4].

In addition, it has been reported[5] that various laboratory parameters can be used in the ED to predict the severity of AP. However, individual tests may have low sensitivity and specificity.

When considering the etiology of AP, gallstones, and alcohol are the top two causes. Other factors, such as hypertriglyceridemia, steroid

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use, diabetic ketoacidosis, hypercalcemia, and complications of endoscopic retrograde cholangiopancreatography, are also included among potential etiologies. However, there are cases of pancreatitis in which the etiology remains unclear[6,7].

There is a need for clinical scoring systems that can predict the severity of AP in the ED for the fragile patient group aged 65 and older. Additionally, cost-effective, rapid laboratory parameters are required.

In this study, we aimed to elucidate the clinical and laboratory characteristics of patients aged 65 and older who presented to the Ankara Etlik City Hospital ED with a diagnosis of AP and assess their impact on hospital stay, in-hospital mortality, and cost.

Patients and Methods

We conducted this study retrospectively after obtaining approval from the Ankara Etlik City Hospital Clinical Research Ethics Committee (Number: AESH-EK1-2023-534). We reviewed the records of 405 patients aged 65 and older who presented to the adult ED and had lipase levels, as measured during the evaluation, exceeding three times the upper limit of the reference range (> 180 U/L) between September 2022 and August 2023.

We excluded patients under the age of 65, those who have elevated lipase levels due to non-acute pancreatitis causes, those who were not clinically compatible with AP, and those who had a confirmed diagnosis of pancreatic malignancy.

We recorded vital signs (temperature, pulse rate, blood pressure, oxygen saturation, and body temperature), medical histories, initial complete blood count, biochemical values, and the etiology of pancreatitis for the patients included in the study. Using these data, we calculated each patient's Ranson, GSS, BISAP, ATLANTA, Harmless Acute Pancreatitis Score (HAPS), Balthazar, modified Computed Tomography severity index (mCTsi), and inflammatory index. We categorized the outcomes of the patients in the ED as discharge, admission to the general ward, or admission to the intensive care unit (ICU). We documented the number of days at which patients passed away during their hospitalization. We examined the number of days of hospitalization in the general ward, the number of days in the ICU, and the total cost of diagnosis and treatment.

Statistical Analysis

We analyzed the data using the Statistical Package for the Social Sciences (SPSS) for Windows, version 26 (IBM Corp., Armonk, NY, USA). We used the Kolmogorov-Smirnov test to determine whether the continuous data follow a normal distribution. For continuous data that showed a normal distribution, we used the *t*-test for independent samples. We utilized the Mann-Whitney U test in our analysis for those data that did not follow a normal distribution. We represented normally distributed continuous data as means ± standard deviations; for data that did not follow a normal distribution, we displayed them as medians (minimum-maximum). We conducted simple and multiple linear-regression analyses to identify independent predictors of mortality and admission to the ICU. We drew receiver operating characteristic (ROC) curves to determine the predictive power of independent predictors that are common to both mortality and admission to the ICU. We defined area-under-the-curve (AUC) values between 0.7 and 0.79 as acceptable, those between 0.8 and 0.89 as very good and those above 0.9 as excellent. We considered $p < 0.05$ to be statistically significant. In the cost analysis, we converted the Turkish lira (₺) values to € at 1 € = 28.8318 ₺, which is the exchange rate as of September 7, 2023.

Results

We recorded the data of 218 patients who met the inclusion criteria for the study. The median age of the patients was 76 (65-113) years. Of these, 70.6% (n = 154) were females. In terms of their medical histories, 78.8% had hypertension, 35.8% had diabetes, 26.1% had coronary artery disease, 8.8% had chronic kidney disease, 10.1% had asthma, 8.3% had heart failure, 5.5% had hypothyroidism, 2.8% had hyperthyroidism, 28.1% had benign prostatic hyperplasia, 5.5% had a history of cerebrovascular events, 5.5% had atrial fibrillation, 2.3% had Alzheimer's disease, 5% had Parkinson's disease, 1.8% had pulmonary thromboembolism, 0.5% had epilepsy, and 0.9% had a diagnosis of osteoporosis.

Regarding the etiology of pancreatitis, 54.6% of the patients (n = 119) had gallstones. The proportion of patients in the ED with pancreatitis of unknown etiology was 37.6% (n = 82). Of the patients, 4.1% (n = 9) received a mass diagnosis in the ED without a previously known history.

In 3.7% (n = 8) of the patients, other rare causes, such as pericolonic abscess, maljunction, and cyst, were present. There were no patients with a history of alcohol use in the records.

Of the patients included in the study, 90.4% (n = 197) were admitted to the general ward from the ED, while 7.3% (n = 16) were admitted to the ICU from the ED. Two patients left the ED voluntarily, and three patients were discharged. A total of 12 patients (5.63%) passed away during their hospitalization. The median day of death for deceased patients was 17.5 (1-64).

There was no statistically significant difference between the survivor and non-survivor patient groups in terms of systolic blood pressure ($p = 0.188$), diastolic blood pressure ($p = 0.907$), body temperature ($p = 0.261$), or pulse rate ($p = 0.157$). There was a statistically significant difference in neutrophil ($p = 0.002$), lymphocyte ($p = 0.005$), and neutrophil-lymphocyte ratio (NLR) ($p < 0.001$) measured at the 48th h after patients were admitted to the hospital. There was no significant difference between these two groups in terms of sodium ($p = 0.958$), potassium ($p = 0.321$), or calcium ($p = 0.087$) values. We display other variables for the survivor and non-survivor groups in Table I.

There were no significant differences in heart rate ($p = 0.486$), body temperature ($p = 0.977$), sodium ($p = 0.424$), calcium ($p = 0.332$), or potassium ($p = 0.402$) between patients admitted to the general ward and those admitted to the ICU. There were statistically significant differences in neutrophil count at 48 h ($p = 0.004$), lymphocyte

Table I. Comparison of clinical and laboratory characteristics between survivor and non-survivor groups.

Parameter	Survivor	Non-survivor	p
Age (years)	76 (65-113)	76 (67-95)	0.397
Oxygen Saturation (%)	95 (66-100)	93.5 (61-97)	**0.012**
Hemoglobin (g/dL)	13.2 (7-18.1)	13.2 (9.1-15.7)	0.811
White blood cell (×10^3/µL)	10.49 (4-31.41)	12.13 (6.18-30.09)	0.112
Neutrophil (×10^3/µL)	8.68 (2.7-85.5)	10.87 (5.54-28.29)	0.127
Lymphocyte (×10^3/µL)	1.3 (0.09-124)	0.93 (0.59-2.52)	0.414
Platelet (×10^3/µL)	242 (2.93-700)	313 (98-606)	**0.033**
RDW (%)	13.9 (11.8-157)	14.9 (12.4-20.9)	0.49
NLR	6.85 (0.04-155.44)	10.6 (2.36-36.27)	0.139
PLR	185.71 (0.91-4,158.33)	331.8 (38.89-680.9)	**0.042**
Creatinine (mg/dL)	0.93 (0.18-8.67)	0.97 (0.57-2.38)	0.348
BUN (mg/dL)	19.3 (1.73-78.04)	23.97 (11.64-55.23)	0.229
Lactate (mmol/L)	1.08 (0.63-9.89)	3.28 (1.98-7.14)	**< 0.001**
AST (U/L)	121 (5-1578)	135 (12-511)	0.665
ALT (U/L)	101 (7-841)	58 (7-532)	0.208
Total Bilirubin (mg/dL)	1.36 (0.1-27.3)	1.19 (0.13-5.41)	0.512
Direct Bilirubin (mg/dL)	0.8 (0.01-19.7)	0.39 (0.06-4.88)	0.228
Amylase (U/L)	781 (2-6,371)	1,126.5 (94-3,772)	0.503
Lipase (U/L)	1,588 (34-15,067)	3,074 (232-10,340)	0.095
LDH (U/L)	246.5 (70-2,127)	399 (174-820)	**0.007**
Glucose (mg/dL)	125 (33-476)	150 (51-301)	0.298
CRP (mg/L)	26.1 (0.06-421)	31.9 (0.29-158)	0.764
Procalcitonin (µg/L)	0.3 (0.02-100)	11.1 (0.32-73.3)	**< 0.001**
Albumin (g/L)	38.1 (20.8-48.1)	33.95 (23.5-41)	**0.003**
Inflammation Index	4.56 (0.01-611.26)	9.76 (0.91-179.51)	0.107
CRP to Albumin Ratio	0.66 (0-12.35)	0.97 (0.1-6.72)	0.261
Lactate to Albumin Ratio	0.045 (0-0.251)	0.12 (0.058-0.206)	**< 0.001**
LOS (ward) (days)	6 (1-57)	9 (0-49)	0.701
LOS (ICU) (days)	0 (0-21)	3.5 (0-21)	**< 0.001**
LOS (total) (days)	7 (1-71)	17.5 (1-64)	0.097
Cost (€)	135.42 (5.52-5,104.39)	1,458.66 (44.31-6,031.14)	**0.002**

ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, BUN: Blood urea nitrogen, CRP: C-reactive protein, ICU: Intensive Care Unit, LDH: Lactate Dehydrogenase, LOS: Length of Stay, NLR: Neutrophil-to-Lymphocyte Ratio, PLR: Platelet-to-Lymphocyte Ratio, RDW: Red cell distribution width.

count at 48 h ($p = 0.009$), and NLR at 48 h ($p < 0.001$) between patients admitted to the ward and those admitted to the ICU. The values of these variables for patients in the ward and ICU are presented in Table II.

We presented the scores on the clinical scoring systems calculated for patients in the ED according to mortality and admission to the ward or ICU in Table III.

In a simple linear regression analysis, the following variables were found to be significant predictors of mortality, along with their respective regression coefficients (B) and p:

- Saturation ($p < 0.001$, B = -0.014)
- Platelet ($p = 0.001$, B = 0.001)
- 48-h Neutrophil ($p < 0.001$, B = 0.016)
- 48-h Lymphocyte ($p = 0.005$, B = -0.062)
- 48-h NLR ($p = 0.001$, B = 0.005)
- Lactate ($p < 0.001$, B = 0.066)
- Procalcitonin ($p = 0.004$, B = 0.003)
- Albumin ($p < 0.001$, B = -0.011)
- Lactate Albumin Ratio (LAR) ($p < 0.001$, B = 2.421)
- Ranson ($p < 0.001$, B = 0.040)
- GSS ($p < 0.001$, B = 0.049)
- BISAP ($p < 0.001$, B = 0.073)

However, platelet lymphocyte ratio (PLR) ($p = 0.701$) and lactate dehydrogenase (LDH) ($p = 0.084$) were not found to be significant predictors of mortality. These results indicate that the listed variables statistically correlate with mortality in the studied population.

Table II. . Comparison of clinical and laboratory characteristics between patients admitted to the ward and ICU groups.

Parameter	Ward Admission	ICU Admission	p
Age (years)	76 (65-113)	74 (66-92)	0.617
Systolic Blood Pressure (mmHg)	137 (50-206)	108 (89-140)	**< 0.001**
Diastolic Blood Pressure (mmHg)	75.52 ± 13.06	63.43 ± 13.24	**0.002**
Oxygen Saturation (%)	95 (61-100)	94 (84-98)	**0.038**
Hemoglobin (g/dL)	13.1 (7-18.1)	12.7 (9.9-16.7)	0.471
White Blood Cell ($\times 10^3/\mu L$)	10.45 (4-31.41)	13.44 (6.98-28.46)	**0.042**
Neutrophil ($\times 10^3/\mu L$)	8.61 (2.7-85.5)	11.36 (5.5-25.25)	**0.040**
Lymphocyte ($\times 10^3/\mu L$)	1.29 (0.17-124)	0.84 (0.09-2.46)	**0.028**
Platelet ($\times 10^3/\mu L$)	242 (2.93-700)	259 (91-606)	0.210
RDW (%)	13.8 (11.8-157)	15 (13-22.6)	**0.004**
NLR	6.85 (0.04-87.9)	13.35 (2.24-155.44)	**0.003**
PLR	184.41 (0.91-1,352.94)	290.6 (104.47-4,158.33)	**0.009**
Creatinine (mg/dL)	0.92 (0.18-7.87)	1.69 (0.57-8.67)	**0.001**
BUN (mg/dL)	18.7 (1.73-78.04)	27.54 (12.1-76.64)	**0.002**
Lactate (mmol/L)	1.71 (0.63-7.14)	2.92 (0.97-9.89)	**0.005**
AST (U/L)	118 (8.43-1,578)	86 (5-850)	0.797
ALT (U/L)	98 (7-841)	55 (7-646)	0.344
Total Bilirubin (mg/dL)	1.4 (0.1-27.3)	1.1 (0.13-5.55)	0.313
Direct Bilirubin (mg/dL)	0.8 (0.01-19.7)	0.45 (0.06-2.74)	0.141
Amylase (U/L)	762 (2-6,371)	933.5 (94-2,565)	0.445
Lipase (U/L)	1,624 (34-15,067)	1,560.5 (583-8,248)	0.792
Triglycerides (mg/dL)	98 (24-799)	114 (64-409)	0.225
LDH (U/L)	242.5 (70-2,127)	442 (150-1,598)	**0.001**
Glucose (mg/dL)	126 (33-476)	129.5 (51-293)	0.869
CRP (mg/L)	23.67 (0.06-421)	74.7 (0.29-158)	**0.004**
Procalcitonin (µg/L)	0.3 (0.02-95)	7.82 (0.04-100)	**0.001**
Albumin (g/L)	38 (20.8-48.1)	36 (23.5-41.5)	0.080
Inflammation Index	4.02 (0.01-611.26)	25.64 (7.29-237.93)	**< 0.001**
CRP/Albumin Ratio	0.65 (0-12.35)	2.22 (0.17-6.72)	**0.001**
Lactate/Albumin Ratio	0.045 (0-0.206)	0.076 (0.025-0.251)	**0.004**
LOS (ward) (days)	6 (1-57)	6 (0-30)	0.975
LOS (ICU) (days)	0 (0-21)	6 (0-21)	**< 0.001**
LOS (total) (days)	6 (1-71)	10.5 (6-36)	**< 0.001**
Cost (€)	134.45 (20.13-6,031.14)	908.78 (233.01-5,470.45)	**< 0.001**

ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, BUN: Blood urea nitrogen, CRP: C-reactive protein, ICU: Intensive care unit, LDH: Lactate Dehydrogenase, NLR: Neutrophil-to-Lymphocyte Ratio, PLR: Platelet-to-Lymphocyte Ratio, RDW: Red cell distribution width, LOS: Length of stay.

Table III. The comparison of mortality and ward/intensive care unit admissions based on clinical scores.

Parameter	Survivor	Non-survivor	*p*	Ward admission	ICU admission	*p*
Ranson	2 (0-7)	4 (0-7)	**0.001**	2 (0-6)	3 (1-7)	**0.002**
GSS	2 (1-8)	4 (2-5)	**< 0.001**	2 (1-6)	3 (1-8)	**0.001**
BISAP	2 (1-5)	2.5 (1-4)	**0.01**	2 (1-4)	2.5 (1-5)	**< 0.001**
ATLANTA	0 (0-1)	0 (0-1)	0.947	0 (0-1)	1 (0-1)	**< 0.001**
HAPS	1 (0-2)	1 (0-2)	0.191	1 (0-2)	1 (0-2)	**0.01**
Balthazar	2 (1-5)	4 (1-5)	0.099	2 (1-5)	3 (1-5)	0.626
mCTsi	2 (0-6)	4 (0-8)	0.107	2 (0-6)	2 (0-8)	0.201

GSS: Glasgow Severity Score, BISAP: Bedside Index for Severity in Acute Pancreatitis, HAPS: Harmless Acute Pancreatitis Score, ICU: Intensive care unit, mCTsi: modified Computed Tomography severity index.

In a simple linear regression analysis, the following variables were found to be significant predictors of ICU admission, along with their respective regression coefficients (B) and *p*. Systolic blood pressure ($p < 0.001$, B = -0.003), diastolic blood pressure ($p = 0.002$, B = -0.004), white blood cell count ($p = 0.033$, B = 0.008), 48-h neutrophil ($p = 0.008$, B = 0.013), 48-h lymphocyte ($p = 0.014$, B = -0.064), NLR ($p < 0.001$, B = 0.004), PLR ($p < 0.001$, B < 0.001), LDH ($p < 0.001$, B < 0.001), creatinine ($p < 0.001$, B = 0.105), blood urea nitrogen (BUN) ($p < 0.001$, B = 0.006), lactate ($p < 0.001$, B = 0.064), procalcitonin ($p < 0.001$, B = 0.005), LAR ($p < 0.001$, B = 2.207), inflammatory index ($p = 0.026$, B = 0.001), C-reactive protein (CRP) to albumin ratio ($p = 0.023$, B = 0.020), Ranson ($p < 0.001$, B = 0.053), GSS ($p < 0.001$, B = 0.059), BISAP ($p < 0.001$, B = 0.110), ATLANTA ($p < 0.001$, B = 0.558), and HAPS ($p < 0.001$, B = 0.079). These results indicate that the listed variables were statistically associated with the need for ICU admission in the studied population.

Oxygen saturation ($p = 0.261$), neutrophils ($p = 0.673$), lymphocytes ($p = 0.532$), red cell distribution width (RDW) ($p = 0.698$), and 48-h NLR ($p = 0.133$) were not significant predictors of ICU admission. Similarly, CRP is also not a significant predictor of ICU admission ($p = 0.062$).

On the other hand, Ranson, GSS, and BISAP scores, as well as lactate, procalcitonin, and LAR, were independent predictors of ICU admission and mortality. We presented the numerical results regarding their predictive power for ICU admission and mortality, as determined by the ROC curve analysis in Table IV and the ROC curves in Figures 1-4.

Discussion

The frequency of medical care needed in individuals aged 65 and older is increasing with the expect-

Table IV. Numerical results of ROC curves by mortality and general ward/intensive unit care admission.

		AUC	SE	95% CI	*p*
ICU Admission	Ranson	0.731	0.061	0.611-0.851	**0.002**
	GSS	0.744	0.059	0.628-0.860	**0.001**
	BISAP	0.783	0.057	0.671-0.895	**< 0.001**
	Lactate	0.702	0.080	0.546-0.858	**0.010**
	Procalcitonin	0.744	0.070	0.607-0.880	**0.002**
	LAR	0.721	0.079	0.565-0.876	**0.005**
Mortality	Ranson	0.776	0.082	0.614-0.937	**0.001**
	GSS	0.808	0.055	0.699-0.916	**< 0.001**
	BISAP	0.705	0.094	0.522-0.889	**0.017**
	Lactate	0.876	0.043	0.792-0.960	**< 0.001**
	Procalcitonin	0.805	0.054	0.698-0.911	**0.001**
	LAR	0.911	0.031	0.849-0.972	**< 0.001**

BISAP: Bedside Index for Severity in Acute Pancreatitis, CI: Confidence Interval, GSS: Glasgow Severity Score, ICU: Intensive care unit, LAR: Lactate Albumin Ratio, SE: Standardized Error, AUC: Area Under Curve.

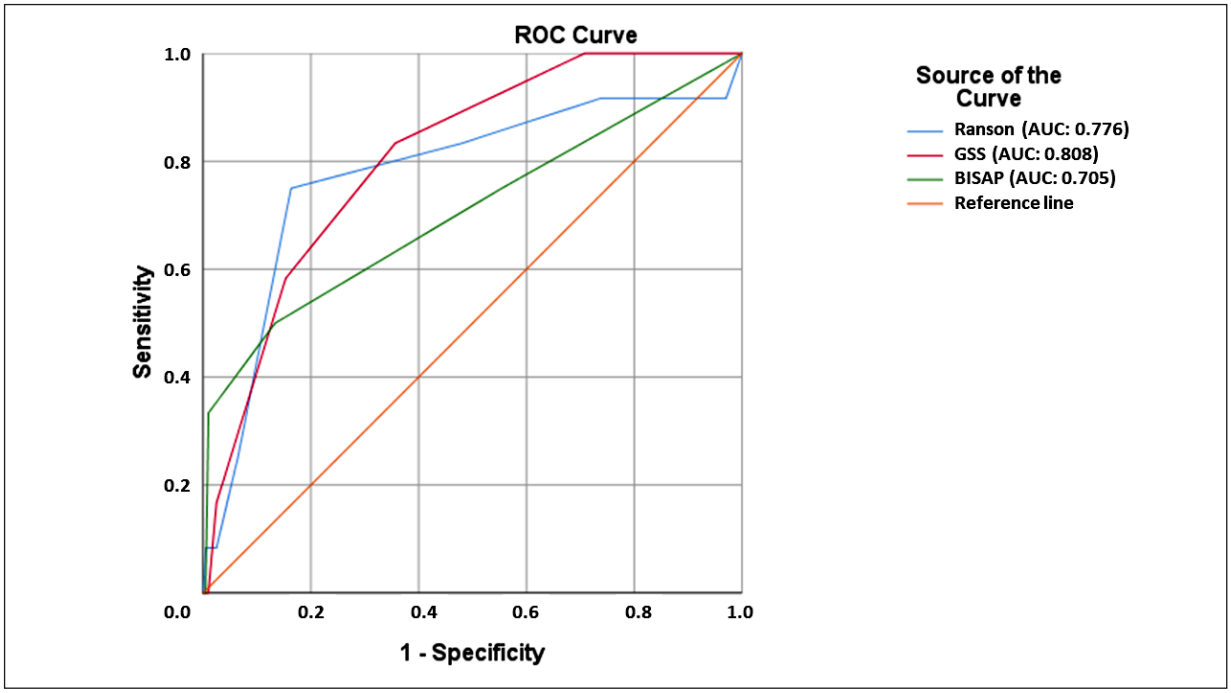

Figure 1. Receiver operating characteristics (ROC) curves of clinical scores for mortality.

ed lifespan. It has been reported[8] that the likelihood of severe AP is also increased in this vulnerable age group. In this study, we investigated the relationship between the clinical characteristics and outcomes of geriatric patients diagnosed with AP in the ED of Turkey's largest healthcare institution. We found that platelet count, procalcitonin, albumin, lactate, and LAR, when based on the laboratory values

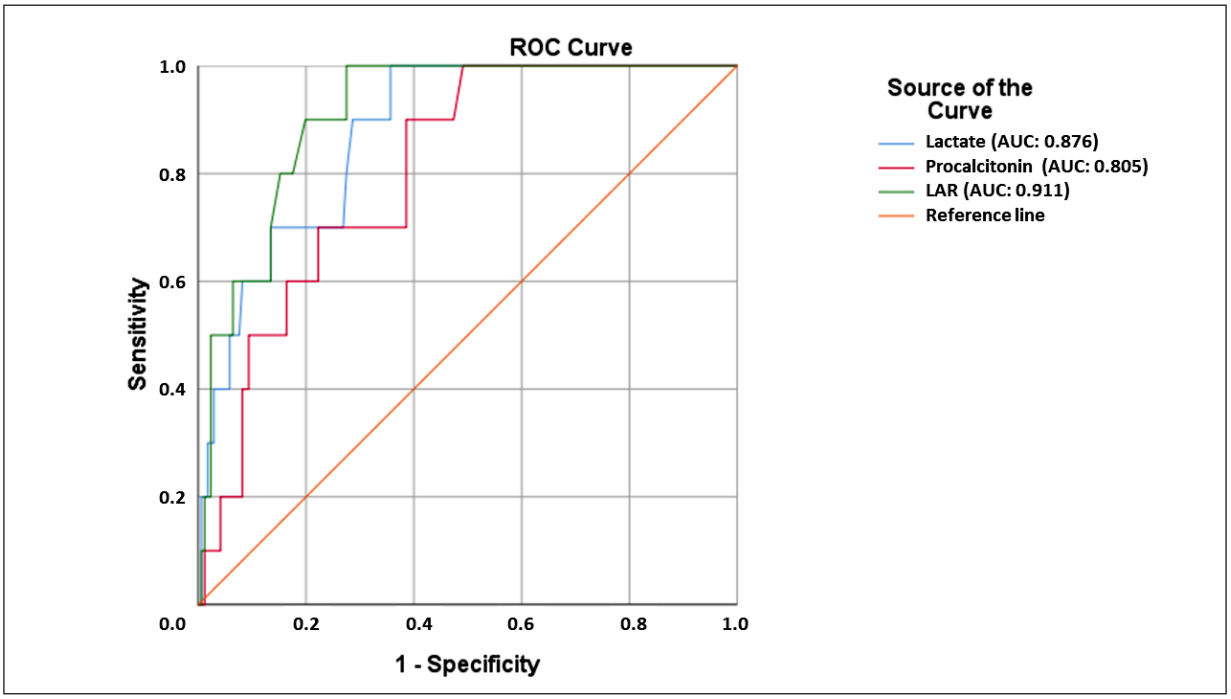

Figure 2. Receiver operating characteristics (ROC) curves of laboratory parameters for mortality.

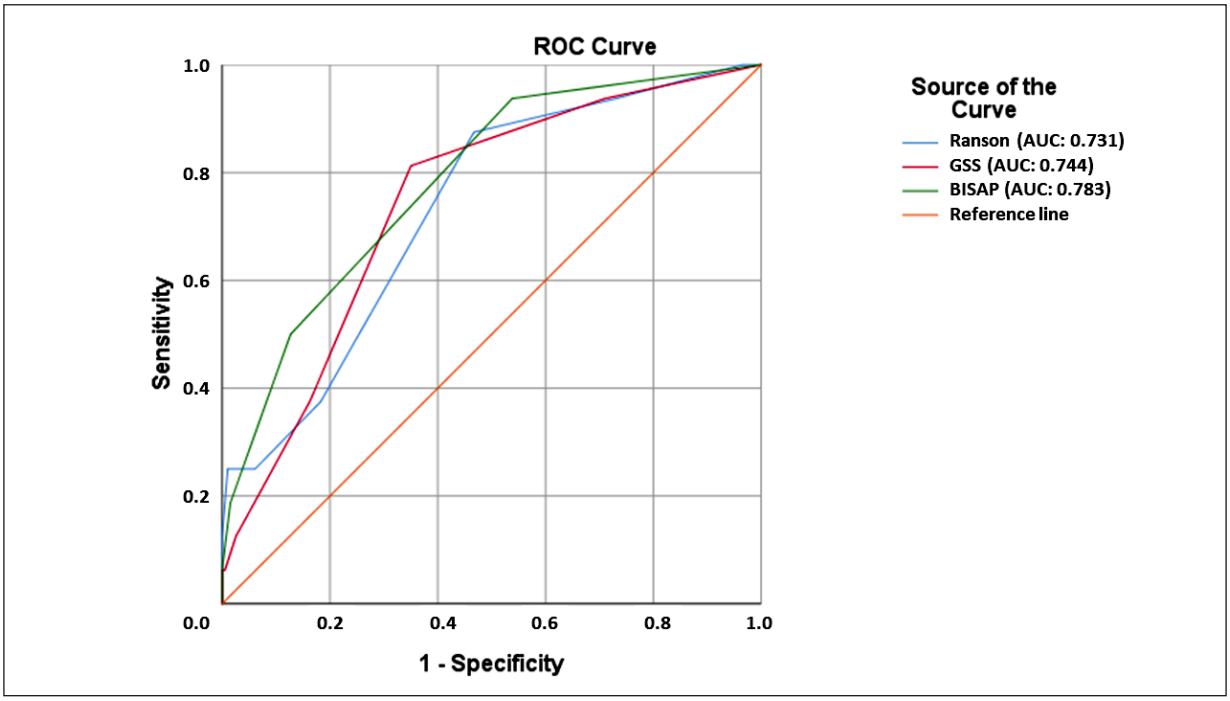

Figure 3. Receiver operating characteristics (ROC) curves of clinical scores for intensive care unit admission.

obtained in the ED, were significant predictors of mortality. We also identified that oxygen saturation level, Ranson score, GSS score, and BISAP score were significant predictors of mortality.

When we examined the patients' admission to the regular ward or the ICU from the ED, we found that laboratory values such as white blood cells (WBC), NLR, PLR, creatinine, BUN, lac-

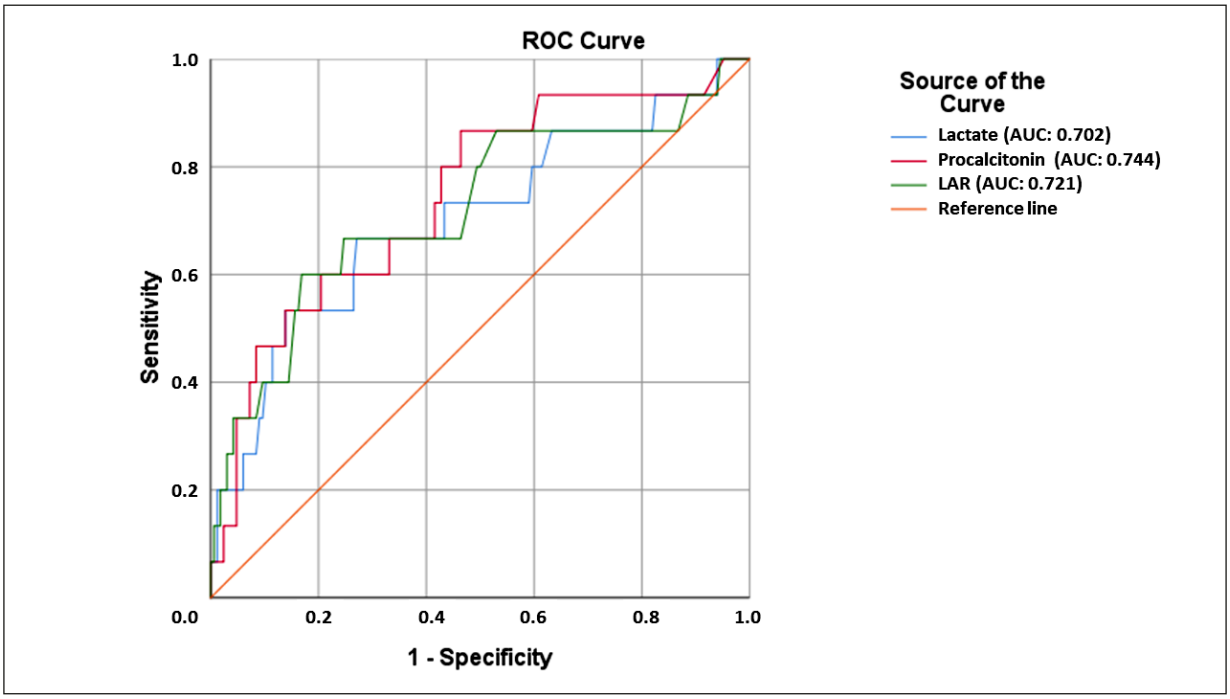

Figure 4. Receiver operating characteristics (ROC) curves of laboratory parameters for intensive care unit admission.

tate, LDH, procalcitonin, inflammatory index, CRP albumin ratio, and LAR were predictors of ICU admission. We also found that systolic blood pressure, Ranson score, GSS score, BISAP score, HAPS score, and ATLANTA score were predictors of ICU admission. When we considered both outcomes, we found that scoring systems, such as Ranson, GSS, and BISAP scores, as well as laboratory values, such as procalcitonin, lactate, and LAR, were independent predictors of both mortality and ICU admission.

The literature has controversial data regarding which scoring system and laboratory values are most useful for geriatric patients. Quero et al[9] found that in patients aged 65 and older, AP had a higher mortality rate, a higher ICU admission rate, and a prolonged length of hospital stay as compared to in patients under 65. Furthermore, they also observed that a high Ranson score at admission was an independent predictor of mortality. On the other hand, Acehan et al[10] demonstrated that the BISAP score was more successful in predicting mortality in geriatric patients than the mCTsi and Ranson. They also found that for each unit increase in the BISAP score, the risk of severe acute pancreatitis increased by 4.7-fold, and mortality increased by 12.3-fold. As in the literature, BISAP and Ranson scores were independent predictors of mortality and ICU admission in our study. Also, BISAP, Ranson, and GSS scores can easily be calculated for geriatric patients in the ED and used in the clinical decision-making process to predict both ICU admission and mortality.

In Sahiner et al[11]'s study, the admission rate to the ICU for patients 65 and older who were diagnosed with AP was 17.4%. In our study, this rate was 7.3%. This difference may be due to delayed hospital admissions in the geriatric age group in the center under study. In addition, our study was based on the rate of patients who were admitted to the ICU directly from the ED. This rate did not include patients who developed intensive-care needs while staying in the general ward and were subsequently transferred to the ICU.

A study[12] involving patients aged 18 and older who were diagnosed with AP found statistically significant differences between the survivor and non-survivor patient groups regarding laboratory values, including RDW, creatinine, BUN, potassium, albumin, lactate, and LAR. It has been found that the ratio of lactate to albumin is an independent predictor of 28-day all-cause mortality. In our study, there was a significant difference in albumin and lactate levels between the survivor and non-survivor groups. Both tests were independent predictors of mortality. Similarly, LAR was also an independent predictor of mortality.

Lactate levels can be used as a prognostic marker for AP and various medical conditions requiring critical care in patients who have presented to the ED. Including lactate levels in blood-gas analysis offers the advantage of providing rapid results in EDs, ICUs, and operating-room settings using arterial or venous blood gas[13]. Wu et al[14] also found that lactate is an independent predictor of overall early mortality in patients with AP who were admitted to the ICU, and they reported an AUC of 0.741 for lactate in their time-dependent ROC analysis. In our study, considering that the AUC for lactate in predicting mortality in geriatric patients diagnosed with AP was 0.876 and the AUC for LAR was 0.911, we can conclude that the initial measurement of lactate levels at the time of admission to the ED is very useful in terms of predicting patients' prognoses and mortality. Additionally, LAR is excellent. Therefore, lactate should be one of the first blood tests to be checked in geriatric AP patients in the ED.

In a study conducted by Jia et al[15] on the Chinese population, it was shown that procalcitonin was the most successful test in terms of predicting severe AP in acute biliary pancreatitis, and they calculated an AUC of 0.84 for procalcitonin. In our study, the AUC for procalcitonin in predicting ICU admission was 0.744, while it was 0.805 in predicting mortality. According to our results, procalcitonin was acceptable in terms of predicting ICU admission and excellent in terms of predicting mortality. In our study, lactate was better at predicting mortality, while procalcitonin was better at predicting ICU admission from the ED. Both biomarkers can be confidently used in making clinical decisions in EDs.

Deniz et al[16] showed that NLR was statistically significantly higher in the non-survivor group among patients admitted to the ICU. Furthermore, in the literature, NLR is highlighted as a predictor of an adverse prognosis in acute pancreatic biliary diseases[17]. Our study also found that neutrophil levels, lymphocyte levels, and NLR measured at 48 h statistically differed between the survivor and non-survivor patient groups and between the groups admitted to the ward and ICU. Therefore, measuring neutrophil and lymphocyte counts and calculating NLR 48 hours after admission can help predict patient mortality.

Predicting a severe course on the part of AP is extremely important in preventing local and systemic complications *via* early diagnosis and treatment. Preventing a severe course and complications in AP in this way will also reduce treatment costs. In a study conducted in Sweden[18], it was found that the cost of mild AP in a group of patients aged 65 and older was higher than in a group under 65 (5,600 ± 2,600 € *vs.* 4,700 ± 2,200 €, $p = 0.001$), while in the younger age group, the cost of severe AP was higher (45,000 ± 48,700 € *vs.* 19,400 ± 28,500 €, $p = 0.024$). The cost of patients with severe AP admitted to the ICU was significantly higher (39,200 ± 30,600 € *vs.* 7,700 ± 6,400 €, $p < 0.001$). The cost of the initial presentation due to AP was found to be, on average, 6,600 ± 10,200 €. Another study[19] conducted in the US revealed that the cost of emergency visits related to AP and the average cost of hospitalized patients has increased yearly. In our study, there was a statistically significant difference in costs between patients admitted to the regular ward [134.45 (20.13-6,031.14) €] and those admitted to the ICU [908.78 (233.01-5,470.45) €] ($p < 0.001$). Similarly, there was a statistically significant difference in costs between patients who have passed away [1,458.66 (44.31-6,031.14) €] and those who did not [135.42 (5.52-5,104.39) €] ($p = 0.002$). Given the significant differences in costs, early diagnosis, predicting the severity of AP, and early treatment will also significantly reduce expenses.

Limitations

Although we conducted our study in the largest hospital in our country, it is a single-center study. Additionally, our hospital opened at the end of September 2022, so we could only conduct the study with 10 months of data. The percentage of patients in the ED with an unclear etiology for AP was high. Additionally, no AP patients in the records had a history of alcohol use. Finally, the study's retrospective nature conferred the disadvantages common to retrospective studies, such as data gaps.

Conclusions

In elderly patients diagnosed with AP in the ED, Ranson, GSS, and BISAP scores can easily be calculated to predict the severity and mortality of AP. Lactate-level measurement, which can yield results within a few minutes through arterial or venous blood-gas analysis, is a significant predictor. When the lactate level is divided into the albumin level, it becomes an excellent predictor. Furthermore, procalcitonin is an independent predictor of severe AP and mortality.

The early diagnosis of acute pancreatitis is essential. When there is a prediction of a severe course, promptly initiating treatment becomes crucial, especially in patients aged 65 and older. This approach can lead to significantly reduced complication rates and treatment costs.

Conflict of Interest

The authors declare that they have no conflict of interests.

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Informed Consent

Because of the study's retrospective nature, informed consent is not applicable to this study.

Ethics Approval

We conducted this study retrospectively after obtaining approval from the Ankara Etlik City Hospital Clinical Research Ethics Committee (Number: AESH-EK1-2023-534).

Authors' Contribution

Afsin Emre Kayipmaz designed the study, analyzed the data, and wrote the manuscript. Seyda Gedikaslan and Rafet Fatih Aydogan collected and processed the data, wrote, and edited the manuscript.

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Availability of Data and Materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

References

1) Chen Y, Li Q, Ma L, Cai Z, Zhou J. Development and internal validation of a practical model to pre-

dict 30 days mortality of severe acute pancreatitis patients. Ann Med 2023; 55: 2236648.

2) Yu B, Li N, Li J, Wan J, He W, Zhu Y, Lu N. The Clinical Characteristics of Acute Pancreatitis in Gerontal Patients: A Retrospective Study. Clin Interv Aging 2020; 15: 1541-1553.
3) Goyal H, Awad H, Hu ZD. Prognostic value of admission red blood cell distribution width in acute pancreatitis: a systematic review. Ann Transl Med 2017; 5: 342.
4) Lee DW, Cho CM. Predicting Severity of Acute Pancreatitis. Medicina (Kaunas) 2022; 58: 787.
5) Liu ZY, Tian L, Sun XY, Liu ZS, Hao LJ, Shen WW, Gao YQ, Zhai HH. Development and validation of a risk prediction score for the severity of acute hypertriglyceridemic pancreatitis in Chinese patients. World J Gastroenterol 2022; 28: 4846-4860.
6) Yawar B, Marzouk A, Ali H, Asim A, Ghorab T, Bahli Z, Abousamra M, Fleville S. Acute Pancreatitis During COVID-19 Pandemic: An Overview of Patient Demographics, Disease Severity, Management and Outcomes in an Acute District Hospital in Northern Ireland. Cureus 2021; 13: e18520.
7) Jain V, Nath P, Satpathy SK, Panda B, Patro S. Comparing Prognostic Scores and Inflammatory Markers in Predicting the Severity and Mortality of Acute Pancreatitis. Cureus 2023; 15: e39515.
8) Kayar Y, Dertli R, Konur S. Clinical outcomes of acute pancreatitis in elderly patients: An experience of single tertiary center. Pancreatology 2020; 20: 1296-1301.
9) Quero G, Covino M, Fiorillo C, Rosa F, Menghi R, Simeoni B, Potenza A, Ojetti V, Alfieri S, Franceschi F. Acute pancreatitis in elderly patients: a single-center retrospective evaluation of clinical outcomes. Scand J Gastroenterol 2019; 54: 492-498.
10) Acehan S, Satar S, Gulen M, Firat BT, Satar DA, Tas A. Evaluation of scoring systems in terms of early prediction of severe acute pancreatitis and mortality in patients over 65 years of age. Cukurova Med J 2022; 47: 1327-1338.
11) Şahiner ES, Acehan F, Inan O, Aslan M, Altiparmak E, Ateş I. Characteristics and clinical outcomes of patients over 80 years of age with acute pancreatitis. Eur Geriatr Med 2022; 13: 1013-1022.
12) Liu Q, Zheng HL, Wu MM, Wang QZ, Yan SJ, Wang M, Yu JJ, Li DP. Association between lactate-to-albumin ratio and 28-days all-cause mortality in patients with acute pancreatitis: A retrospective analysis of the MIMIC-IV database. Front Immunol 2022; 13: 1076121.
13) Alshiakh SM. Role of serum lactate as prognostic marker of mortality among emergency department patients with multiple conditions: A systematic review. SAGE Open Med 2023; 11: 20503121221136401.
14) Wu M, Shi L, Zhang H, Liu H, Liu Y, Zhang W. Predictive value of arterial blood lactic acid concentration on the risk of all-cause death within 28 days of admission in patients with severe acute pancreatitis. Postgrad Med 2022; 134: 210-216.
15) Jia Z, Xu J, Gu Y, Zheng L, Xia T. Values of different biochemical indices and clinical scoring systems for the assessment of acute biliary pancreatitis in a Chinese population. Am J Transl Res 2023; 15: 3300-3308.
16) Deniz M, Ozgun P, Ozdemir E. Relationships between RDW, NLR, CAR, and APACHE II scores in the context of predicting the prognosis and mortality in ICU patients. Eur Rev Med Pharmacol Sci 2022; 26: 4258-4267.
17) Yeşil B, Çalışkan AR, Koşar K, Yüksel M, Gökcan H, Tümtürk A, Köseoğlu HT, Akdoğan Kayhan M. Lymphocyte count and NLR as predictive value for the severity of acute cholangitis. Eur Rev Med Pharmacol Sci 2023; 27: 8732-8739.
18) Andersson B, Appelgren B, Sjödin V, Ansari D, Nilsson J, Persson U, Tingstedt B, Andersson R. Acute pancreatitis-costs for healthcare and loss of production. Scand J Gastroenterol 2013; 48: 1459-1465.
19) Garg SK, Sarvepalli S, Campbell JP, Obaitan I, Singh D, Bazerbachi F, Singh R, Sanaka MR. Incidence, Admission Rates, and Predictors, and Economic Burden of Adult Emergency Visits for Acute Pancreatitis: Data From the National Emergency Department Sample, 2006 to 2012. J Clin Gastroenterol 2019; 53: 220-225.