



Clinical Profile and Outcomes of COVID-19-Infected Chronic Kidney Disease Patients on Maintenance Hemodialysis

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Abstract

Background: Coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has led to a global pandemic. Mortality and morbidity following COVID-19 were high in patients with preexisting comorbidities like diabetes mellitus, hypertension, underlying lung disease like COPD, etc. Patients with chronic kidney disease have a particularly high chance of acquiring infection, as well as high mortality following COVID-19 infection. **Materials and Methods:** We have done a retrospective observational analysis of 39 chronic kidney disease patients on maintenance hemodialysis admitted at our center with COVID-19 infection. **Results:** Among the 39 participants, 57% were male and 43% were female, with a mean age of 44.2 years. The primary presenting symptoms were cough (64.1%) and breathlessness (59%). The following factors were associated with mortality: comorbidities like hypertension and COPD, breathlessness during presentation, delayed admission, prolonged hospital stay, dialysis vintage, CORADS score, and requirement of invasive ventilation (statistically significant). 5 patients died during hospitalization (12.8%). **Conclusion:** The study found that chronic kidney disease (CKD) patients with COVID-19 had an encouraging survival rate of 87.2%. However, delayed diagnosis and admission (within 2 days of symptoms), longer hospital stays (6 days or more), presence of breathlessness, hypertension, longer time on dialysis (3 years or more), patients with more severe lung involvement (higher CO-RADS score), development of multiple organ dysfunction syndrome (MODS), and those requiring invasive mechanical ventilation had a significantly higher risk of death. Interestingly, Remdesivir administration was linked to a decreased risk of mortality.

Keywords: COVID-19, chronic kidney disease (CKD), Hemodialysis, SARS-CoV-2.

Introduction:

The global health crisis precipitated by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has disproportionately affected individuals

with underlying comorbidities, particularly chronic kidney disease (CKD). Patients with CKD are at heightened risk of both SARS-CoV-2 infection and severe disease progression, leading to increased

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morbidity and mortality. Several studies have highlighted the vulnerability of CKD patients to COVID-19(1,2). Factors such as immune dysregulation, inflammation, and underlying comorbidities contribute to their increased susceptibility (3). Moreover, the impact of dialysis modalities and immunosuppressive therapies on the immune response may further exacerbate the disease course. To address this pressing issue, we conducted a retrospective observational study to investigate the clinical characteristics, risk factors, and outcomes of CKD patients hospitalized with COVID-19 at our center.

Materials and methods:

This is a retrospective observational study conducted at a tertiary care center (Aarupadai Veedu Medical College & Hospital) in South India. The study population comprised patients undergoing maintenance hemodialysis who were admitted to our facility with a confirmed COVID-19 infection. The study period was from July 2020 to December 2020. The patients had positive nasopharyngeal swabs for SARS-CoV-2 by reverse transcription polymerase chain reaction (RT-PCR) (4).

Inclusion criteria:

1. Chronic kidney disease patients on maintenance hemodialysis who have been diagnosed with COVID-19 infection by serology or RT-PCR.
2. Age more than 20 years
3. At least 3 months on maintenance hemodialysis

Exclusion criteria:

1. Acute kidney injury patients on hemodialysis.
2. COVID-19 suspect patients who are seronegative and RT-PCR negative

Following admission, patients underwent the following investigations: CRP, serum LDH, renal function test, and serum ferritin, apart from routine investigations. Patients underwent chest imaging by computed tomography (CT). The findings were graded radiologically based on the percentage of lung involvement (<25%, 25%–50%, 50%–75%,

and >75% lung involvement were assigned as Grades 1, 2, 3, and 4, respectively). Specific therapy included the use of low-molecular-weight heparin (LMWH; enoxaparin 40 mg subcutaneously daily for 5 days) and steroids for all patients who were hypoxemic despite adequate ultrafiltration and those with radiological lung involvement of >25% (Grade 2 and above). Remdesivir injection was given to all patients who had severe lung involvement.

Ethical clearance:

This study was approved by the Institutional Ethics Committee at our center. An informed consent form was obtained from all study group subjects.

Statistical methods:

This study employed descriptive statistics, including percentages and frequencies, to summarize the baseline characteristics of participants, such as age, sex, CO-RADS score, and comorbidities. To investigate associations between categorical variables (e.g., symptoms, treatments, and the outcome of death or survival), the Chi-square test was utilized, with p-values (less than 0.05) indicating the statistical significance of any observed relationships.

Results:

The study included a predominantly young adult population, with most patients aged between 20-40 years and 41-60 years. Males slightly outnumbered females. In terms of disease severity, a significant portion of patients had moderate to mild lung involvement, as indicated by a CO-RADS score of 2 or 1. A quarter of the patients developed multiple organ dysfunction syndrome. Regarding treatment and hospitalization, the majority of patients were hospitalized for 4 or 5 days. Nearly half received remdesivir, and a similar proportion received steroids. Most patients did not require invasive mechanical ventilation, while a significant number needed non-invasive ventilation. The majority of the patients had been on maintenance hemodialysis for two to three years. Despite the challenges posed by COVID-19, the overall survival rate was

encouraging, with 87.2% of patients surviving the infection (Table 1).

Table 2 summarizes the signs, symptoms, and comorbidities of 39 CKD patients. Most patients did not have fever (97.4%) or loose stool (87.2%). However, a significant proportion experienced cough (64.1%), myalgia (46.2%), and breathlessness (59.0%). Anosmia was reported in 33.3% of patients. Regarding comorbidities, diabetes mellitus was present in 25.6% of patients, hypertension in 28.2%, and CAD and COPD in 15.4% each. Only one patient (2.6%) had HCV.

(Table 3 & 4) shows that patients who were diagnosed and admitted within 2 days ($p = 0.004$)

and who stayed in the hospital for 6 or more days had a higher risk of death compared to those with shorter stays ($p = 0.020$). Patients with breathlessness ($p = 0.046$), hypertension ($p = 0.006$), COPD ($p = 0.003$), and longer dialysis vintage (3 years or more) had a higher risk of death compared to those with a shorter dialysis vintage ($p = 0.004$).

Table 5 suggests that the severity of lung involvement (CO-RADS score), the presence of MODS, and the need for invasive mechanical ventilation are important factors associated with increased mortality risk in CKD patients with COVID-19.

Table 1 Basic characteristics of study participants:

Variables		N	%(percentage)
Age	20-40 years	17	43.6
	41-60 years	17	43.6
	More than 60 years	5	12.8
Sex	Female	17	43.6
	Male	22	56.4
CO-RADS score	CO-RADS 1	7	17.9
	CO-RADS 2	14	35.9
	CO-RADS 3	3	7.7
	CO-RADS 4	6	15.4
	CO-RADS 5	9	23.1
MODS(multiple organ dysfunction syndrome)	No	29	74.4
	Yes	10	25.6
Duration of hospital stay(days)	2	1	2.6
	3	2	5.1
	4	12	30.8
	5	12	30.8
	6	3	7.7
	7	1	2.6
	8	4	10.3
	10	2	5.1
	14	1	2.6
	18	1	2.6
Remdesivir treatment	No	20	51.3
	Yes	19	48.7
Steroid treatment	No	22	56.4
	Yes	17	43.6
NIV(Non invasive ventilation)	No	23	59
	Yes	16	41
Invasive mechanical ventilation	No	35	89.7
	Yes	4	10.3
Dialysis vintage(years)	1	3	7.7
	2	20	51.3
	3	9	23.1
	4	5	12.8
	5	2	5.1
Outcomes	Death	5	12.8
	Survived	34	87.2
	Total	39	100

Table 2 shows the signs, symptoms, and comorbidities of the study participants:

Variables		N	%
Fever	No	38	97.4
	yes	1	2.6
Cough	No	14	35.9
	yes	25	64.1
Myalgia	No	21	53.8
	yes	18	46.2
Breathlessness	No	16	41.0
	yes	23	59.0
Loose stool	No	34	87.2
	yes	5	12.8
Anosmia	No	26	66.7
	yes	13	33.3
Diabetes Mellitus	No	29	74.4
	yes	10	25.6
Hypertension	No	28	71.8
	YES	11	28.2
CAD	No	33	84.6
	YES	6	15.4
COPD	No	33	84.6
	YES	6	15.4
HCV	No	38	97.4
	YES	1	2.6

Table 3. Distribution of outcome with selected variables:

Variables		Outcome					Chi square	p value
		Death		Survived		Total		
Age	20 - 40 years	1	2.6	16	41.0	17	4.054 ^a	.132
	41 - 60 years	2	5.1	15	38.5	17		
	more than 60 years	2	5.1	3	7.7	5		
Sex	Female	1	2.6	16	41.0	17	1.298 ^a	.255
	Male	4	10.3	18	46.2	22		
Diagnosis to admission(days)	1	0	0.0	8	20.5	8	19.242 ^a	.004*
	2	0	0.0	11	28.2	11		
	3	1	2.6	5	12.8	6		
	4	1	2.6	7	17.9	8		
	5	0	0.0	2	5.1	2		
	6	2	5.1	0	0.0	2		
	7	1	2.6	1	2.6	2		
Duration of hospital stay(days)	2	0	0.0	1	2.6	1	19.615 ^a	.020*
	3	1	2.6	1	2.6	2		
	4	0	0.0	12	30.8	12		
	5	0	0.0	12	30.8	12		
	6	1	2.6	2	5.1	3		
	7	0	0.0	1	2.6	1		
	8	2	5.1	2	5.1	4		
	10	0	0.0	2	5.1	2		
	14	1	2.6	0	0.0	1		
	18	0	0.0	1	2.6	1		
Based on symptoms	Symptomatic	5	12.8	33	84.6	1	0.151	0.698
	Asymptomatic	0	0.0	1	2.6	38		

p-value less than 0.005 (statistical significance)

Table 4. Distribution of outcomes with various symptoms

Variables		Outcome				Total	Chi square	P value
		Death		Survived				
		N	%	N	%			
Fever	No	5	12.8	33	84.6	38	.151 ^a	.698
	yes	0	0.0	1	2.6	1		
Cough	No	0	0.0	14	35.9	14	3.212 ^a	.073
	yes	5	12.8	20	51.3	25		
Myalgia	No	1	2.6	20	51.3	21	2.644 ^a	.104
	yes	4	10.3	14	35.9	18		
Breathlessness	No	0	0.0	16	41.0	16	3.990 ^a	.046*
	yes	5	12.8	18	46.2	23		
Loose stool	No	3	7.7	31	79.5	34	3.791 ^a	.052
	yes	2	5.1	3	7.7	5		
Anosmia	No	3	7.7	23	59.0	26	2.649 ^a	.266
	yes	2	5.1	11	28.2	13		
Diabetes mellitus	No	2	5.1	27	69.2	29	4.446 ^a	.108
	YES	3	7.7	7	17.9	10		
Hypertension	No	1	2.6	27	69.2	28	7.598 ^a	.006*
	YES	4	10.3	7	17.9	11		
CAD	No	4	10.3	29	74.4	33	.094 ^a	.759
	YES	1	2.6	5	12.8	6		
COPD	No	2	5.1	31	79.5	33	8.770 ^a	.003*
	YES	3	7.7	3	7.7	6		
HCV	No	5	12.8	33	84.6	38	.151 ^a	.698
	YES	0	0.0	1	2.6	1		
Dialysis vintage(years)	1	0	0.0	3	7.7	3	15.290 ^a	.004*
	2	1	2.6	19	48.7	20		
	3	0	0.0	9	23.1	9		
	4	3	7.7	2	5.1	5		
	6	1	2.6	1	2.6	2		

*p-value less than 0.005 (statistical significance)

Table 5: Distribution of outcome with CO-RADS score, MODS, and various treatments.

Variables		Outcomes					Chi square	P value
		Death		Survived		Total		
		N	%	N	%	N		
CO-RADS score	1	0	0	7	17.9	7	11.662	.020*
	2	0	0	14	35.9	14		
	3	0	0	3	7.7	3		
	4	1	2.6	5	12.8	6		
	5	4	10.3	5	12.8	9		
MODS	No	0	0	29	74.4	29	16.632	.000*
	Yes	5	12.8	5	12.8	10		
Steroid	No	1	2.6	21	53.8	22	3.092	.079
	Yes	4	10.3	13	33.3	17		
Remdesivir	No	0	0	20	51.3	20	6.037	.014*
	Yes	5	12.8	14	35.9	19		
NIV	No	3	7.7	20	51.3	23	.002	.960
	Yes	2	5.1	14	35.9	16		
Invasive mechanical ventilation	No	2	5.1	33	84.6	35	15.418	.000*
	Yes	3	7.7	1	2.6	4		

*p-value less than 0.005 (statistical significance).

Discussion:

Chronic kidney disease patients, particularly those undergoing hemodialysis, are at heightened risk of contracting COVID-19 due to the close proximity and contact experienced during dialysis sessions. The prolonged close interactions between hemodialysis patients, as well as with healthcare workers, during these procedures significantly elevate the potential for disease transmission (5,6). While the COVID-19 pandemic has significantly impacted the global population, the clinical course

and outcomes of the infection among hemodialysis patients have been documented in relatively fewer studies. Most hemodialysis patients with COVID-19 exhibited clinically observable symptoms, corroborating the findings reported by Valeri et al. and other studies (7). Regarding the association with diabetes, our study's lack of a statistically significant link between diabetes and mortality/morbidity aligns with results from other investigations. This suggests that while diabetes is a risk factor for severe COVID-19 in the general population, its impact on

hemodialysis patients may be less pronounced (8-10). The research by Mohamed NE et al. demonstrated that pre-existing chronic obstructive pulmonary disease and hypertension were significantly linked to elevated mortality rates among COVID-19 patients. The study patients diagnosed with COPD demonstrated a substantially greater risk of mortality than those unaffected by the disease. Likewise, patients with hypertension experienced a greater mortality risk relative to those without hypertension (11). These results are consistent with the findings of the current study. Salerno et al. reported a COVID-19 mortality rate of 26.0% among long-term dialysis patients within a cohort of 60,090 Medicare beneficiaries with the virus, of whom 15,612 succumbed. This rate is substantially higher than the 12.8% observed in the current investigation, suggesting a marked contrast in clinical outcomes between the two studied populations (12). Our study found no significant difference in mortality rates between patients who received steroid treatment and those who did not, which contrasts with the findings reported by P. Hoby et al (13). The investigation conducted by P. Hoby and colleagues suggested a potential association between corticosteroid therapy and elevated mortality rates among COVID-19 patients. Specifically, their systematic review and meta-analysis revealed a notably higher mortality rate among individuals receiving corticosteroid treatment compared to those who did not. The reason might be due to the timing and dosage of steroid treatment in COVID-19 patients are crucial, as early or prolonged use may have adverse effects, while a well-timed course can be beneficial, especially in severe cases, where it can reduce inflammation. A single-center study in Iran involving 43 adults with chronic kidney disease and confirmed COVID-19 infection found that 38 of the 43 patients were discharged after treatment, reflecting a high survival rate within this population. Only 5 patients succumbed to the illness, which closely aligns with the 87.2% survival rate reported in the present study.

These findings suggest that while CKD patients may be at elevated risk, many can recover from COVID-19 (14). A recent study suggests that CKD patients diagnosed and admitted to the hospital within two days of COVID-19 symptom onset had a significantly elevated mortality risk, as indicated by a p-value of 0.004. This finding underscores the importance of timely diagnosis and hospitalization for improving clinical outcomes in CKD patients with COVID-19 (15). The current study found that longer hospital stays were associated with increased mortality risk. However, other investigations conducted by Özdemir et al. (16) and He et al. (17) reported statistically non-significant results, potentially influenced by variations in patient cohorts and methodological factors like sample size and study design. Our findings indicate that chronic kidney disease patients who develop multiple organ dysfunction syndrome or necessitate invasive mechanical ventilation are at a significantly elevated risk of mortality. This observation aligns with previous research highlighting the heightened vulnerability of CKD individuals to severe COVID-19 outcomes, owing to their compromised health status and the systemic impact of the virus on multiple organs, including the lungs (18). Use of Remdesivir was associated with reduced mortality risk in our patients ($p = .014$), which is corroborated by other research indicating that antiviral interventions like Remdesivir can enhance outcomes for COVID-19 individuals, especially those with comorbidities such as chronic kidney disease (19).

Conclusion:

The study found that chronic kidney disease (CKD) patients with COVID-19 had an encouraging survival rate of 87.2%. However, certain factors were linked to a higher risk of death. These included delayed diagnosis and admission (within 2 days of symptoms), longer hospital stays (6 days or more), presence of breathlessness, hypertension, and longer time on dialysis (3 years or more). Patients with more severe lung involvement (higher CO-RADS

score), development of multiple organ dysfunction syndrome (MODS), and those requiring invasive mechanical ventilation had a significantly higher risk of death. Interestingly, Remdesivir administration was linked to a decreased risk of mortality. These findings suggest that early intervention, close monitoring for specific risk factors, and the use of Remdesivir may be important for improving outcomes in CKD patients with COVID-19.

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