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NEPHROLOGY - ORIGINAL PAPER

COVID-19: mortality rates of patients on hemodialysis and peritoneal dialysis

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Abstract

Objective Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection might have a higher mortality rate in patients with end-stage renal disease due to immunosuppression. This study investigates the mortality rates of SARS-CoV-2 infection and the factors affecting mortality among patients who were on maintenance hemodialysis and continuous ambulatory peritoneal dialysis.

Materials and methods A total of 200 patients, including 157 maintenance hemodialysis and 43 continuous ambulatory peritoneal dialysis patients followed in our hospital, were included in the study. The patients' sociodemographic characteristics, comorbidities, history of SARS-CoV-2 infection in the previous year, death event, source of death (SARS-CoV-2 or not), presence of hospitalization due to SARS-CoV-2 infection, need for intensive care unit, need for ventilatory support in intensive care unit were obtained from the clinical file records.

Results 85 of the 200 patients had a history of SARS-Cov-2 infection during the last 12 months. Forty-two (49.5%) patients with SARS-CoV-2 infection were hospitalized. Patients with SARS-CoV-2 had longer dialysis time, increased mortality, and significantly higher comorbidities such as coronary artery disease, congestive heart failure. Besides, heart failure and hypertension were the determining factors in the risk factor analysis for SARS-CoV-2 infection. In dialysis patients, the mortality rate in the last year, due to all causes, including SARS-CoV-2 infection, was 23% while the mortality rate due to "SARS-CoV-2 infection only" was 13%) ($p > 0.05$). Our findings are important in guiding clinical decision-making and informing the public and health authorities about the risk of death associated with COVID-19 in this patient group.

Keywords COVID-19 · SARS-CoV-2 · Maintenance hemodialysis · Peritoneal dialysis · Mortality

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection emerged in Wuhan, China, in December 2019 and has spread rapidly worldwide [1]. The estimated mortality rates in the general population vary between 1.4 and 8% according to the severity of the cases [2], and this rate may rise to 78% in patients admitted to the intensive care unit [3].

The pandemic has dramatically affected the patient group with chronic diseases such as end-stage renal disease (ESRD). Compared to the general population, patients undergoing maintenance dialysis treatment are expected to be at high risk for Coronavirus disease 19 (COVID-19) and its complications due to multiple comorbid conditions such as advanced age, cardiovascular disease, hypertension, diabetes, lung disease, and a suppressed immune system [2, 4].

The necessity of transporting hemodialysis patients to the dialysis center with the patient service three times a week, the clustering of patients in dialysis units, and the patient's contact with hemodialysis personnel more than once a week limit the physical isolation from the virus in this group of patients. On the other hand, since continuous ambulatory peritoneal dialysis (CAPD) treatment is administered at home, it is thought to provide better physical isolation from

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Table 1 Comparison of clinical and laboratory parameters of the patients participating in the study

	Total (*n*:200)	MHD (*n*:157)	CAPD (*N*:43)	p^* value
Age, year	61.3 ± 13.7	61.8 ± 13.6	59.4 ± 13.9	0.291
Gender (F/M)	88/112	63/94	25/18	0.035
Duration of dialysis, months	32 (6–291)	39(6–291)	15(7–168)	**0.001**
Urea, mg/dl	122.2 ± 37	121.9 ± 37.4	123.1 ± 36.1	0.853
Creatinine, mg/dl	7.8 ± 2.6	7.7 ± 2.6	8 ± 2.4	0.404
Calcium,mg/dl	8.5 ± 0.8	8.6 ± 0.7	8.4 ± 1.1	0.255
Phosphorus,mg/dl	5.1 ± 1.2	5.1 ± 1.2	4.9 ± 1.3	0.458
Albumin, g/dl	3.5 ± 0.5	3.5 ± 0.5	3.3 ± 0.5	0.911
Ferritin	405 (28–2000)	420(28–2000)	405(44–2000)	0.913
Hemoglobin	10.7 ± 1.3	10.7 ± 1.3	11.1 ± 1.4	0.089
CRP, g/L	7 (0.4–348)	8(0.4–348)	8(3–149)	0.678

p value < 0.05 is significant statistically and was shown as bold

**p*-value belongs to hemodialysis and CAPD patients

the virus in patients than maintenance hemodialysis (MHD) treatment [5].

Guidelines on preventive and isolation measures to be taken in hemodialysis units to prevent the spread of the virus are known [6]. However, we still do not know the effects of this disease among patients on dialysis programs with chronic renal failure. The prevalence and mortality rate studies in this group of patients since the beginning of the pandemic have been in the form of isolated observations or small case series and have generally been conducted with hemodialysis patients [7, 8]. There is little information on this subject about peritoneal dialysis patients [5].

This observational study aimed to compare sociodemographic characteristics, clinical laboratory parameters, annual mortality rates due to SARS-CoV-2 infection and all-causes, and factors affecting these in MHD and CAPD patients.

Materials and methods

The study was approved by the local ethical committee of our institute with protocol number GOKA/2021/8/14. A total of 200 patients including 157 MHD and 43 CAPD patients, who were treated in our hospital during the last year and were on dialysis for at least six months were included in the study. The patients under the age of 18 were not included. The patients' sociodemographic characteristics, comorbidities, COVID-19 history in the last year, death event, source of death (COVID-19 or not), presence of hospitalization due to COVID-19, need for intensive care unit (ICU), need for ventilatory support in ICU were obtained from the clinical file records. The hospital electronic medical record system was searched for the laboratory test information and reverse transcriptase-polymerase chain reaction (rRT-PCR) results studied in routine follow-ups.

Statistical analysis

SPSS 21.0.0.1 for Windows (SPSS; IBM) software was used for the analyses. Data distribution was determined using the Kolmogorov–Smirnov test. Continuous variables were reported as mean and standard deviation or as median and minimum–maximum according to data distribution. Categorical variables were reported as *n* (%). Student *t*-test or Mann Whitney *U* test was used according to the data distribution for comparison of the continuous variables. The Chi-square test or Fisher's Exact test was used to compare categorical variables. Logistic regression analysis was used in risk factor analysis. A *p*-value of < 0.05 was considered statistically significant.

Results

A total of 200 patients (112 men, 88 women), including 157 (78.5%) MHD, 43 (21.5%) CAPD, with a median age of 63 years (23–92) included in the study. The median dialysis duration was 32 (6–291) months. The clinical and laboratory parameters of the patients participating in the study are shown in Table 1.

Table 2 Comparison of clinical parameters between 200 patients with and without SARS-CoV2

	SARS-CoV2 (−) (n:115)	SARS-CoV2 (+) (*n*:85)	*p*
Age (years)	60.4 ± 14.5	62.6 ± 12.6	0.26
Gender (Female)	51 (44.3)	37 (43.5)	0.91
Coronary artery disease	26 (22.6)	41 (48.2)	**< 0.001**
Chronic obstructive pulmonary disease (COPD)	3 (2.6)	6 (7.1)	0.13
Diabetes Mellitus	41 (35.7)	42 (49.4)	0.05
Hypertension	52 (45.2)	49 (57.6)	0.08
Heart failure	10 (8.7)	32 (37.6)	**< 0.001**
MHD/CAPD	30 (26.1)	13 (15.3)	0.07
Duration of dialysis, (months)	28 (6 – 291)	40 (11–240)	**0.002**
Mortality	13 (11.3)	33 (38.8)	**< 0.001**

p value < 0.05 is significant statistically and was shown as bold

Unless otherwise stated, data were presented as *n* (%)

Age was presented as mean ± standard deviation, and duration of dialysis as median (min–max)

85 (42.5%) of the 200 patients followed within a year had SARS-Cov-2 infection. Forty-two (49.5%) patients with SARS-CoV2 infection were hospitalized. 31 (73.8%) of the 42 hospitalized patients were admitted to the intensive care unit because of general health status deterioration and oxygen saturation decline. Twenty-eight (90.3%) of the patients who were admitted to the intensive care unit were intubated, and mechanical ventilatory support was given. Only three patients did not need ventilator support in the intensive care unit. Unfortunately, all 28 intubated patients died.

In dialysis patients, the mortality rate in the last year, due to all causes, including SARS-CoV-2 infection, was 23% (95% CI 0.18–0.29), while the mortality rate due to SARS-CoV-2 infection only was 13% (95% CI 0.09–0.18). Considering only SARS-CoV-2 positive dialysis patients (*n*:85), the all-cause mortality rate was 38.8% (95% CI 0.29–0.49), while the "SARS-CoV-2-related mortality rate" was 30.6% (95% CI 0.22–0.41).

A comparison of the clinical parameters between the patients with SARS-CoV-2 and patients without SARS-CoV-2 is shown in Table 2. Patients with SARS-CoV-2 infection had longer dialysis duration, significantly higher comorbidities such as coronary artery disease, congestive heart failure, and increased mortality (Table 2). In addition, the presence of heart failure and hypertension were significant risk factors for SARS-CoV2 infection (Table 3).

Table 3 Risk factor analysis for SARS-CoV2 infection in patients on dialysis (*n*:200)

	OR	95% CI	*p*
Heart failure	6.33	2.83–14.15	**< 0.001**
Hypertension	2.06	1.09–3.87	**0.04**

p value < 0.05 is significant statistically and was shown as bold

Table 4 Comparison of clinical parameters of living and deceased patients

	Living (*n*:154)	Deceased (46)	*p*
Age (years)	59.7 ± 13.5	66.8 ± 12.9	**0.002**
Gender (Female)	68 (44.2)	20 (43.5)	0.94
Coronary artery disease	41 (26.6)	26 (56.5)	**< 0.001**
COPD	6 (3.9)	3 (6.5)	0.45
Diabetes Mellitus	66 (42.9)	17 (37)	0.48
Hypertension	72 (46.8)	29 (63)	0.05
Heart failure	19 (12.3)	23 (50)	**< 0.001**
MHD/CAPD	32 (20.8)	11 (23.9)	0.65
Duration of dialysis (months)	31 (6 – 291)	40 (12–240)	**0.03**
SARS COV-2	52 (33.8)	33 (71.7)	**< 0.001**

p value < 0.05 is significant statistically and was shown as bold

Unless otherwise stated, data were presented as *n* (%)

Age was presented as mean ± standard deviation, and duration of dialysis as median (min–max)

Last year, the number of patients dying from all causes, including SARS-CoV-2 infection, was 46 (35 MHD, 11 CAPD). Comparison of clinical parameters between alive and deceased patients is shown in Table 4, while risk factor analysis for all-cause mortality is shown in Table 5. The

Table 5 Risk factor analysis for mortality of all-cause

	OR	95% CI	p
Heart failure	3.88	1.64–9.20	**0.002**
SARS-CoV2	3.20	1.44–7.14	**0.004**

p value < 0.05 is significant statistically and was shown as bold

deceased patients were older and had a longer duration of dialysis. In addition, they had significantly higher SARS-CoV-2 infection positivity and comorbidity rates such as coronary artery disease, heart failure (Table 4). In addition, heart failure and SARS-CoV2 infection positivity were significant risk factors for mortality (Table 5).

SARS-CoV2 infection was detected in 72 (45.9%) of MHD patients in the last year, while in 13 (30.2%) of CAPD patients ($p=0.07$). 36 (50%) of MHD patients and 6 (46.2%) of CAPD patients required hospitalization ($p=0.79$), considering the hospitalization rates due to SARS-CoV-2 infection. 25 (69.4%) of MHD patients and 6 (100%) of CAPD patients needed intensive care ($p=0.17$), considering the rates of intensive care admission due to SARS-CoV-2 infection. We found that 22 (88%) of MHD patients and 6 (100%) of CAPD patients in intensive care needed mechanical ventilation ($p=0.99$).

Mortality rates due to all causes, including SARS-CoV-2 infection in the last year, were 22.3% (95% CI 0.16–0.29) in MHD patients and 25.6% (95% CI 0.15–0.40) in CAPD patients ($p=0.65$). Mortality rates due to SARS-CoV-2 infection only was 12.7% (95% CI 0.08–0.19) in MHD patients, and 14% (95% CI 0.07–0.27) in CAPD patients ($p=0.83$). In those who had SARS-CoV-2 infection, the all-cause mortality rate was 37.5% (95% CI 0.27–0.49) in MHD patients and 46.2% (95% CI 0.23–0.71) ($p=0.56$) in CAPD patients, whereas mortality rates due to SARS-CoV-2 infection alone were 27.8% (95% CI 0.19–0.39) in MHD patients, and 46.2% (95% CI 0.23–0.71) in CAPD patients ($p=0.19$).

Discussion

Patients with ESRD are more vulnerable to SARS-CoV-2 infection, because of the immunosuppressive nature of renal failure and the high comorbidity in this group [9]. This article shared our experience on the factors affecting mortality related to SARS-CoV-2 infection among hemodialysis and CAPD patients with end-stage renal disease.

In our study, the rate of SARS-CoV-2 infection was high in dialysis patients in the last year, and the duration of dialysis was longer; comorbidities such as coronary artery disease, congestive heart failure, and mortality were markedly higher. Besides, in hemodialysis and CAPD patients, there was no significant difference for SARS-CoV-2 positivity, mortality, hospitalization, need for intensive care, and need for ventilator support, and finally for overall mortality rate. The risk factor analysis for all-cause mortality was primarily associated with congestive heart failure and SARS-CoV-2 infection.

Eighty-five (% 42.5) of the 200 patients followed within a year had SARS-CoV-2 infection. Approximately half of the patients with SARS-CoV-2 infection were treated with hospitalization; most hospitalized patients needed advanced life support, were admitted to the third-level intensive care unit, and intubated. No other (non-COVID-19) patients were admitted to the intensive care unit. Bedside hemodialysis or continuous renal replacement therapy was applied to these patients in the intensive care unit when needed. Unfortunately, all intubated patients died.

In-hospital case-fatality rates reported in previous COVID-19 studies were 10.2%, 15.6%, and 20.3% in the general population with median ages of 62, 61, and 63, respectively [10–12]. In our study, the all-cause mortality rate in patients with only SARS-CoV-2 infection was 37.5% and 46.2% in MHD and CAPD patients, while mortality rates due to SARS-CoV-2 infection alone were 27.8% and 46.2%, respectively. ($p=0.19$). The mortality rate associated with COVID-19 was found to be higher in both groups of patients than in the general population. Dialysis patients treated without hospitalization did not die, suggesting that patients who can be treated at home were correctly identified.

The primary mode of spread of COVID-19 is direct person-to-person transmission through respiratory droplets emitted during coughing, sneezing, and even talking [13]. Therefore, the primary way to prevent the disease is social isolation and protection from droplets. In our hemodialysis unit, from the beginning of the pandemic, the number of sessions per week was reduced for possible patients, and the problems of CAPD patients were resolved by phone calls as much as possible. Only patients whose problem could not be resolved by phone calls, were invited to the clinic, and all-needed personal protective measures were taken in dialysis units. The patients were taken to dialysis units by keeping the distance between them, and the patient number in the shuttle bus was diluted to prevent clustering of the patients. The patients' contact with dialysis unit personnel was prevented entirely through the full use of masks, distance, hygiene, and personal protective equipment. In the literature, the mortality rate in care center hemodialysis patients due to COVID-19 has been reported as 16–30% [2, 14]. In our study, similar to the literature, mortality rates due to all causes including SARS-CoV-2 infection in the last year were 22.3% and 25.6% in MHD and CAPD patients, while "specific mortality rate due to SARS-CoV-2 infection only" was 12.7% and 14%, respectively. We thought that by the precautions taken in the hemodialysis and peritoneal dialysis unit and the full compliance of the patients and clinical staff with the mask-distance-hygiene rule, the even more mortal consequences of the pandemic were avoided.

During the pandemic, home dialysis modalities such as CAPD come into prominence and are recommended by the Internal Society for Peritoneal Dialysis (ISPD) as a first-line treatment option if possible [15]. There is limited data on the frequency and mortality of COVID-19 in patients

undergoing CAPD. One study reported that the incidence of COVID-19 was 0.7–0.6%, and no patient died [16]. In another study, only two of 59 COVID-19 positive dialysis patients performed peritoneal dialysis, and no mortality was observed in CAPD patients [17]. The lower frequency of COVID-19 among peritoneal dialysis patients than hemodialysis patients may be due to the complete compliance of the patients with the hygiene rules and isolation. In our study, although MHD patients had a higher rate of SARS-CoV-2 infection than CAPD patients in the last year, this result did not reach statistical significance. Also, there was no statistically significant difference between the two groups in hospitalization due to SARS-CoV-2 infection, admission to intensive care unit, need for mechanical ventilation, and mortality. Although there are studies on the safety of CAPD against HD during the COVID-19 pandemic in the literature, the data from our study contradicted the literature on the idea that CAPD was superior to HD based on reducing mortality, the frequency of disease transmission, and its safety. This suggests that they failed to wisely evaluate the hospital independence that the peritoneal dialysis modality provides for CAPD patients.

Our study had limitations. Theoretically, the patients with no or mild symptoms have been underrepresented in our database. Such bias was not expected to be significant because dialysis patients are generally under close medical follow-up and are likely to express themselves without hesitation when they have complaints.

In summary, although no difference was observed between the two dialysis modalities, the mortality rate in hemodialysis and CAPD patients, especially in hospitalized ones, was higher than in the general population. In the last year, mortality in dialysis patients was significantly associated with heart failure and SARS-CoV-2 infection. Our findings are important in guiding clinical decision-making and informing the public and health authorities about the risk of death associated with COVID-19 in hemodialysis and CAPD patients. Besides, in hemodialysis and CAPD patients, there was no significant difference for SARS-CoV-2 positivity, mortality, hospitalization, need for intensive care, and need for ventilator support, and finally for overall mortality rate.

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Declarations

Conflict of interest The authors declare that there are no conflicts of interest in connection with this paper.

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