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Evaluation of the effects of kidney function tests on prognosis and mortality in geriatric patients with a pulmonary embolism

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Abstract

Aim: The instant study's aim is to investigate the effect that BUN and creatinine values have on a prognosis in geriatric patients that are diagnosed with pulmonary embolism. Material and methods: Our study was planned as a retrospective data review and included patients over the age of 65 with a diagnosis of pulmonary embolism who were admitted applied to Ümraniye Training and Research Hospital between March 1, 2020, and March 1, 2022. Statistical analysis was performed using SPSS version 26.0.

Results: The study included 148 patients, and 66.89% of them were women. The mortality rate was 28.38%. Considering the blood gas parameters, there was a statistically significant relationship between PH and low saturation and mortality (p=0.029, p=0.001, respectively). Although creatinine values were higher in non-surviving patients than in surviving patients, it was not statistically significant (p=0.252). Blood urea nitrogen was statistically significantly higher in patients who died (p=0.001). Sodium and potassium values were also not associated with mortality (p=0.991, p=0.886, respectively).

Conclusion: The effect of kidney function tests on the prognosis is very important in managing pulmonary embolism. BUN will be more beneficial to the clinician than creatinine and plasma electrolytes in the management of patients with pulmonary embolism.

Key words: pulmonary embolism, BUN, creatinine, sodium, potassium

Introduction

Although the pulmonary embolism is an important disease—the incidence of which increases as age increases—it can be difficult to diagnose in geriatric patients due to reasons such as the vagueness of symptoms and the inability of the patient to clearly express himself. Similar to shortness of breath, chest pain, syncope symptoms may suggest different diagnoses [1]. The high morbidity and mortality rates have caused further investigation of laboratory parameters that affect prognosis, including parameters such as PH, hco3 [2], d-dimer [3], and ionized calcium [4], which were investigated in terms of their relationships with mortality and morbidity. In recent years, the relationship between mortality and troponin, creatinine kinase, BNP [5,6], blood urea nitrogen (BUN) and creatinine has been investigated in patients with a pulmonary embolism [2,5].

Blood urea nitrogen and creatinine are generally used to evaluate kidney function tests. While both are filtered from the glomeruli and can give an idea of the glomerular filtration rate, tubules only reabsorb BUN [7,8]. Instead of the initial evaluation of renal function tests, the relationship between chronic renal failure and prognosis of chronic renal failure was examined. While there was a statistically significant relationship between chronic renal failure and mortality in some pulmonary embolism studies [2,6], other studies showed no relationship between the two [9].

In addition, the number of patients diagnosed with renal failure and diagnosed with pulmonary embolism was low. This suggested the possibility that renal function tests may be more determinative in predicting prognosis. Thus, the effect of kidney function tests on prognosis and mortality to be import in regards to pulmonary embolism in myocardial infarction [10] and ischemic stroke diseases [11].

Aim: The instant study's primary aim is to investigate the effect that BUN and creatinine values have on a prognosis in geriatric patients that are diagnosed with pulmonary embolism. Our secondary aim is to compare the effect of BUN and creatinine values with the effects of sodium and potassium parameters on prognosis.

Material and methods

Study design

Our study was planned as a retrospective data review and included patients over the age of 65 with a diagnosis of pulmonary embolism who were admitted applied to Ümraniye Training and Research Hospital between March 1, 2020, and March 1, 2022. Our hospital is an 836-bed hospital with 2.8 million patient applications per year. There are yellow, green, and red areas in the emergency department and approximately 500,000 patients apply to the emergency department annually.

Study population

We obtained data from the hospital database on patients over 65 years of age who were diagnosed with pulmonary embolism by thorax angio CT (computed tomography). According to their survival status, the patients were divided into two groups—survivors and those who died—according to the National death notification system in Turkey. All patients under 65 years of age, patients over 65 years of age who were not diagnosed with pulmonary embolism, and patients with missing data were excluded from the study.

Data collection

Age, gender, symptoms, and comorbidities of patients over 65 years of age who were diagnosed with pulmonary embolism were recorded. Hypertension (HT), diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), coronary artery disease (CAD), chronic cardiac failure (CCF), cerebrovascular disease (CVD), chronic renal failure (CRF), and malignancies, blood pressure, pulse, respiratory rate, saturation, PH, PCO2, BUN (blood urea nitrogen), creatinine, sodium, potassium and mortality status (30-day mortality information), length of hospital stay, discharge during the clinical course, service admission, and intensive care admission were recorded. Patients receiving thrombolytic therapy received a bolus of 10 mg t-PA, followed by an intravenous infusion of 90 mg over a 2-hour period. Subcutaneous low molecular weight heparin was used after the thrombolytic therapy. The relationship between mortality and BUN, creatinine, sodium, and potassium values was investigated. This evaluation included consideration of whether these values were superior to each other in affecting mortality.

Ethics committee

The local clinical research ethics committee of our hospital provided approval (date: March 10, 2022; number: B.10.1.TKH.4.34.H.GP.0.01/70).

Statistical analysis

Statistical analysis was performed using SPSS version 26.0. The conformity of the variables to the normal distribution was determined by visual (histogram and probability charts) and analytical (Kolmogorov-Smirnov test) methods. Chi-square and Fishers' exact test were used for categorized data. Quantitative variables were presented as median and interquartile range (IQR, 25th-75th percentile) values, and the Mann-Whitney U test was used to analyze paired groups and kidney function tests. Bonferroni correction was preferred in multiple comparisons. The receiver operating characteristic (ROC) curve analysis was performed in order to evaluate the diagnostic test's performance of the investigated parameters in predicting mortality. This included an analysis of the area under the curve (AUC) values were calculated, and the sensitivity, specificity, and 95% confidence interval (CI) data. Statistical significance was accepted as $p<0.05$ (Jamovi 1.2.27).

Results

The study included 148 patients, and 66.89% of them were women. The mortality rate was 28.38%. A statistically significant correlation was found between high heart rate, low systolic and diastolic blood pressure, and mortality ($p=0.015$, $p<0.001$, $p=0.008$, respectively).

Among the comorbid diseases, only those with congestive heart failure and malignancy had a higher mortality rate than other comorbidities ($p=0.03$, $p=0.05$, respectively). While there was no statistically significant relationship between symptoms and mortality, mortality was significantly higher in patients who were admitted to the intensive care unit compared to those who were discharged from the hospital and those who were admitted to the ward ($p<0.001$). Demographic characteristics, vital signs, and clinical outcomes for the patients are provided in Table 1.

Considering the blood gas parameters, there was a statistically significant relationship between PH and low saturation and mortality ($p=0.029$, $p=0.001$, respectively). Although creatinine values were higher in non-surviving patients than in surviving patients, it was not statistically significant ($p=0.252$). Blood urea nitrogen was statistically significantly higher in patients who died ($p=0.001$). Sodium and potassium values were also not associated with mortality ($p=0.991$, $p=0.886$, respectively).

The most common electrocardiographic (ECG) finding in our patients was sinus rhythm. It was present in 33.3% of the patients who died ($p=0.003$). In 48.64% of the patients, echocardiography (ECO) provided evidence of pulmonary embolism. On the other hand, 57.14% of the patients who died had ECO findings, but did not have a statistically significant correlation between the presence of ECO findings and their mortality ($p=0.20$).

There was a statistically significant relationship between the pulmonary embolism severity index (PESI) and the simplified pulmonary embolism severity index (sPESI) and mortality ($p<0.001$, $p=0.006$, respectively). This was represented in Table 2.

There was a statistically significant difference between high BUN and low saturation and mortality ($p=0.001$, $P=0.001$, respectively). The diagnostic test performance analyses BUN and saturation in predicting mortality revealed that BUN and creatinine were statistically significant in predicting 0.67mortality, with the AUC value being calculated as 0.67(0.591-0.748) for BUN at a cut-off value of 53.5, sensitivity of 69.05, and specificity of 74.53; 0.68(0.597-0.753) for saturation at a cut-off value of 89, sensitivity of 66.67, and specificity of 66.04($p=0.0019$, $P=0.0003$, respectively).

Discussion

Our study determined that high BUN could predict mortality in patients diagnosed with pulmonary embolism. In addition, creatinine, sodium, and potassium could not predict mortality

Table 1 Relationship between demographic data, vital signs, comorbid diseases, and first admission symptoms with mortality

	Total	Survivor	Non-survivor	p
	148(100%)	106(71.62%)	42(28.38%)	
Age (median 25-75)	77(70-82)	77.5(70-82)	76(71.50-83.25)	0.94
Age(mean±std)	77±7.6	76.89±7.46	77.29±8.05	
Gender				0,33
Female	99(66.89%)	68(64.15%)	31(73.8%)	
Male	49(33.11%)	38(35.84%)	11(26.19%)	
GCS (median 25-75)	15(15-15)	15(15-15)	15(11-15)	**<0.001**
GCS(mean±std)	14.38±1.9	14.92±0.52	13±3.14	
Fever(median 25-75)	36.4(36-36.8)	36.4(36-36.7)	36.6(36-37)	0.11
Fever(mean±std)	36.45±0.48	36.42±0.45	36.54±0.54	
Heart rate/min(median 25-75)	101(87-120.75)	100(83-117.25)	109(90-131.50)	**0.015**
Heart rate/min(mean±std)	104.01±23.72	100.38±21.99	113.17±25.67	
Respiratory_rate_min (median 25- 75)	19(18-23)	19(18-22)	21(17-30.25)	0.262
Respiratory_rate_min (mean±std)	21.11±5.8	20.46±4.65	22.74±8.08	
Sistolik_TA(median 25-75)	123(100-142.75)	125.5(110-155.25)	105(91.50-130.25)	**<0.001**
Sistolik_TA (mean±std)	124.68±31.15	130.76±30.75	109.31±26.83	
Diastolik_TA(median 25-75)	74(60.25-87)	76.5(65-90)	69.50(54.75-80)	**0.008**
Diastolik_TA(mean±std)	74.30±18.12	76.79±17.8	68±17.6	
Comorbidities				
Hypertension	60(40.54%)	18(16.98%)	42(100%)	0.71
Diabetes Mellitus	26(17.56%)	18(16,98)	8(19.04%)	0.81
Chronic Obstructive Pulmonary Disease	17(11.48%)	14(13.2%)	3(7.14%)	0.39
Coronary artery disease	24(16.21%)	18(16.98%)	6(14.28%)	0.8
Congestive Heart Failure	12(8.1%)	5(4.71%)	7(16.6%)	**0.03**
cerebrovascular disease	25(16.89%)	14(13.20%)	11(26.19%)	0.08
Chronic Renal Failure	1(0.67%)	0	1(2.38%)	0.28
Malignancy	33(22.29%)	19(17.92%)	14(33.3%)	**0.05**
History of surgery	21(14.18%)	16(15.09%)	5(11.9%)	0.79
History of deep vein thrombosis	12(8.1%)	8(7.54%)	4(9.52%)	0.74
Anticoagulant use	36(24.32%)	21(19.81%)	15(35.71%)	0.05
Symptoms				
Syncope	40(27.02%)	29(27.35%)	11(26.19%)	1
Shortness of breath	84(56.75%)	60(56.6%)	24(57.14%)	1
Chest pain	25(16.89%)	20(18.86%)	5(11.9%)	0.46
Back pain	2(1.35%)	1(0.94%)	1(2.38%)	0.48
Hemoptysis	6(4.05)	4(3.77%)	2(4.76%)	1
Deep vein thrombosis	15(10.13%)	9(8.49%)	6(14.28%)	0.36
Weakness	35(23.64%)	27(25.47%)	8(19,4%)	0.52
Clinical outcome				**<0.001**
Discharge	4(2.7%)	4(3.77%)	0	
Ward admission	96(64.86%)	89(83.96%)	7(16.6%)	
Intensive care hospitalization	48(32.43%)	13(12.26%)	35(83.33%)	

in patients with a pulmonary embolism and were insufficient in determining prognosis. There is no significant superiority between low saturation and high BUN. Many diseases have been the subject of research in terms of the effects of kidney function tests on prognosis and mortality [10,11]. In a study conducted in patients who developed shock due to acute myocardial infarction, there was an increase in BUN and creatinine levels in the non-surviving group; renal blood flow was decreased [10]. In a study examining ischemic stroke patients, there was no statistically significant difference in terms of this and creatinine levels in patients who developed venous thromboembolism and those who did not develop venous thromboembolism. The logistic regression analysis predicted that the BUN/creatinine ratio may be an independent risk factor in ischemic stroke patients who develop venous thromboembolism [11].

Different results were obtained regarding BUN, creatinine, and potassium in pulmonary embolism studies. In a multicentric prospective study, a statistically significant correlation was found between renal dysfunction and mortality in patients diagnosed with acute pulmonary embolism [12]. In a study examining patients with a diagnosis of venous thromboembolism, the urea level was significantly higher in the mortal patient group [13]. In a retrospective study examining 252 patients with pulmonary embolism who received thrombolytic therapy, mortality, need for inotropic therapy, and development of cardiogenic shock were statistically significantly higher in the patient group with high BUN levels upon admission [2]. In our study, the rate of patients given thrombolytic therapy was 6.75%, and there was no statistically significant relationship between thrombolytic therapy and mortality.

Our study found that high creatinine did not affect prognosis. In a study of 206 pulmonary embolism patients high creatinine associated with mortality [14]. In a prospective study in which Kostrubiec et al. examined renal functions in acute pulmonary embolism, they examined 2,845 patients with a mean age of 67±18 years, and a statistically significant

Table 2 Relationship between blood gas, kidney function tests, ECG and ECO findings with mortality

	Total	Survivor	Non-survivor	p value
PH(median 25-75)	7.41(7.36-7.46)	7.41(7.38-7.46)	7.37(7.29-7.44)	**0.029**
PH(mean±std)	7.39±0.1	4.40±0.06	7.35±0.14	
PCO2(median 25-75)	38.4(32.32-43.9)	38.2(31.9-43.65)	39.3(33.3-46.22)	0.272
PCO2(mean±std)	38.84±9.15	38.09±8.47	40.75±10.56	
saturation(median 25-75)	90(85-95)	91(86.75-95)	86.50(82-92)	**0.001**
saturation% (mean±std)	89±7.11	90.32±6.2	85.67±8.19	
Glucose(mmol/l)(median 25-75)	147(116-199.75)	146(117.5-190.25)	152.50(115-230.25)	0.81
Glucose(mmol/l)(mean±std)	167.54±74.93	163.30±62.93	178.26±99.11	
BUN(mg/dl)(median 25-75)	49.2(38.5- 70.45)	47.08(36.38-57.78)	70.31(40.66-94.69)	**0.001**
BUN(mg/dl)(mean±std)	59.41±34.49	52.62±25.21	76.53±47.11	
Creatinine(mg/dl)(median 25-75)	0.99(0.82-1.18)	0.97(0.82-1.17)	1.06(0.81-1.22)	0.252
Creatinine(mg/dl) (mean±std)	1.08±0.44	1.04±0.38	1.17±0.55	
Sodium(mEq/L)(median 25-75)	138(134-140)	138(135-140)	136.50(132.75-143)	0.991
Sodium(mEq/L)(mean±std)	137.63±5.68	137.25±4.09	138.6±8.46	
Potassium(mEq/L)(median 25-75)	4.3(4-4.8)	4.3(4-4.8)	4.25(4-4.9)	0.886
Potassium(mEq/L)(mean±std)	4.36±0.64	4.35±0.63	4.40±0.66	
ECG finding				0.003*
Sinus rhythm	72(48.6%)	58(54.7%)	14(33.3%)	
ST depression	44(29.7%)	31(29.2%)	13(31%)	
Sinus tachycardia	3(2%)	0(0%)	3(7.1%)	
Atrial fibrillation	16(10.8%)	6(5.7%)	10(23.8%)	
T negativity	4(2.7%)	3(2.8%)	1(2.4%)	
Left bundle branch block	1(0.7%)	1(0.9%)	0(%0)	
Right bundle branch block	4(2.7%)	4(3.8%)	0(%0)	
S1Q3T3	4(2.7%)	3(2.8%)	1(2.4%)	
EKO finding	72(48.64%)	48(45.28%)	24(57.14%)	0.20
Thrombolytic therapy	10(6.75%)	6(5.66%)	4(9.52%)	0.47
PESI class	4(3-5)	4(3-4.25)	5(4-5)	**<0.001**
sPESI	2(1-3)	2(1-2.25)	2(1-3)	**0.006**
sPESI risk				0.068
low risk	15(10.1%)	14(13.2%)	1(2.4%)	
high risk	133(89.9%)	92(86.8%)	41(97.6%)	
Length of hospital stay	6.5(4-9)	7(4-10)	5(3-8)	0.095

*BUN, blood urea nitrogen; ECG, electrocardiography; PESI,pulmonary embolism severity index; sPESI, simplified pulmonary embolism severity index

correlation was found between high creatinine and mortality [6]. In a retrospective study conducted in patients diagnosed with normotensive pulmonary embolism, BUN and creatinine values were significantly higher in patients with a poor prognosis [15]. Babaoğlu et al. determined that the serious increase in urea and creatinine levels in patients with a pulmonary embolism increased the risk of mortality. While there was no statistically significant difference in sodium values in low-risk and high-risk pulmonary embolism patients, similar to our study. Unlike in our study, Babaoğlu et al.'s study showed potassium values that were statistically significantly higher in patients with high-risk pulmonary embolism [5].

Our study supported the premise that BUN could predict the prognosis, as previous studies similarly found. However, the relationship between creatinine and prognosis is different than in the literature. We think that BUN should be more prominent in disease management in terms of results that are obtained from geriatric patients. The use of drugs that regulate renal functions due to comorbid diseases may also have caused this result. In our study, hypertension was the most common comorbid disease; there was only a statistically significant correlation between congestive heart failure and malignancy and mortality. In a retrospective study, Fabian et al. determined a statistically significant relationship between comorbidities such as hypertension, diabetes mellitus, peripheral vascular disease, and mortality in patients diagnosed with pulmonary embolism [16]. They found that there was no statistically significant relationship between patients with chronic renal failure and end-stage renal disease and mortality [16]. In a meta-analysis by Xing et al., a significant correlation was found between acute renal failure and mortality in patients diagnosed with pulmonary embolism; they did not find a statistically significant relationship between chronic renal failure and mortality [17]. In our study, PESI and sPESI values were also able to predict mortality in accordance with the literature [9,18,19]. While sinus tachycardia is most common in electrocardiography, sinus tachycardia was the most common in the mortal group. There was no significant correlation with mortality in patients with pulmonary embolism echocardiographic findings. This showed that pulmonary embolism requires more careful management, especially in geriatric patients.

Limitations

In our study, full data of a certain number of patients were available, and the study only included clinical findings at first admission. The patients' 30-day mortality data and hospital stay were reached, and the patient's quality of life at hospital discharge was not recorded.

Conclusion

The effect of kidney function tests on the prognosis is very important in managing pulmonary embolism. BUN will be more beneficial to the clinician than creatinine and plasma electrolytes in the management of patients with pulmonary embolism.

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