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ORIGINAL INVESTIGATION / ÖZGÜN ARAŞTIRMA

COVID-19 in Hemodialysis Patients: Clinical Features, Results, and Factors Associated with Mortality

Hemodiyaliz Hastalarında COVID-19 Enfeksiyonu: Klinik Özellikler, Sonuçlar ve Mortalite İlişkili Faktörler

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ABSTRACT

Objective: Globally, coronavirus disease-2019 (COVID-19) has affected the elderly population and patients with multiple comorbid diseases. Hemodialysis (HD) patients are at risk of contracting COVID-19 due to immunosuppression caused by chronic kidney disease, advanced age, and existing comorbid diseases. We retrospectively studied the clinical characteristics of total of 121 HD patients with COVID-19.

Method: A total of 121 HD patients who met the COVID-19 probable case definition were included in the study. The patients were divided into groups according to their clinical and laboratory findings: mild-moderate, severe, and critical. Subsequently, the patients were divided into classified as either survivors or non-survivors and their demographic and laboratory data were compared.

Results: Of the 121 patients, 61 (51%) and 59 (49%) were female and male, respectively. Mean age of the patients was 61 ± 14. The most common comorbid disease among the patients was hypertension, followed by coronary artery disease and diabetes mellitus. The most common complaints were cough, myalgia, and shortness of breath.

Conclusion: This study contributes to literature by determining biomarkers to predict mortality due to COVID-19 infection in high-risk and vulnerable HD patient population.

Keywords: COVID-19, hemodialysis, mortality

ÖZ

Amaç: Koronavirüs hastalığı-2019 (COVID-19) enfeksiyonu tüm dünyada, yaşlı popülasyonu ve birçok komorbid hastalığı olan hastaları etkilemiştir. Hemodiyaliz (HD) hastaları, ileri yaş, mevcut komorbid hastalıklar ve kronik böbrek hastalığının, neden olduğu immünosupresyon nedeniyle COVID-19 enfeksiyonu için riski altındadır. Çalışmamızda COVID-19 enfeksiyonu olan 121 HD hastasının klinik özellikleri, sonuçları ve mortalite ile ilişkili faktörleri inceledik.

Yöntem: COVID-19 olası olgu tanımına uyan 121 hemodiyaliz hastası çalışmaya dahil edildi. Hastalar klinik ve laboratuvar özelliklerine göre hafif-orta, ağır ve kritik olarak gruplara ayrıldı. Daha sonra hastalar sağ kalanlar ve eksitus olanlar olarak gruplara ayrılarak demografik ve laboratuvar verileri açısından karşılaştırıldı.

Bulgular: Çalışmaya 61'i (% 51) kadın, 59'u (%49) erkek olmak üzere toplam 121 hasta dahil edildi. Hastaların ortalama yaşı 61 ± 14 idi. Hastaların en sık eşlik eden komorbid hastalığı hipertansiyon, ardından koroner arter hastalığı ve diabetes mellitus idi. En yaygın şikayetler öksürük, kas ağrısı ve nefes darlığı idi.

Sonuç: Bu çalışma, yüksek riskli ve savunmasız HD hasta popülasyonunda COVID-19 enfeksiyonuna bağlı mortaliteyi öngörmek için beyaz kan hücre sayısı, nötrofil sayısı, laktat dehidrogenaz, aspartat transaminaz gibi biyobelirteçlerin kullanımının faydalı olacağını göstermiştir.

Anahtar kelimeler: COVID 19, hemodiyaliz, mortalite

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INTRODUCTION

Globally, coronavirus disease-2019 (COVID-19) has affected the elderly population and patients with multiple comorbid diseases more drastically [1]. The number of cases worldwide is estimated to be 115 million, with approximately 2.56 million deaths recorded due to the disease. The virus is transmitted through viral droplets and direct contact and the incubation period varies within 2-14 days. Common symptoms of the disease include respiratory symptoms, such as fever, cough, and shortness of breath. COVID-19 patients may be asymptomatic or may have severe pneumonia and acute respiratory distress syndrome. Hemodialysis (HD) patients are at risk of COVID-19 due to immunosuppression caused by chronic kidney disease (CKD), advanced age, and existing comorbid diseases. Applying social isolation measures to prevent and control infectious diseases, including COVID-19 in dialysis patients is difficult to prevent and control infectious diseases, including COVID-19, as they spend time in crowded waiting areas before and after their HD sessions. HD patients have a less efficient immune system, which can alter their response to COVID-19 [2-4]. Therefore, it is not surprising that there is an increased rate of mortality among HD patients due to the disease. Studies have shown that mortality is higher among HD patients, as compared to normal population. It is necessary to pay more attention on this patient cohort. Identification of patients at risk and early intervention are of great importance to prevent mortality [5-7]. Although there are numerous reports on dialysis and COVID-19, many are preliminary reports including a small number of patients. We retrospectively studied the clinical characteristics of total of a 121 HD patients with COVID-19.

METHOD

A total of 121 HD patients who met the COVID-19 probable case definition were included in this study. All patients were treated at the pandemic hospital in our region between March 22 and January 31, 2021. This study was designed as a retrospective cross-sectional study. Demographic characteristics of patients, such as age, gender, and dialysis duration, as well as parameters, including chronic diseases, complaints during hospitalization, pH, oxygen saturation (SO_2), white blood cell count (WBC), neutrophil count, lymphocyte count, alanine aminotransferase (ALT) (U/L), aspartate aminotransferase (AST) (U/L), total bilirubin (mg/dL), lactate dehydrogenase (LDH) (U/L), creatinine kinase (CK) (U/L), albumin (g/L), D-dimer (ng/mL), ferritin (ng/mL), C-reactive protein (CRP) (mg/L), and procalcitonin (ng/mL), were determined. Whether the patients were admitted to the intensive care unit (ICU) during follow-up, treated, and survived were recorded from patient files and electronic data retrospectively. Computed tomography images and reports of the patients were accessed from the hospital's information system. The patients were divided into groups according to their clinical and laboratory findings: mild-moderate, severe, and critical. The severity of the disease was determined according to the WHO criteria [1]. Subsequently, the patients were divided classified as either survivors or non-survivors and their demographic and laboratory data were compared. This study was conducted with the necessary permissions from the Erzurum Regional Training and Research Hospital Committee (Erzurum Regional Training and Research Hospital KAEK-2020/20-201) and the Turkish Ministry of Health.

Statistical Analysis

Statistical analyses were performed using the IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, N.Y., USA). The study variables were investigated using visual (histograms and probability plots) and analytic methods (Kolmogorov-Simirnov/Shapiro-Wilk's test) to determine whether data are normally distributed. Data with normal distribution were presented as mean ± standard deviation, while the data whose distribution was not normal were presented as median interquartile range. After checking the normality distribution of the scale variables, independent samples were compared with appropriate significance tests (e.g., the Mann-Whitney U test). Pearson's chi-square and Fisher's exact tests were used for the categorical variables where appropriate. Receiver operating characteristics (ROC) analysis was applied to determine the predictive power of mortality among the values that were statistically significant between the survivors and non-survivors. The cut-off point was determined and the sensitivity, specificity, and 95% confidence intervals of the cut-points were calculated. The Youden index (J = Sensitivity + Specificity - 1) was used to determine the cut-off point. P-values of less than 0.05 were considered statistically significant.

RESULTS

Of the 121 patients, 62 (51%) and 59 (49%) were female and male, respectively. Mean age of the patients was 61 ± 14 and mean dialysis duration was 56 ± 42 months. The most common comorbid disease among the patients was hypertension (HT), followed by coronary artery disease and diabetes mellitus (DM). The most common complaints were cough, myalgia, and shortness of breath. While the need

for intensive care developed in 31 (26%) patients, 30 (25%) patients died (Table 1). In comparison of mild/moderate and severe/critical patients, the mean age of severe/critical patients was found to be significantly higher (p = 0.007). Also, the frequency of DM and heart failure (HF) was significantly higher in these patients (p = 0.018, p = 0.007). While the most common symptom in the severe/critical patients was shortness of breath, the need for ICU and rate of mortality were also found to be significantly higher among these patients (p < 0.001; Table 1).

In the comparison of severe and critical patients, no significant difference was found between the ages of the patients and duration of dialysis. While no difference was found between the comorbid diseases of the patients, shortness of breath was found to be significantly higher among the critical patients (p = 0.001). In critical patients, the need for ICU, invasive mechanical ventilation, non-invasive mechanical ventilation, high flow oxygen requirement, and rate of mortality were found to be significantly higher (p < 0.001). Again, while SO_2, albumin, and total protein values were found to be significantly lower in these patients, WBC, neutrophil count, LDH, AST, CK, ferritin, CRP, and INR values were found to be significantly higher (Table 2).

Table 1: Baseline characteristics of patients with COVID-19 according to the severity of disease

Characteristics	Total (n = 121)	Mild/moderate (n = 56)	Severe/critical (n = 65)	P value
Age (year)	61.1 ± 13.5	57.3 ± 13	64.3 ± 13.1	**0.007**
Dialysis duration (m)	47.5 (26 - 80)	60 (28 - 85.5)	45 (21 - 71)	0.242
Gender, n (%)				0.400
Female	62 (51)	31 (55)	31 (48)	
Male	59 (49)	25 (45)	34 (52)	
CD, n (%)				
HT	116 (96)	53 (95)	63 (97)	0.662
DM	55 (46)	19 (34)	36 (55)	**0.018**
CAD	93 (77)	39 (70)	54 (83)	0.081
HF	26 (22)	6 (12)	20 (31)	**0.007**
COPD	26 (22)	11(20)	15 (23)	0.647
Cancer	5 (4)	2 (4)	3 (5)	NA
Hepatitis B	1 (1)	0	1 (2)	NA
Hepatitis C	4 (3)	3 (5)	1 (2)	0.335
Symptoms, n (%)				
Fever	40 (33)	21 (38)	19 (29)	0.335
Myalgia	85 (70)	41 (73)	44 (68)	0.508
Cough	86 (71)	41 (73)	45 (69)	0.630
Dyspnea	73 (60)	18 (32)	55 (85)	**< 0.001**
Nausea/vomiting	13 (12)	5 (9)	8 (12)	0.550
Diarrhea	12 (10)	6 (11)	6 (9)	0.785
Loss of taste	1 (1)	1 (2)	0 (9)	0.463
Loss of smell	1 (1)	1 (2)	0	0.458
Headache	18 (15)	9 (16)	9 (14)	0.732
Need of ICU, n (%)	31 (25.6)	2 (4)	29 (45)	**< 0.001**
Mortality, n (%)	30 (25)	0	30 (46)	**< 0.001**

Data is given as mean ± SD and median (IQR).

CD: Comorbid diseases, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, HF: Heart failure, COPD: Chronic obstructive pulmonary disease, ICU: Intensive care unit, SD: Standard deviation

In comparison of survivor and non-survivor patients, the mean age of non-survivor patients was found to be significantly higher (p = 0.006) and no significant difference was found between the dialysis durations. The rate of DM and HF was found to be significantly higher among the non-survivor patients (p = 0.023, p = 0.004). While SO_2, albumin, and total protein values were found to be significantly lower in these patients, WBC, neutrophil count, LDH, AST, CK, ferritin, CRP, and INR values were found to be significantly higher (Table 3).

Results of the ROC analysis performed to determine the predictive power of the parameters with statistically significant difference between survivor and non-survivor patients in terms of rate of mortality are given in Table 4. Among these parameters, SO_2, LDH, AST, neutrophil, and CRP were found to have the highest predictive power.

DISCUSSION

COVID-19, caused by a novel severe acute respiratory syndrome coronavirus 2 (SARS CoV-2), was first reported in China in December 2019 and declared a pandemic by World Health Organization in March 2020 [1]. The first reported case of COVID-19 in Turkey was in March 11, 2020 and the first death due to the disease occurred in March 15, 2020. While approximately 3.4 million people have been affected by the disease in our country so far, approximately 34 thousand people have died due to the disease. The disease has a wide clinical spectrum ranging from asymptomatic course to fatal multiorgan failure; however, the mechanisms underlying these differences, which can vary from person to person, have not yet been elucidated. Studies have shown that advanced aged patients as well as patients with underlying cardiovascular and pulmonary diseases, DM, and HT have high critical disease susceptibility and mortality rates [8,9]. Patients with CKD, especially those with end-stage renal disease, carry a high risk for both COVID-19 and other infectious diseases due to insufficient immune system functions, advanced age, and accompanying comorbid diseases. In studies conducted with HD patients, mortality rate due to COVID-19 was in the range of 16%-31% and was found to be significantly higher than that of the general population [2]. In our study, no difference was found between severe and critical patients in terms of age, whereas the average age of non-survivor patients (67 years) was found to be significantly higher. The severe/critical rate and the mortality rate were found to be significantly higher in patients with DM and HF. The total mortality rate was found to be approximately 25%. These findings are consistent with the findings in literature.

The most common symptoms encountered during COVID-19 are fever, cough, shortness of breath, myalgia, headache, smell and taste disturbances, and gastrointestinal system complaints [9,10]. However, the symptoms encountered in HD patients may differ from those encountered in the normal population. While cough took the first place in some studies, weakness, fatigue, and myalgia took the first place in some other studies. In a meta-analysis that included 396,062 HD patients, fever was the most predominant clinical manifestation (reported in 19 studies) and was observed in 889 of 1,448 HD patients with COVID-19, followed by cough, dyspnea, and fatigue [10]. The most common symptoms in our study were weakness, muscle pain, cough, shortness of breath, and fever. The low incidence of fever can be explained by the decreased lymphocyte count, lower serum inflammatory cytokine level, and lower inflammatory response in HD patients, as compared with the general population [11,12].

In severe COVID-19 patients, a decrease in lymphocyte, hemoglobin, and platelet count as well as a significant increase in neutrophil count have been detected [13,14]. The results of studies conducted with HD patients are contradictory. In a study conducted by Xiong et al. [5], in which a total of 154 patients were examined, no significant difference was found in terms of the WBC, neutrophil, and lymphocyte counts between patients with and without serious disease. In another study by Stefan et al. [11], they found no significant difference in terms of WBC, neutrophil, and lymphocyte values between mild/moderate and severe/critical as well as between survivor and non-survivor patients. In a study by Shang et al. [13], a significant difference was found between survivor and non-survivor patients in terms of WBC and neutrophil count, but no difference was found in terms of lymphocyte counts. Similarly, in our study, WBC and neutrophil counts were found to be significantly higher in severe, critical, and non-survivors patients, but there was no difference in terms of the lymphocyte counts.

Various biomarkers are being investigated for use in determination of the severity, course, and mortality of patients with COVID-19. LDH, an intracellular enzyme, is mostly found in the liver, striated muscles, heart, kidneys, lungs, brain, and erythrocytes. In case of cell damage, it leaks into extracellular fluid, elevating its level in the blood. High serum LDH levels appear as prognostic markers in many pathologies, such as infections, malignancies, and

Table 2. Comparison of demographic data and laboratory parameters of severe and critical groups			
	Severe (n = 34)	**Critical (n = 31)**	**P value**
Age (yr)	62.6 ± 10.4	66.2 ± 15.5	0.258
Dialysis Duration (m)	50.5 (19.3 - 71)	40 (23 - 74)	0.757
Gender, n (%)			0.915
Female	16 (47)	15 (48)	
Male	18 (53)	16 (52)	
CD, n (%)			
HT	33 (97)	30 (97)	NA
DM	16 (47)	20 (65)	0.157
CAD	29 (85)	25 (81)	0.618
HF	10 (29)	10 (32)	0.804
COPD	6 (18)	9 (29)	0.277
Cancer	2 (6)	1 (3)	NA
Symptoms, n (%)			
Fever	11 (32)	8 (26)	0.562
Myalgia	22 (65)	22 (71)	0.590
Cough	25 (74)	20 (65)	0.432
Dyspnea	24 (71)	31 (100)	**0.001**
Nausea/vomiting	7 (21)	1 (3)	0.056
Diarrhea	4 (12)	2 (7)	0.674
Headache	6 (18)	3 (10)	0.480
Need of ICU, n (%)	1 (3)	28 (90)	**<0.001**
High flow	0	17 (55)	**<0.001**
NIMV	0	12 (39)	**<0.001**
IMV	1 (3)	27 (87)	**<0.001**
Mortality n, (%)	4 (12)	26 (84)	**<0.001**
SO_2 (%)	87.6 ± 5.5	83.3±7.4	**0.005**
WBC (10^3/µL)	5,920 (4,060 - 9,020)	8,760 (5,353 - 12,800)	**0.020**
Neutrophil (10^3/µL)	3,860 (3,105 - 7,250)	7,145 (4,918 - 10,988)	**0.010**
Lymphocyte (10^3/µL)	790 (520 - 1,070)	690 (515 - 985)	0.561
LDH (U/L)	284 (247.8 - 381.3)	455.5 (352 - 750)	**0.002**
AST (U/L)	22 (14 - 44.5)	54.5 (24.5 - 99.3)	**0.009**
CK (U/L)	83 (54 - 127.5)	218 (81 - 644.3)	**0.038**
Albumin (gr/L)	36.6 ± 4.9	32.7 ± 4.3	**0.005**
T. Protein (gr/L)	63.8 ± 6.8	58.7 ± 7	**0.020**
Ferritin (ng/mL)	1135.9 (775.7 - 1598.7)	1,650 (1200.1 - 1984.5)	**0.020**
D-dimer (ng/mL)	1.85 (1.05 - 4.17)	3.79 (1.71 - 10.8)	0.108
CRP (mg/L)	71.6 (12.8 - 116.1)	161 (74.3 - 201.1)	**0.011**
PCT (ng/mL)	1.84 (1.22 - 2.86)	3.95 (1.08 - 15.32)	0.412
INR	1.14 ± 0.3	1.67 ± 1.3	**0.010**

Data is given as mean ± SD and median (IQR).

CD: Comorbid diseases, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, HF: Heart Failure, COPD: Chronic obstructive pulmonary disease, NIMV: Non-invasive mechanic ventilation, IMV: Invasive mechanic ventilation, SO_2: Oxygen saturation, WBC: White blood cell, LDH: Lactate dehydrogenase, AST: Aspartate transaminase, CK: Creatin kinase, CRP: C-reactive protein, PCT: Procalcitonin, SD: Standard deviation

Table 3. Comparison of demographic data and laboratory parameters of survival and non-survivor groups			
	Survivor (n = 91)	**Non-survivor (n = 30)**	**P value**
Age (yr)	59±12.1	67.4±15.5	**0.006**
Dialysis (m)	50 (26 - 80)	43 (25 – 84.5)	0.878
Gender, n (%)			0.563
Female	48 (53)	14 (47)	
Male	43 (47)	16 (53)	
CD, n (%)			
HT	87 (96)	29 (97)	NA
DM	36 (40)	19 (63)	**0.023**
CAD	67 (74)	26 (87)	0.142
HF	14 (15)	12 (40)	**0.004**
COPD	20 (22)	6 (20)	0.819
Cancer	4 (4)	1 (3)	NA
Symptoms, n (%)			
Fever	33 (36)	7 (23)	0.192
Myalgia	63 (69)	22 (73)	0.670
Cough	67 (74)	19 (63)	0.281
Dyspnea	43 (47)	30 (100)	**< 0.001**
Nausea/vomiting	12 (13)	1 (3)	0.182
Diarrhea	10 (11)	2 (7)	0.728
Loss of taste	1 (1)	0 (0)	NA
Loss of smell	1 (1)	0 (0)	NA
Headache	15 (17)	3 (10)	0.557
SO_2 (%)	91.6 ± 4.7	82.9 ± 7.5	**< 0.001**
WBC (10^3/µL)	5640 (3820 - 6880)	7910 (5275 - 11660)	**0.002**
Neutrophil (10^3/µL)	3450 (2460 - 5560)	6820 (4715 - 10385)	**< 0.001**
Lymphocyte (10^3/µL)	890 (620 - 1160)	640 (520 - 990)	0.083
LDH (U/L)	271 (220 - 343)	521 (379 - 750)	**< 0.001**
AST (U/L)	23 (17 - 37.8)	57 (26.5 - 124)	**< 0.001**
CK (U/L)	78 (46 - 123)	209 (52 - 540)	**0.013**
Albumin (gr/L)	36.5 ± 4.6	33.1 ± 5.8	**0.004**
T. protein (gr/L)	63.2 ± 6.1	59.1 ± 8	**0.048**
Ferritin (ng/mL)	1007.6 (545.4 - 1650)	1650 (1375.1 - 1984.5)	**0.002**
D-dimer (ng/mL)	1.81 (0.98 - 3.86)	3.64 (0.96 - 13.49)	0.100
CRP (mg/L)	48.5 (13.5 - 98.5)	161 (68.7 - 201.1)	**0.001**
PCT (ng/mL)	1.14 (0.65 - 2.13)	3.95 (1.12 - 20.11)	**0.012**
INR	1.1 ± 0.2	1.7 ± 1.4	**0.001**

Data is given as mean ± SD and median (IQR).

CD: Comorbid diseases, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, HF: Heart Failure, COPD: Chronic obstructive pulmonary disease, SO_2: Oxygen saturation, WBC: White blood cell, LDH: Lactate dehydrogenase, AST: Aspartate transaminase, CK: Creatin kinase, CRP: C-reactive protein, PCT: Procalcitonin

Table 4. The AUC and optimal threshold of each related variable

Variables	AUC	95% CI	P value	Optimal threshold	Sensitivity	Specificity	Youden index*
SO_2 (%)	0.875	0.807 - 0.942	< 0.001	88	87.6%	70%	**0.576**
LDH (U/L)	0.844	0.734 - 0.955	< 0.001	320	90%	73%	**0.630**
AST (U/L)	0.802	0.684 - 0.921	< 0.001	34	75%	70.3%	0.453
Neutrophil (10^3/µL)	0.744	0.628 - 0.861	< 0.001	4.900	72%	69.3%	0.413
CRP (mg/L)	0.739	0.620 - 0.858	0.001	81	70%	69.4%	0.394

SO_2: Oxygen saturation, LDH: Lactate dehydrogenase, AST: Aspartate transaminase, CRP: C-reactive protein. *The Youden index was calculated based on the sensitivity and specificity of the ROC curve, and the cut-off point with higher sensitivity was selected as the optimal threshold among several points with relatively large Youden index

myocardial infarction. High LDH levels have been associated with poor outcomes, especially in viral infections [14,15]. Henry et al. [16] demonstrated the association between elevated LDH levels and mortality among patients with COVID-19. Studies have shown a relationship between LDH and mortality among HD patients with COVID-19. In a study by Fisher et al. [17], serum LDH levels were found to be significantly higher in a total of 32 patients who died due to COVID-19. In another study conducted in Turkey, Islam et al. [18] demonstrated that LDH levels were significantly higher in patients who needed ICU and non-survivors. Consistent with this finding, in our study, LDH levels were found to be significantly higher in critical patients and non-survivor patients.

Increased serum levels of ALT and AST indicate acute hepatocellular injury, such as viral infection, toxic damage, hypoxia, and hypoperfusion. AST levels can increase due to damage to other organs. There are cases where non-hepatic respiratory or gastrointestinal viral infections lead to increased levels of ALT and AST without hepatic failure [19]. COVID-19 patients present some cases of varying degrees of abnormal liver enzymes throughout the disease. Abnormal liver enzymes in patients with COVID-19 were demonstrated by some potential mechanisms, including SARS-CoV-2 viral infection directly on liver cells, inflammatory response syndrome, hyperactivated immune responses, psychological stress, hepatic ischemia, hypoxia-reperfusion dysfunction, progression of pre-existing liver diseases, and drug induced liver injury [20]. Zhang et al. [21], showed that approximately 14%-51% of COVID-19 patients had abnormal concentrations of ALT and AST. Chen and et al. [22], summarized that 52% of non-survivor patients with COVID-19 presented abnormal serum AST levels (> 40 U/L), indicating that severe COVID-19 patients tend to have higher rates of abnormal liver enzymes. In our study, AST levels were found to be significantly higher in the critical and non-survivor patients and AST levels have been shown to be used to predict mortality.

In a study by Valeri et al. on HD patients, it was found that the CRP values of the patients who died were higher at the time of admission [8]. In our study, CRP value was found to be a strong predictor of mortality. This finding supports the information that inflammatory response mediates clinical deterioration.

Study Limitations

The limitations of our study include the relatively small sample size and the observational nature of our data. In addition, the treatments applied to the patients were not evaluated, but were given in accordance with the guidelines published by the Ministry of Health.

Mortality rate is high in HD patients and these patients are considered to be in the high-risk group. Although vaccination of the whole population, especially the risk groups, is planned in a short time, it is still very important to determine the patients with high mortality risk. Therefore, it is very important to determine easily accessible and reproducible parameters and demonstrate their applicability in high-risk patients, such as HD patients, in order to reduce mortality.

CONCLUSION

In conclusion, this study contributes to literature by determining biomarkers, such as WBC, neutrophil count, LDH, and AST, to predict mortality due to COVID-19 in high-risk and vulnerable HD patient population.

Ethics

Ethics Committee Approval: This study was conducted with the necessary permissions from the Erzurum Regional Training and Research Hospital Ethics Committee (Erzurum Regional Training and Research Hospital KAEK-2020/20-201) and the Turkish Ministry of Health.

Informed Consent: Is a retrospective study.

Peer-review: Externally peer reviewed.

Authorship Contributions

Concept: C.S., Ö.T., R.D., Design: C.S., Ö.T., R.D., Data Collection or Processing: C.S., Ö.T., R.D., Analysis or Interpretation: C.S., Ö.T., R.D., Literature Search: C.S., Ö.T., R.D., Writing: C.S., Ö.T., R.D.

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REFERENCES

1. World Health Organization. WHO Coronavirus Disease (COVID-19) Dashboard. World Health Organization. 2020. Available from: https://covid19.who.int/
2. Ozturk S, Turgutalp K, Arici M, et al. Mortality analysis of COVID-19 infection in chronic kidney disease, haemodialysis and renal transplant patients compared with patients without kidney disease: a nationwide analysis from Turkey. Nephrol Dial Transplant. 2020;35:2083-95.
3. Park HC, Lee YK, Lee SH, et al; Korean Society of Nephrology MERS-CoV Task Force Team. Middle East respiratory syndrome clinical practice guideline for hemodialysis facilities. Kidney Res Clin Pract. 2017;36:111-6. doi: 10.23876/j.krcp.2017.36.2.111.
4. Collins AJ, Kliger AS. Urgent: stop preventable ınfections Now. Clin J Am Soc Nephrol. 2018;13:663-5. doi: 10.2215/CJN.10790917.
5. Xiong F, Tang H, Liu L, et al. Clinical characteristics of and medical ınterventions for COVID-19 in hemodialysis patients in Wuhan, China. J Am Soc Nephrol. 2020;31:1387-97. doi: 10.1681/ASN.2020030354.
6. Scarpioni R, Manini A, Valsania T, et al. Covid-19 and its impact on nephropathic patients: the experience at Ospedale "Guglielmo da Saliceto" in Piacenza. G Ital Nefrol. 2020;37:2020-vol2.
7. Goicoechea M, Sánchez Cámara LA, Macías N, et al. COVID-19: clinical course and outcomes of 36 hemodialysis patients in Spain. Kidney Int. 2020;98:27-34. doi: 10.1016/j.kint.2020.04.031.
8. Valeri AM, Robbins-Juarez SY, Stevens JS, et al. Presentation and outcomes of patients with ESKD and COVID-19. J Am Soc Nephrol. 2020;Jul;31:1409-15. doi: 10.1681/ASN.2020040470.
9. Guan W, Ni Z, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med. 2020;382:1708-20. doi: 10.1056/NEJMoa2002032.
10. Chen CY, Shao SC, Chen YT, et al. Incidence and clinical ımpacts of COVID-19 ınfection in patients with hemodialysis: systematic review and meta-analysis of 396,062 hemodialysis patients. Healthcare (Basel). 2021;9:47. doi: 10.3390/healthcare9010047.
11. Stefan G, Mehedinti AM, Andreiana I, et al. Clinical features and outcome of maintenance hemodialysis patients with COVID-19 from a tertiary nephrology care center in Romania. Ren Fail. 2021;4349-57. doi: 10.1080/0886022X.2020.1853571
12. Ma Y, Diao B, Lv X, et al. COVID-19 in hemodialysis (HD) patients: Report from one HD center in Wuhan, China. medRxiv. 2020. doi: 10.1101/2020.02.24.20027201.
13. Shang W, Li Y, Li H, et al. Correlation between laboratory parameters on admission and outcome of COVID-19 in maintenance hemodialysis patients. Int Urol Nephrol. 2021;53:165-9. doi: 10.1007/s11255-020-02646-0.
14. Szarpak L, Ruetzler K, Safiejko K, et al. Lactate dehydrogenase level as a COVID-19 severity marker. Am J Emerg Med. 2021;45:638-9. doi: 10.1016/j.ajem.2020.11.025.
15. Chen C, Lee C, Liu C, Wang J, Wang L, Perng R. free information in English and Mandarin on the novel coronavirus COVID- Clinical Features and Outcomes of Severe Acute Respiratory Syndrome and Predictive Factors for Acute Respiratory Distress Syndrome. 2020;(January).
16. Henry BM, Aggarwal G, Wong J, et al. Lactate dehydrogenase levels predict coronavirus disease 2019 (COVID-19) severity and mortality: a pooled analysis. Am J Emerg Med. 2020. doi:10.1016/j.ajem.2020.05.073.
17. Fisher M, Yunes M, Mokrzycki MH, Golestaneh L, Alahiri E, Coco M. Chronic Hemodialysis Patients Hospitalized with COVID-19: Short-term Outcomes in the Bronx, New York: Kidney 360; 2020.
18. Islam M, Ozturk Y, Koc Y. Clinical outcomes of COVID-19 in hemodialysis patients in the city of Zonguldak, Turkey. Int Urol Nephrol. 2021;53:1445-52. doi: 10.1007/s11255-020-02781-8
19. Oh JS, Choi JS, Lee YH, et al. The relationships between respiratory virus ınfection and aminotransferase in children. Pediatr Gastroenterol Hepatol Nutr. 2016;19:243-50. doi: 10.5223/pghn.2016.19.4.243.
20. Chen LZ, Lin ZH, Chen J, Liu SS, Shi T, Xin YN. Can elevated concentrations of ALT and AST predict the risk of 'recurrence' of COVID-19? Epidemiol Infect. 2020;148:e218. doi: 10.1017/S0950268820002186.
21. Zhang C, Shi L, Wang FS. Liver injury in COVID-19: management and challenges. Lancet Gastroenterol Hepatol. 2020;5:428-30. doi: 10.1016/S2468-1253(20)30057-1.
22. Chen T, Wu D, Chen H, et al. Clinical characteristics of 113 deceased patients with coronavirus disease 2019: retrospective study. BMJ. 2020 Mar 31;368:m1295. doi: 10.1136/bmj.m1091.