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EVALUATION OF MORTALITY RISK WITH CURB-65 AND PSI IN PATIENTS WITH AND WITHOUT GERIATRIC COVID-19 PNEUMONIA

GERİATRİK COVID-19 PNÖMONİSİ OLAN VE OLMAYAN HASTALARDA CURB-65 VE PSI İLE MORTALİTE RİSKİNİN DEĞERLENDİRİLMESİ

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Abstract

Aim: The evaluation and management of pneumonia resulting from the infections of coronavirus disease 2019 (COVID-19) urgently require assessing disease severity to decide on the hospital admission and determine the therapeutic needs and options. This study compared the effectiveness of the CURB-65 scoring system and pneumonia severity index (PSI) to evaluate the mortality risk in the geriatric group having COVID-19 pneumonia and with other non-COVID-19 pneumonia.

Methods: 527 patients in ages 65 years or older, whose computerized tomography scans showed ground glass densities, were selected among 21,134 patients who applied for laboratory confirmation of COVID-19. All demographic, clinical, and laboratory data were retrospectively scanned, and selected patients having COVID-19 pneumonia or non-COVID-19 pneumonia were followed up.

Results: The overall mortality rate among all patients was 25.6%, the ratio of the patients having COVID-19 pneumonia was 14.3%, and the ratio of patients having non-COVID-19 pneumonia was 29.2%. ROC analysis showed that PSI>group III among COVID-19 patients had an effective discriminative effectiveness in predicting mortality with 77.8% sensitivity, 73.2% specificity, PPV 32.6%, NPV 95.2% (AUC:0.800, 95% CI: 0.720–0.866; P<0.0001). In predicting mortality in COVID-19 pneumonia patients with a CURB-65 score >2, sensitivity was 66.7%, PPV 60% specificity, and NPV 94.3% (AUC: 0.857, 95% CI: 0.783–0.913; P<0.0001).

Conclusions: For pneumonia patients with a PSI score greater than three and CURB-65 score greater than two, COVID-19 and non-COVID-19 infections are powerful scores in predicting mortality. Each scoring system has its advantages in stratifying geriatric patients on admission and hospitalization.

Keywords: COVID-19, CURB-65, geriatric, pneumonia, pneumonia severity index, mortality

Öz

Amaç: 2019 koronavirüs hastalığı (COVID-19) enfeksiyonlarından kaynaklanan pnömoninin değerlendirilmesi, yönetimi, hastaneye kabule karar vermek, terapötik ihtiyaçları ve seçenekleri belirlemek için acilen hastalık şiddetinin değerlendirilmesi gerektirmektedir. Bu çalışma, COVID-19 pnömonisi olan geriatrik grupta ve diğer COVID-19 olmayan pnömonilerle mortalite riskini değerlendirmek için CURB-65 skorlama sistemi ve pnömoni şiddet indeksinin (PSI) etkinliğini karşılaştırdı.

Yöntemler: COVID-19 laboratuvar teyidi için başvuran 21.134 hasta arasından, bilgisayarlı tomografi taramalarında buzlu cam yoğunlukları görülen 65 yaş ve üzeri 527 hasta seçildi. Tüm demografik, klinik ve laboratuvar verileri retrospektif olarak tarandı ve COVID-19 pnömonisi olan veya COVID-19 dışı pnömonisi olan hastalar seçilip takip edildi.

Bulgular: Tüm hastalar arasında genel ölüm oranı %25,6, COVID-19 pnömonisi olan hastalarda oran %14,3 ve COVID-19 dışı pnömonisi olan hastalarda oran %29,2 idi. ROC analizi, COVID-19 hastaları arasında PSI>grup III'ün mortaliteyi tahmin etmede %77,8 duyarlılık, %73,2 özgüllük, %32,6 PPV, %95,2 NPV'idi. (AUC:0,800, %95 GA: 0,720-0,866; P<0,0001).

CURB-65 skoru >2 olan COVID-19 pnömoni hastalarında mortaliteyi tahmin etmede duyarlılık %66,7, PPV %60 özgüllük ve NPV %94,3 idi. (EAA: 0,857, %95 GA: 0,783–0,913; P<0,0001).

Sonuç: PSI skoru üçten büyük ve CURB-65 skoru ikiden büyük olan COVID-19 ve COVID-19 olmayan enfeksiyonlara sahip pnömoni hastaları için mortalite tahmininde güçlü skorlamalardır. Geriatrik hastaların kabul ve yatışlarına göre sınıflandırılmasında her bir skorlama sisteminin avantajları vardır.

Anahtar Kelimeler: COVID-19, CURB-65, geriatri, pnömoni; pnömoni şiddet indeksi, mortalite

Introduction

The severe acute respiratory syndrome known as SARS-CoV-2 resulted in the recent coronavirus disease 2019 (COVID-19), turning into a worldwide pandemic in a short period. According to the recent data reported by the World Health Organization (WHO), starting on February 25, 2022, there were roughly 428,5 million confirmed cases and 5,9 million deaths[1]. One of the major problems in the combat against COVID-19 is the lack of a feasible risk scale to use in prognosis, which could alleviate the burden of such settings as primary care or general practice[2].

The evaluation and management of pneumonia due to viral infections urgently require assessing the disease severity to decide on admission or hospitalization in inpatient services or intensive care units (ICU) and determine the therapeutic needs and options. The high prevalence of COVID-19, especially in Turkey with a comprehensive healthcare system giving a medical treatment free of charge for all residents during the outbreak, requires a simple scoring system to quickly triage severe patients[3]. One of these systems, the pneumonia severity index (PSI), scores and classifies patients having pneumonia into five groups in line with their features and risk of mortality[4]. Despite yielding a detailed, precise classification of severity with the calculating a score using 20 variables, PSI is not likely to be efficiently used as a routine application in emergency rooms or primary care for which time effectiveness is of due significance. Moreover, this index is suggested to evaluate outpatients with a low mortality risk rather than in-patients having pneumonia in severe degrees when they are admitted to the hospital[5].

Another scoring system, the CURB-65 score, is commonly used in management of community-acquired pneumonia (CAP), including five parameters which can be easily obtained: namely, age, blood pressure, confusion, blood urea nitrogen (BUN), and rate of respiration[6]. CURB-65 has also been beneficial in effectively predicting the clinical results of CAP by viral infection and 14-day mortality for hospital-acquired pneumonia[7,8].

Besides these scoring systems, prognostic factors, including the presence of comorbidities, age and gender have also been cited as a having correlation with the severity and mortality in COVID-19 infection[5,9]. The guidelines of Turkish Ministry of Health orders that any possible patient in age 50 and over having any comorbidities must be categorized as eligible for hospitalization regardless of computed tomography (CT) findings, vital signs and laboratory results[10]. Thus, these criteria for admission and hospitalization includes a high number COVID-19 patients, which may result in an additional burden for the healthcare system and health professionals during the outbreak[3]. Therefore, a practical scoring system such as PSI or CURB-65 should first be implemented in geriatric patients to diminish the burden of hospitalization. However, age may play a role in mortality. A recent report about some clinical manifestations of cases with COVID-19 including not only elderly but also young patients indicated PSI scores were found to be higher in the former in comparison to the latter group[11]. Another study reported that older patients having a CURB-65 score of 2 or above could not survive COVID-19 infection compared with young patients. Nevertheless, these predictive criteria sets have not been compared for geriatric patients having COVID-19. As such, the present study compared the CURB-65 and PSI ability to evaluate the mortality risks of geriatric patients with pneumonia resulting from COVID-19 and non- COVID-19 infections.

Materials and Methods

- *Study Design and Patients*

The present study designed in retrospective manner was conducted in a tertiary hospital (Antalya, Turkey), a designated tertiary hospital fully equipped for COVID-19 patients. Totally 1,886 elderly patients (ages 65 or older) were selected from 21,134 patients who applied for laboratory confirmation of COVID-19 by real-time reverse transcription-polymerase chain reaction (real-time RT–PCR) test and computerized tomography (CT) for a timeline from March 11, 2020, (the date of the first case reported in Turkey) to August 25, 2020. The WHO interim guidance was utilized as the diagnostic criteria of COVID-19, confirmed through RT-PCR detection of the SARS-CoV-2 in an onsite clinical laboratory[12]. 527 participants whose CT scans showed ground glass densities consistent with COVID-19 pneumonia comprised the study group (Fig. 1).

126 patients having positive RT-PCR obtained from nasopharyngeal swab were clustered as COVID-19 pneumonia, and 401 patients with negative results were clustered as non-covid-19 pneumonia. Patients under age 65, patients whose thoracic CT scans did not show any ground glass densities, patients whose findings showed no suspicion of pneumonia (negative CT scan), and patients whose findings exhibited no suspicion of COVID-19 infection were excluded from the study.

The present study received approval; the requirement for informed consent was waived by the Ethics Commission of Antalya Training and Research Hospital (No: 2020-256- l3/8 Date: August 27, 2020). This study was carried out in line with the Declaration of Helsinki.

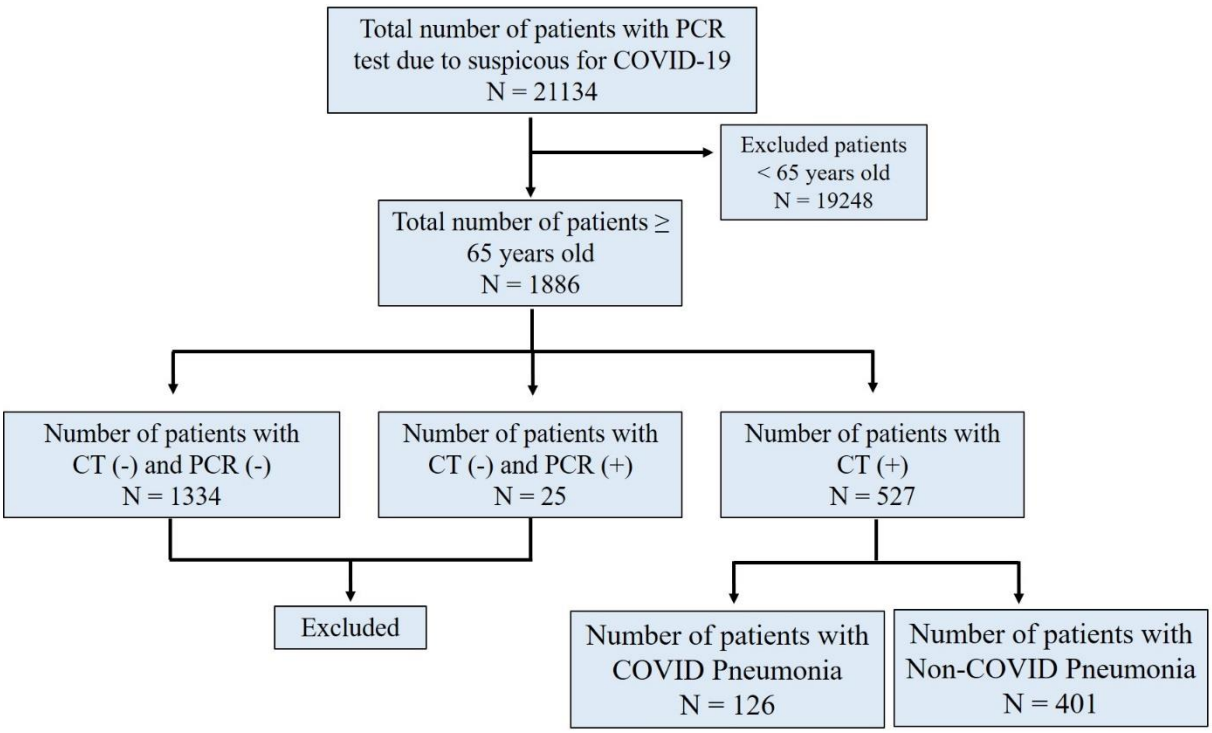

Figure 1. The flow chart of selection of the patients for the study

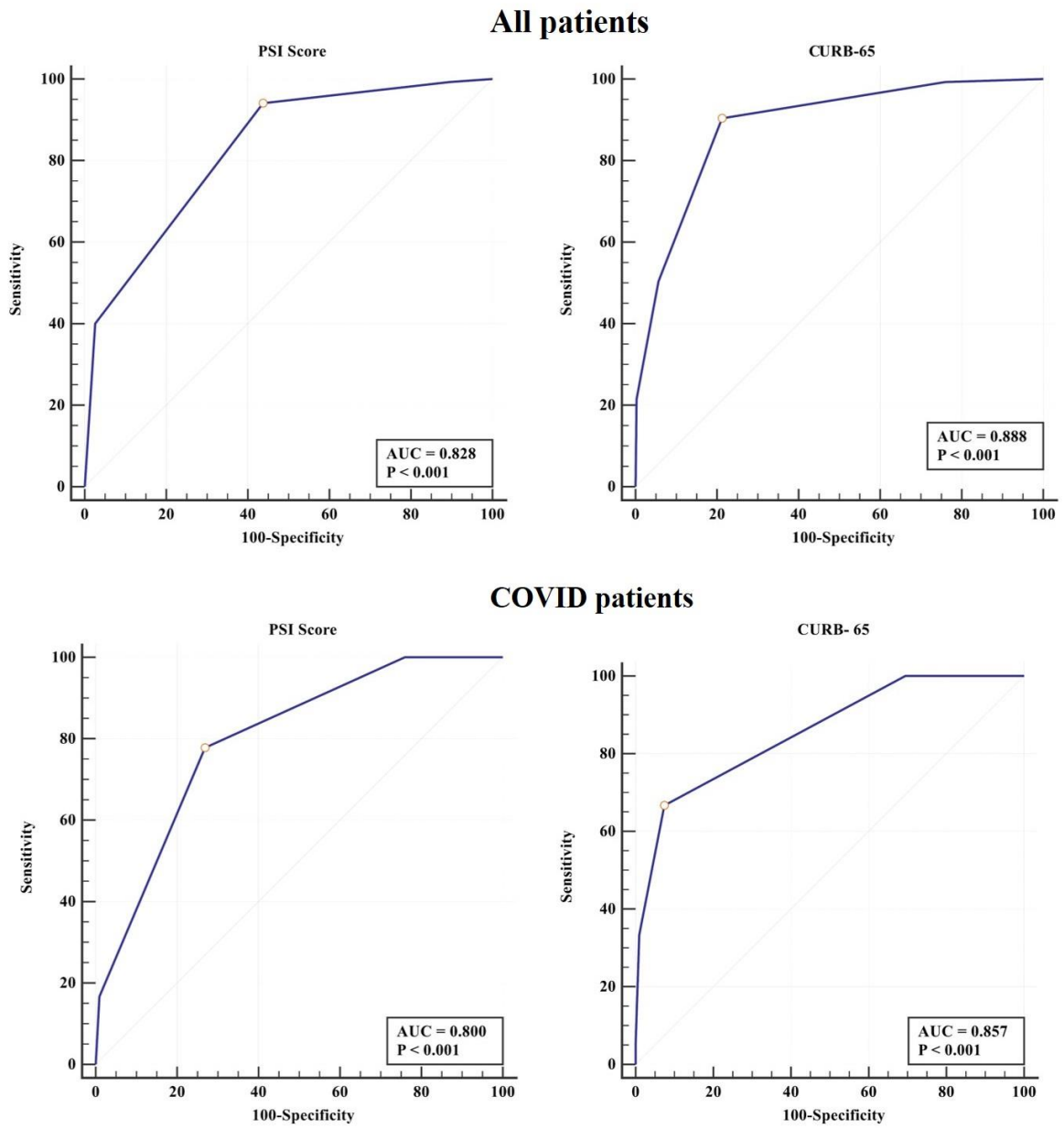

Figure 2. Receiver operator characteristic (ROC) curves for the PSI and CURB-65 scores to predict the mortality among all patients and COVID-19 patients (AUC: Area under curve)

- *Data collection*

All demographic data, presenting symptoms, comorbidities, triage vital signs (including blood pressure, fever, oxygen saturation at rest, respiratory and heart rate), clinical and laboratory data collected at the first admission of the patients, and resulting data were obtained from electronic medical records through a standardized data collection form. The data were controlled by two physicians, and another expert reevaluated possible differences in evaluation between the two reviewers.

The initial outcome was the type of pneumonia, classified as either due to COVID-19 infection or to other infections, including bacteria or other viruses. As the severity scores for pneumonia, PSI and CURB-65 scores collected at hospital admission were calculated. The CURB-65 comprises five variables (with 1 point

attributed for each item): new-onset confusion; urea >7 mmol/L; respiratory rate ≥30/minute, systolic blood pressure <90 mmHg and/or diastolic blood pressure ≤60 mmHg, and age ≥65 years, all criteria were defined in line with the related literature[13]. PSI scores were categorized into groups I, II, III, IV, and V, according to the literature[3].

- *Laboratory assay and scanning*

According to the clinical examination findings, nasopharyngeal swabs were obtained from 527 patients suspected of SARS-CoV-2 infection for the RT-PCR test. The samples were stored at 2–8°C for up to 72 hours after collection. The technique and its safety requirements were in accordance with the literature[14].
A CT scanner (Canon Aquilion Lightning 160 slice/80 detector row Ultra Helical CT) was used for thoracic CT scanning of the patients with pneumonia findings on clinical examination.
Blood samples were obtained right after their admission to conduct usual laboratory tests. All evaluations were conducted within 2 hours after the collection of blood samples. In the evaluation of the nasopharyngeal swabs and blood samples, only the samples collected in admission were utilized.

- *Hospitalization and Treatments*

In line with the regulations of the Turkish Ministry of Health, suspected patients over 65 years old with a comorbidity (e.g., hypertension, chronic renal disease, diabetes, mellitus, cardiopulmonary disease, immunosuppressive/immunomodulatory conditions, or malignancy) or with tachypnea (respiratory rate >22/min), tachycardia (pulse >125/min), hypoxemia (Spo2 <93%), hypotension (<90/60 mmHg) were admitted to the hospital[10] .
The COVID-19 Diagnosis and Treatment Protocol, established by the Turkish Ministry of Health, was used to treat all of the hospitalized patients[10].

- *Statistical Analysis*

Chi-square test was utilized to evaluate the categorical variables, and the Mann-Whitney U test was utilized to evaluate the continuous variables. The Spearman Rank Correlation was performed to determine the correlation between the two continuous variables. These statistical analyses were conducted using the GraphPad InStat Version 3.6. $P<0.05$ was accepted as statistically significant.
In order to determine the cut-off value for PSI and CURB-65 scores for predictions of patients' mortality, Number Cruncher Statistical System 2007 (NCSS, Kaysville, Utah, USA) program was utilized. Diagnostic screening tests (sensitivity, specificity, PPV, NPV) were used, and receiver operating characteristic (ROC) curve analyses were plotted using each of the following disease severity measures as predictors of mortality to calculate the cut-off for the parameters. $P<0.001$ level was accepted as significant.

Results

- *Demographic, Clinical, and Laboratory Findings*

Totally, 527 patients were included in the research. The mean age was 75.2 ± 7.9 years. ($P <0.0001$). 60.3% of the patients were male and the groups exhibited significant differences according to the pneumonia type ($P = 0.0279$).
The mean systolic blood pressure (SBP), oxygen saturation (SpO2), and Glasgow coma score (GCS) were all significantly higher; alternatively, the respiratory rate was lower in patients having COVID-19 pneumonia in comparison to non-COVID-19 patients ($P<0.01$). The comparison of the

Table 1. Demographic and clinical features of the patients in comparison to the type of pneumonia

Variable	Total N = 527	COVID-19 N = 126	NON-COVID-19 N = 401	P value
Age (year), Mean±SD	75.2 ± 7.9	72.2 ± 6.9	76.1 ± 8.0	<0.0001
Gender, n (%)				
• Male	318 (60.3)	65 (51.6)	253 (63.1)	0.0279
• Female	209 (39.7)	61 (48.4)	148 (36.9)	
Comorbidities, n (%)				
• Hypertension	382 (72.5)	93 (73.8)	289 (72.1)	0.789
• Diabetes Mellitus	206 (39.1)	53 (42.1)	153 (38.2)	0.497
• COPD/Asthma/Bronchitis	168 (31.9)	23 (18.3)	145 (39.2)	0.0003
• Malignity	95 (18.0)	7 (5.6)	88 (21.9)	<0.0001
• Cardiovascular diseases	212 (40.2)	32 (25.4)	180 (44.9)	0.0002
• Cerebrovascular diseases	123 (23.3)	13 (10.3)	110 (27.4)	0.0001
• Chronic renal failure	67 (12.7)	8 (6.3)	59 (14.7)	0.0212
• Chronic liver disease	18 (3.4)	4 (3.2)	14 (3.5)	0.864
• Coronary Failure	76 (14.4)	7 (5.6)	69 (17.2)	0.0019
Symptoms at diagnosis, n (%)				
• Fever	311 (59.0)	85 (67.5)	226 (56.4)	0.0352
• Malaise	337 (63.9)	113 (89.7)	224 (55.9)	<0.0001
• Dry cough	269 (51.0)	83 (65.9)	186 (46.4)	0.0002
• Sore throat	232 (44.0)	91 (72.2)	141 (35.2)	<0.0001
• Dyspnea	360 (68.3)	74 (58.7)	286 (71.3)	0.0111
• Chest pain	53 (10.1)	9 (7.1)	44 (11.0)	0.282
• Headache	47 (8.9)	16 (12.7)	31 (7.7)	0.127
• Dizziness	39 (7.4)	12 (9.5)	27 (6.7)	0.396
• Diarrhea	22(4.2)	8 (6.3)	14 (3.5)	0.253
• Nausea	46 (8.7)	18 (14.3)	28 (7.0)	0.0186
• Myalgia	122 (23.1)	72 (57.1)	50 (12.5)	<0.0001
• Purulent sputum	512 (97.2)	122 (96.8)	390 (97.3)	0.799
Clinical Findings, Mean±SD				
• Fever °C	37.3 ± 0.7	37.4 ± 0.7	37.4 ± 0.6	0.056
• Pulse	93.3 ± 18.8	94.2 ± 16.7	93.0 ± 19.5	0.234
• SBP mmHg	116.2 ± 20.5	121.4 ± 18.4	114.6 ± 20.9	0.0013
• DBP mmHg	69.2 ± 12.4	70.8 ± 11.2	68.7 ± 12.7	0.125
• Respiratory rate /min	24.7 ± 4.2	23.5 ± 3.5	25.0 ± 4.3	0.0005
• SpO_2 (%)	92.6 ± 6.1	94.5 ± 4.5	91.9 ± 6.4	<0.0001
• GCS	14.5 ± 1.5	14.9 ± 0.4	14.4 ± 1.7	0.0018

SD: Standard deviation, SBP: Systolic blood pressure, DBP: diastolic blood pressure, SpO2: Oxygen saturation, COPD: Chronic obstructive pulmonary disease, GCS: Glasgow Coma Scale

Table 2. Laboratory findings of the patients in comparison to the type of pneumonia

Parameters	Total N = 527	COVID-19 N = 126	NON-COVID-19 N = 401	P value
Blood groups				
• A	96 (18.2)	24 (19.0)	72 (18.0)	<0.0001
• AB	13 (2.5)	3 (2.4)	33 (8.2)	0.081
• B	41 (7.8)	8 (6.3)	10 (2.5)	0.0207
• 0	79 (15.0)	12 (9.5)	67 (16.7)	0.201
Undefined	322 (61.1)	81 (64.3)	219 (54.6)	
Rh				
• Negative	25 (4.7)	9 (7.1)	16 (4.0)	
• Positive	204 (38.7)	38 (30.2)	166 (41.4)	0.077
Glucose (mg/dL)	154.9 ± 89.5	140.5 ± 67.6	159.5 ± 95.1	0.0056
Renal Functional Tests				
• BUN (mg/dL)	29.6 ± 21.7	22.9 ± 12.1	31.7 ± 23.6	0.0001
• Creatinine (mg/dL)	1.3 ± 0.9	1.15 ± 0.7	1.36 ± 0.97	0.112
Na (mmol/L)	136.2 ± 6.4	135.8 ± 3.7	136.3 ± 7.0	0.824
K (mmol/L)	4.4 ± 5.9	5.2 ± 11.7	4.2 ± 0.6	0.730
Liver Metabolism				
• ALT (U/L)	40.0 ± 167.4	27.8 ± 19.1	44.0 ± 192.2	0.0041
• AST (U/L)	58.2 ± 279.8	35.7 ± 18.2	65.6 ± 321.9	0.0004
• CK (U/L)	162.3 ± 338.3	146.1 ± 145.6	166.5 ± 372.3	0.072
• CK-MB (U/L)	23.9 ± 26.2	22.0 ± 29.5	24.7 ± 24.6	0.0278
• Total bilirubin (mg/dL)	0.98 ± 2.1	0.6 ± 0.3	1.08 ± 2.4	0.0027
• Direct bilirubin (mg/dL)	0.35 ± 1.1	0.17 ± 0.1	0.39 ± 1.3	0.0357
CRP (mg/L)	79.2 ± 89	67.7 ± 72.9	82.9 ± 93.4	0.834
Total Blood Counts				
• WBC (103/mm3)	10.9 ± 8.3	6.5 ± 3.5	12.3 ± 8.9	<0.0001
• HBG (g/dL)	11.8 ± 2.3	12.5 ± 1.7	11.6 ± 2.4	<0.0001
• HTC (%)	36.0 ± 6.8	37.4 ± 4.5	35.6 ± 7.4	0.001
• PLT (103/mm3)	242.2 ± 115.8	217.5 ± 87.9	250.3 ± 122.5	0.0007
• PLR	210.7 ± 143.2	262.1 ± 159.3	206.2 ± 141.2	0.105
• NEU (103/mm3)	8.7 ± 8.9	4.6 ± 3.4	9.97 ± 9.7	<0.0001
• LYM (103/mm3)	1.9 ± 2.6	1.27 ± 0.5	2.04 ± 3.0	0.084
• MON (103/mm3)	1.0 ± 2.3	0.58 ± 0.3	1.13 ± 2.6	<0.0001
• NLR	8.4 ± 11.6	4.8 ± 6.0	9.5 ± 12.7	<0.0001
• LMR	2.8 ± 5.6	2.56 ± 1.5	2.9 ± 6.4	0.0012
Troponin T (ng\L)	91.6 ± 419.4	19.2 ± 43.8	119.8 ± 490.8	<0.0001
Procalcitonin (ng/ml)	10.1 ± 79.9	0.75 ± 2.3	12.5 ± 89.7	0.0211
Myoglobulin (ng/ml)	143.8 ± 364.2	122.9 ± 210.9	156.4 ± 432.3	0.519
Clothing Metabolism				
• aPTT (sec)	31.5 ± 9.4	30.5 ± 4.2	31.9 ± 10.8	0.928
• PT (sec)	14.6 ± 7.7	12.7 ± 2.4	15.3 ± 8.9	<0.0001
• INR	1.3 ± 0.8	1.1 ± 0.2	1.4 ± 0.98	<0.0001
• D-dimer (µg/L)	1213.8 ± 3611.2	466.2 ± 709.1	1526.0 ± 4238.9	<0.0001
Sedimentation (mm/h)	48.4 ± 80.9	46.3 ± 43.6	49.5 ± 94.2	0.405
Fibrinogen (mg/dL)	493.5 ± 211.0	471.9 ± 178.3	505.5 ± 226.9	0.446
Iron (µg/L)	31.6 ± 23.4	27.9 ± 15.6	32.8 ± 25.4	0.955
Ferritin (µg/L)	291.1 ± 449.3	223.5 ± 216.4	314.2 ± 634.4	0.689
TIBC (µg/L)	267.9 ± 133.5	295.8 ± 111.5	258.9 ± 139.3	0.0151
Blood Gas Parameters				
• pH	7.4 ± 0.1	7.4 ± 0.06	7.4 ± 0.1	0.228
• PaCO2 (mm Hg)	39.5 ± 9.8	36.0 ± 9.8	40.0 ± 9.8	0.0229
• PaO2 (mm Hg)	66.3 ± 10.9	71.0 ± 9.7	64.8 ± 10.9	<0.0001
• HCO3 (mmol/L)	22.6 ± 4.3	22.3 ± 3.5	22.6 ± 4.4	0.813
• Lactate (mmol/L)	2.36 ± 1.9	1.75 ± 0.7	2.5 ± 1.98	0.198

All parameters are given as mean ± standard deviation.

BUN: Blood urea nitrogen, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, CK: Creatinine kinase, CK-MB: Creatinine kinase isoenzyme MB, CRP: C reactive protein, WBC: White blood cells, HBG: Hemoglobin, HTC: Hematocrit, PLT: Platelets, PLR: Platelet/lymphocyte ratio, LYM: Lymphocyte, NEU: Neutrophil, MON: Monocyte, LMR: Lymphocyte/Monocyte, NLR: Neutrophil/Lymphocyte ratio, aPTT: activated partial prothrombin time, PT: Prothrombin time, INR: international normalized ratio, TIBC: Total Iron Binding Capacity, ABG: Arterial Blood Gases

patients in terms of their demographic and clinical features can be seen in Table 1.
Type A was the most common blood type among all patients, and the percentage of COVID-19 patients having the A-type was significantly higher in comparison to those of non-COVID-19 patients (P<0.0001).
Among renal functional tests, the mean concentration of blood urea nitrogen (BUN) of COVID-19 patients was significantly higher in comparison to those of non-COVID-19 ones (P<0.001). Nearly all parameters of liver metabolism (i.e., liver enzymes), except for creatine kinase, were significantly lower among COVID-19 patients (P<0.05). The difference between the mean CRP was not statistically significant among the groups (P=0.834). The laboratory findings showed that the mean glucose level in COVID-19 patients was significantly higher than in non-COVID-19 patients (P<0.01). The parameters of total blood counts, including white blood cells (WBC), hematocrit (HTC), platelets (PLT), neutrophil (NEU), monocyte (MON), Neutrophil/Lymphocyte ratio, were significantly lower among COVID-19 patients compared with those of non-COVID-19 patients (P<0.001). Troponin T and procalcitonin levels were also lower among COVID-19 patients (P<0.0001 and P=0.0211, respectively).
Almost all parameters of clotting as prothrombin time (PT), international normalized ratio (INR), D-dimer, were far lower among COVID-19 patients compared with those of non-COVID-19 patients (P<0.0001). Among blood gas parameters, the mean PaCO2 was significantly lower (P=0.0229), while PaO2 was significantly higher among COVID-19 patients in comparison to non-COVID-19 ones (P<0.0001; Table 2).

- *Follow-up Outcomes*

From the 527 patients who were admitted to the hospital, 94 (21.7%) were transferred to their house for containment after their treatment in emergency department. According to the instructions of the Ministry of Health of Turkey, 94 patients with COVID-19 clinical symptoms and ground glass density detected in CT scans were taken into isolation at home so that their treatments and clinical course were closely followed. (Table 3). The mortality rates among non-COVID-19 patients were higher among those hospitalized directly in ICU. Mean duration of hospitalization in inpatient settings was significantly longer among patients having non-COVID-19 pneumonia than those having COVID-19 (P=0.0122). However, the mean duration in ICU of non-COVID-19 patients was shorter in comparison to those of COVID-19 patients (P=0.0028; Table 3). The COVID-19 and non-COVID-19 patients receiving oxygen therapy and surviving to discharge were significantly higher in number in comparison to the non-surviving patients who received the same therapy (P<0.0001).

- *Correlations with the mortality rates of patients with COVID-19 pneumonia*

Patients' age, symptoms at diagnosis including malaise and dyspnea, clinical findings including pulse, DBP, respiratory rate, SpO2 and GCS, Na levels, parameters of liver metabolism including creatine kinase isoenzyme MB (CK-MB) and direct bilirubin, CRP levels, total blood counts of WBC, NEU, LYM and MON, NLR and LMR, concentrations of troponin T, procalcitonin, myoglobulin, D-dimer, fibrinogen, blood gas parameters, and lactate were found to be significantly in correlation to the mortality rates among COVID-19 patients (P<0.05; Table 4).

- *PSI and CURB-65*

Patients were divided into five different groups in accordance with pneumonia severity ranging from I (no disease) to V (most severe) on the PSI and 1 to 5 on the CURB-65. Out of all the patients, 42

patients (7.97%) were categorized into group II, 186 (35.3%) were in group III, 234 (44.4%) in group IV, and 64 (12.1%) in group V (Table 3). The mortality rates among all patients for both types of pneumonia were dramatically higher in groups IV and V (P<0.0001). Non-COVID-19 patient's mortality rates in groups IV and V were significantly higher in comparison to the COVID-19 patients in the same groups (P<0.0001; Table 3). PSI scores also were significantly in correlation to the mortality rates of COVID-19 patients (P<0.0001; Table 5). ROC analysis showed that the PSI greater than group III among COVID-19 patients also had a good discriminative efficiency in predicting mortality with 77.8% sensitivity, 73.2% specificity, PPV of 32.6%, and NPV of 95.2% (AUC = 0.800, 95% CI 0.720 – 0.866; P<0.0001; Table 5; Fig. 2).

A total of 95 (18.0%) patients gave a CURB-65 score of 1, only one of whom (0.7%) died during follow-up. A CURB-65 score ≥2 was obtained in 432 patients (82.0%). Of these, 134 patients (25.4%) died during follow-up. CURB-65 scores were significantly in correlation to the mortality rates of COVID-19 patients (P<0.0001; Table 4).

ROC analysis showed a CURB-65 score of >2 among COVID-19 patients, having a discriminative effectiveness in predicting mortality with 66.7% sensitivity, 92.6% specificity, PPV of 60%, and a NPV of 94.3% (AUC: 0.857, 95% CI 0.783 – 0.913; P<0.0001; Table 5).

Discussion

COVID-19 associated mortality is a multifaceted entity, including myriad factors as the age and any underlying disease, which has resulted in a healthcare burden during the pandemic[15]. The present study evaluated and compared the efficiencies of two prognostic scoring systems in predicting mortality risks in a geriatric group of patients with pneumonia and compared the outcomes among patients having COVID-19 pneumonia or non-COVID-19 pneumonia (bacterial or viral pneumonia). These measures functioned reliably in both COVID-19 and Non-COVID-19 pneumonia. The average mortality rate among all patients was 25.6%; the rate among patients having COVID-19 pneumonia was 14.3%, and that of patients having non-COVID-19 pneumonia was 29.2%. PSI scores above III showed better sensitivity (77.8% vs. 66.7%) but lower specificity (73.2% vs. 92.6%) and PPV (32.6% vs. 60%) and a comparable NPV (96.2% vs. 94.3%) in predicting mortality among all patients compared with a CURB-65 score above 2.

In a meta-analysis for community-acquired pneumonia, the PSI and CURB-65 score systems were shown to have high negative predictive values in predicting mortality. Similar results were found in non-COVID-19 pneumonias in our study [16].

COVID-19 related mortality rate has been cited between 11.7% and 28.2% [9,17-20]. The mortality rates of geriatric patients having COVID-19 pneumonia in the present study (14.3%) were inconsistent with these reports, and Turkish reports, with a mortality rate between 2.1% and 19% [3,20-21].

This wide range in mortality rate may be due to differences in the demographic and clinical features of study groups, the hospitalization criteria, the treatment strategies, and the measures of mortality rates. On the other hand, ground-glass appearance can be seen in chronic interstitial lung diseases, acute alveolar diseases, cardiogenic edema as well as viral atypical pneumonias. This may be due to the older age, more frequent comorbidities, and worse clinical findings in respiratory rate and saturation in the non-COVID-19 group.

For patients with infection resulting from SARS-CoV-2, developing prognostic rating scales with the ability to yield consistent predictions is necessary[24].

Table 3. Treatments, follow-up and mortality scores of the patients in comparison to the type of pneumonia and the mortality

Parameters	Total N = 527			COVID-19 N = 126			NON-COVID-19 N = 401			P value*
Mortality, n (%)		135 (25.6)			18 (14.3)			117 (29.2)		0.0013
	Survivor N = 392	Mortality N = 135	P value	Survivor N = 108	Mortality N = 18	P value	Survivor N = 284	Mortality N = 117	P value	
Oxygen therapy, n (%)	148 (37.8)	129 (95.6)	<0.0001	25 (23.1)	17 (94.4)	<0.0001	123 (43.3)	112 (95.7)	<0.0001	<0.0001
Mechanic Ventilation, n (%)										
• Non-invasive	25 (6.4)	29 (21.5)	<0.0001	1 (0.9)	4 (22.2)	0.0003	24 (8.5)	25 (21.4)	0.0006	0.0126
• Invasive	17 (4.3)	108 (80)	<0.0001	5 (4.6)	14 (77.8)	<0.0001	12 (4.2)	94 (80.3)	<0.0001	0.0126
Endpoint, n (%)										
• Discharge from ES	93 (23.7)	1 (0.7)	<0.0001	33 (30.6)	0 (0)	0.0147	60 (21.1)	1 (0.9)	<0.0001	0.0075
• Hospitalization in service	251 (64.0)	57 (42.2)	<0.0001	72 (66.7)	13 (72.2)	0.846	179 (63.0)	44 (37.6)	<0.0001	0.0244
• ICU	47 (12.0)	77 (57.0)	<0.0001	3 (2.8)	5 (27.8)	0.0005	44 (15.5)	72 (61.5)	<0.0001	<0.0001
• Transfer to ICU	18 (4.6)	50 (37.0)	<0.0001	5 (4.6)	9 (50)	<0.0001	13 (4.6)	41 (35.0)	<0.0001	0.592
Duration (day)										
• In service	6.2 ± 4.1	8.2 ± 7.7	0.997	7.7 ± 4.3	5.3 ± 4.3	0.0199	6.1 ± 4.1	8.8 ± 8.1	0.248	0.0122
• In ICU	8.8 ± 10.7	10.99 ± 12.9	0.123	15.3 ± 10.6	15.3 ± 15.9	0.647	8.0 ± 10.5	10.4 ± 12.3	0.144	0.0028
PSI Score, n (%)										
• I	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)	0 (0)		
• II	41 (10.5)	1 (0.7)		26 (24.1)	0 (0)		15 (5.3)	1 (0.9)		
• III	179 (45.8)	7 (5.2)	<0.0001	53 (49.1)	4 (22.2)	<0.0001	126 (44.4)	3 (2.6)	<0.0001	<0.0001
• IV	161 (41.1)	73 (54.1)		28 (25.9)	11 (61.1)		133 (46.8)	62 (53.0)		
• V	10 (2.6)	54 (40)		1 (0.9)	3 (16.7)		9 (3.2)	51 (43.6)		
CURB-65										
• 1	94 (24.0)	1 (0.7)		33 (30.6)	0 (0)		61 (21.5)	1 (0.9)		
• 2	214 (54.6)	12 (8.9)	<0.0001	67 (62.0)	6 (33.3)	<0.0001	147 (51.8)	6 (5.1)	<0.0001	<0.0001
• 3	61 (15.6)	54 (40)		7 (6.5)	6 (33.3)		54 (19.0)	48 (41.0)		
• 4	21 (5.4)	39 (28.9)		1 (0.9)	5 (27.8)		20 (7.0)	34 (29.1)		
• 5	1 (0.3)	29 (21.5)		0 (0)	1 (5.6)		1 (0.4)	28 (23.9)		

ES: Emergency Service, ICU: Intensive care unit, PSI, Pneumonia Severity Index, CURB-65: 5-point score based on confusion, urea, respiratory rate, blood pressure, and age 65.
*Giving the comparison between all COVID patients and all Non-COVID patients regardless of the mortality

Table 4. Correlation of the demographic, clinical and laboratory findings of COVID-19 patients with the mortality rates

Variable	Spearman r	95% CI	P value
Age	0.287	0.113 – 0.444	0.0011
Gender	0.0584	-0.123 – 0.236	0.516
Symptoms at diagnosis			
• Fever	0.041	-0.140 – 0.220	0.645
• Malaise	-0.542	-0.811 – 0.086	0.0201
• Dry cough	-0.089	-0.265 – 0.093	0.323
• Sore throat	-0.051	-0.229 – 0.131	0.573
• Dyspnea	0.204	0.025 – 0.370	0.0219
• Chest pain	0.062	-0.120 – 0.240	0.492
• Headache	-0.088	-0.263 – 0.093	0.329
Clinical Findings			
• Fever °C	0.046	-0.136 – 0.224	0.612
• Pulse	0.249	0.072 – 0.411	0.005
• SBP mmHg	-0.100	-0.275 – 0.081	0.264
• DBP mmHg	-0.223	-0.387 – -0.045	0.0121
• Respiratory rate	0.261	0.085 – 0.421	0.0032
• SpO2	-0.406	-0.546 – -0.244	<0.0001
• GCS	-0.594	-0.699 – -0.463	<0.0001
CRP	0.394	0.232 – 0.534	<0.0001
Total Blood Counts			
• WBC	0.265	0.091 – 0.424	0.0033
• HBG	-0.062	-0.238 – 0.118	0.499
• HTC	-0.134	-0.310 – 0.051	0.144
• PLT	-0.032	-0.212 – 0.151	0.727
• PLR	0.270	-0.173– 0.622	0.212
• NEU	0.390	0.221 – 0.536	<0.0001
• LYM	-0.253	-0.417 – -0.073	0.0051
• MON	0.198	0.020 – 0.364	0.0295
• NLR	0.415	0.249 – 0.557	<0.0001
• LMR	-0.300	-0.458 – -0.123	0.0008
Troponin T	0.281	0.098 – 0.446	0.0023
Procalcitonin	0.342	0.071 – 0.566	0.0123
Myoglobulin	0.344	0.089 – 0.557	0.0076
CK-MB	0.286	0.025 – 0.511	0,028
D-dimer	0.283	-0.090 – 0.456	0.0036
Sedimentation	-0.025	-0.286 – 0.240	0.851
Fibrinogen	0.233	0.006 – 0.438	0.0385
Blood gas parameters			
• pH	-0.029	-0.141 – 0.366	0.887
• PaCO2	-0.267	-0.595 – 0.138	0.179
• PaO2	-0.139	-0.224 – 0.051	0.0015
• HCO3	-0.224	-0.565 – 0.182	0.262
• Lactate	0.630	0.246 – 0.843	0.0029
Endpoint	0.347	0.178 – 0.496	<0.0001
Transfer to ICU	0.479	0.299 – 0.626	<0.0001
Duration (day)			
• In service	-0.252	-0.443 – -0.039	0.0178
• In ICU	-0.108	-0.516 – 0.341	0.633
PSI Score	0.390	0.226 – 0.533	<0.0001
CURB-65 Score	0.488	0.337 – 0.614	<0.0001

BUN: Blood urea nitrogen, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, CK: Creatinine kinase, CK-MB: Creatinine kinase isoenzyme MB, CRP: C reactive protein, WBC: White blood cells, HBG: Hemoglobin, HTC: Hematocrit, PLT: Platelets, PLR: Platelet/lymphocyte ratio, LYM: Lymphocyte, NEU: Neutrophil, MON: Monocyte, NLR: Neutrophil/Lymphocyte ratio, aPTT: activated partial prothrombin time, PT: Prothrombin time, INR: international normalized ratio, TIBC: Total Iron Binding Capacity, ABG: Arterial Blood Gases

Table 5. Comparative scores of PSI and CURB-65 in predicting the mortality among all patients

Score		Cut-off	Sensitivity [95% CI]	Specificity [95% CI]	PPV [95% CI]	NPV [95% CI]	AUC [95% CI]	P value
All patients	PSI	>III	94.1 88.7 - 97.4	56.3 51.2 - 61.2	42.6 39.7 - 45.6	96.5 93.3 - 98.2	0.828 0.793 - 0.859	<0.0001
	CURB-65	>2	90.4 84.1 - 94.8	78.8 74.4 - 82.7	59.5 54.6 - 64.2	96.0 93.4 - 97.6	0.888 0.858 - 0.913	<0.0001
Covid patients	PSI	>III	77.8 52.4 - 93.6	73.2 63.8 - 81.2	32.6 24.5 - 41.8	95.2 89.2 - 97.9	0.800 0.720 - 0.866	<0.0001
	CURB-65	>2	66.7 41.0 - 86.7	92.6 85.9 - 96.7	60.0 41.7 - 75.9	94.3 89.6 - 97.0	0.857 0.783 - 0.913	<0.0001

ROC: Receiver operating characteristic, PPV: Positive Predictive Value, NPV: Negative Predictive Value, AUC: Area under ROC curve, CI: Confidence Interval. PSI, Pneumonia Severity Index, CURB-65: 5-point score based on confusion, urea, respiratory rate, blood pressure, and age 65.

Among them, PSI, was associated with the clinical features and results of elderly and young patients with COVID-19, and this was found to be higher in the elderly group in comparison to young patients[11]. Another score, CURB-65, was also reported to be considerably higher in non-surviving patients due to COVID-19 [9]. A Turkish report by Satici et al. evaluated CURB-65 and PSI's performance in 30-day mortality prediction among COVID-19 patients regardless of age groups[3]. They determined the PSI ≥ 4 group had 80% sensitivity and 89% specificity, while CURB-65 scores of ≥ 2 had 73% sensitivity and 85% specificity[3]. However, in the present study, a PSI score over III showed better sensitivity, but a CURB-65 score above 2 showed better specificity for all pneumonia patients, including COVID-19 patients, likely to be resulting from the fact that our geriatric study population was over the age of 65.

The significant correlation of the present study regarding the findings of COVID-19 patients shows parallelism with the report showing a significant association between higher CRP levels and increases in mortality risk[2,25]. In another study, older age, low lymphocyte count, comorbidities, and a high score of lung edema radiographic assessment were cited as independent factors linked to elevated mortality risk[26].

In this study, the rate of Neutrophil lymphocyte was found to be high in covid-19 patients[27]. Unlike the literature, lower neutrophil/lymphocyte ratios were found in COVID-19 pneumonia patients. The reason for this may be due to some additional diseases as our patient group, which we included in the study, is geriatric. Because many reasons such as abnormal thyroid functions, metabolic syndrome, acute coronary syndrome, diabetes mellitus, hypertension kidney and malignancies, liver dysfunction, systemic infections, and the use of drugs affecting hematological parameters might have an influence on the neutrophil-lymphocyte ratio [28,29]. Algorithms based on multiple machine-learning by Yadaw et al. recommended such prognostic predictors as O2 saturation, age, patient type and body temperature[30]. A large retrospective study from China reported that age and the comorbidities of the patients were indicated to have a link with COVID-19 patients' mortality rates[31]. Another report in Turkey showed that dyspnea, the presence of comorbidities, pulse O2 saturation and CRP level have a

potential to predict mortality depending on the severity of the disease[22]. Especially, an association was found between any comorbid disease and dyspnea in the patients and an increased mortality rate.

The correlation between elevated mortality and advanced age has become well-established finding presently. One of the initial reports in China indicated that the mortality rate could be three times higher for older patient group, specifically for those 80 and older[32]. An Italian report demonstrated that the rate of mortality was 26% in the ICU, whereas it was 36% after 65 years of age[33]. Another crucial point is that the average survival time in days from the manifestation of symptoms to loss of life due to COVID-19 was fewer in older patients[34]. In the present study, the percentage of geriatric patients having COVID-19 pneumonia transferred to the ICU during follow-ups significantly correlated considering the mortality rates. Patients with COVID-19 may be first hospitalized in inpatient services, but if their prognosis deteriorates rapidly and unexpectedly, they may be transferred to the ICU due to declining health status. Moreover, the duration of hospitalization in inpatient services also significantly correlated with the mortality rates among COVID-19 patients, but the ICU duration did not.

In a study for COVID-19 mortality, it was stated that the PSI and CURB-65 scores scales in the emergency department did not have sufficient decision-making power for hospitalization[35].

In our study, PSI scores above group III and CURB-65 scores above 2 are powerful tools for predicting pneumonia patients' mortality rates due to COVID-19 infections. Both scoring systems assist healthcare providers in the emergency departments in their decisions regarding the discharge or hospitalization of patients with geriatric COVID-19 pneumonia. Using these two scoring systems in emergency departments, geriatric COVID-19 pneumonia patients with a high mortality risk can be identified, further and given treatment to improve healthcare services and reducing mortality rates.

The limitations of this study mostly depend on its retrospective nature. We did not perform multivariate analysis on all clinical and laboratory data correlated with the mortality rates. Additionally, the prognostic scores of patients were not determined prospectively. Though, the majority of the Turkish clinical institutes have routinely been collecting the demographic and clinical data starting from the onset of the pandemic. Another limitation of the study was the missing laboratory data, which were not parts of the discharged patients' routine evaluation. Ground glass was detected in thorax CT in all patients included in the study. But the ground glass appearance can be seen in chronic interstitial lung diseases, acute alveolar diseases, cardiogenic edema as well as viral atypical pneumonias. There is a limitation in this sense.

Conclusion

In conclusion, this present study designed in retrospective manner with a large cohort of geriatric COVID-19 patient group and patients with non-COVID-19 pneumonia collected from a single-center, indicated that PSI scores over group III and CURB-65 over 2 are potent tools for predicting mortality rates in patients having pneumonia accompanied by COVID-19 infections or not. Both scores have advantages in stratifying the geriatric patients on admission and hospitalization.

Author contributions

All authors contributed to the study conception and design. All authors read and approved the final manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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Ethical approval

The present study received approval; the requirement for informed consent was waived by the Ethics Commission of Antalya Training and Research Hospital (No: 2020-256- l3/8 Date: August 27, 2020). This study was carried out in line with the Declaration of Helsinki.

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