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COVID-19 in Chronic Hemodialysis Patients: A Multicenter Study

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Abstract **Original Research Article**

Introduction*:** In December 2019, a series of cases of viral pneumonia caused by a new coronavirus appeared in Wuhan, China, and quickly spread to all continents, becoming a global pandemic. The disease called COVID 19 threatens the health and life of patients, especially those with a concomitant disease. Chronic hemodialysis patients represent a vulnerable population due to the high prevalence of comorbidities, namely diabetes, hypertension, immunosuppression, etc., adding to this the need to go to a hospital several times a week to receive their treatment increasing the risk of contamination. Mohammed VI University hospital center in Marrakech was the first structure in Morocco to take charge a chronic hemodialysis patient suffering from COVID 19, the aim of this analysis is therefore to describe the clinical, biological and radiological characteristics of COVID19 in chronic hemodialysis patients, but above all to address the methods of management and the various therapeutic protocols adapted to this type of patients. ***Materials and Methods: We conducted a multicenter prospective longitudinal study over a period of 12 months, including chronic hemodialysis patients with both first and second wave of COVID 19; in different hemodialysis centers in the Marrakech Tansift Alhaouz region. The diagnostic criteria for COVID 19 were selected according to the recommendations of the Ministry of Health. ***Results*:** A total of 76 patients were studied. The average age of our patients is 57 years ± 16 years with a sex ratio of 1.45. Among our patients, 59 patients (77.6%) present one or more risk factors for morbidity and mortality from COVID 19:

- 22 patients (28.94%) are diabetic
- 42 patients (55.26%) are hypertensive
- 13 patients (17.10%) are carriers of cardiovascular disease
- 09 patients (11.84%) are carriers of a chronic respiratory disease
- 13 patients (17.10%) presented with obesity
- 03 patients (03.94%) are on immunosuppressants

The most common symptoms in our patients were fever, asthenia, cough and anosmia.
CRP was elevated in 67 patients (88.15%), lymphopenia was found in 61 patients (80.2%) and ferritin was elevated in 42 patients (55%). Forty-six patients (60%) have blood group O, 17 patients are blood group A, 6 patients have blood group B and 5 are blood group AB. Thoracic computed tomography was performed in 56 patients objectifying ground glass images of varying severity in 53 % of them.
The prescribed medical treatment is as follows:

- First-line treatment: chloroquine + Azythromicyne
- 2nd line treatment: Lopinavir + Azythromicyne
- Anticoagulation
- Adjuvant treatment: Vitamin C, Vitamin D, ZINC, Paracetamol
- Associated antibiotic therapy: C3G, Levofloxacin, Amoxicillin clavulanic acid.
- Corticosteroid therapy

The management of hemodialysis sessions is schematized as follows:

- Dialysis protocol
- Rhythm of sessions - durations
- Anticoagulation during sessions

Thirty-five patients or 46% had recourse to resuscitation measures (NIV, INTUBATION)
The number of deaths in our sample was 16 or 21.05%.

Short-term sequelae of COVID19 were observed in 32 patients (42%), dyspnea and asthenia ranked first.
Conclusion: Chronic hemodialysis patients remain a population particularly vulnerable to COVID 19, hence the importance of prevention and the intensification of barrier measures in these patients. The management remains poorly codified in the absence of any obvious recommendation, making the prognosis in his patients mixed.
Keywords: COVID-19, SARS-CoV-2, End-Stage Chronic Kidney Disease, Hemodialysis, Diagnosis, Treatment, Evolution.

INTRODUCTION

The COVID-19 pandemic, originating in Wuhan, China, in late December 2019, rapidly evolved into a global health crisis [1], affecting millions worldwide [2]. Caused by the highly contagious SARS-CoV-2 virus, characterized by an incubation period of 3 to 14 days [3], the disease presents with variable severity, ranging from asymptomatic infection to severe pneumonia and multi-systemic failure [4]. While most cases are mild, individuals with certain risk factors, including advanced age (>62 years), obesity, arterial hypertension, diabetes, cardiovascular diseases, and immunosuppressive diseases [5], are prone to severe outcomes.

From the pandemic's outset, patients with chronic diseases were identified as being at higher risk. Chronic hemodialysis patients are particularly vulnerable due to both their frequent comorbidities (such as diabetes, hypertension, and heart disease) and the necessity of regular visits to healthcare facilities for treatment. This routine increases their potential exposure through contact with healthcare staff, transport agents, and other patients. Recognizing this vulnerability, the Nephrology department at Mohammed VI University Hospital in Marrakech began managing these patients in March 2020. This multicenter study was undertaken to describe the epidemiological and clinical characteristics, diagnostic approaches, therapeutic management, and outcomes of chronic hemodialysis patients diagnosed with COVID-19 in the Marrakech region.

MATERIALS AND METHODS

I. Study Design

We conducted a prospective, multicenter, longitudinal study combining descriptive and analytical approaches. The study spanned a 12-month period, from March 2020 to March 2021. It involved analyzing the medical records of chronic hemodialysis patients within various hemodialysis centers in the Marrakech-Tensift-Alhaouz region. The study cohort included patients affected during both the first and second waves of the COVID-19 pandemic.

II. Study Population

The study population consisted of chronic hemodialysis patients diagnosed with COVID-19. We established specific inclusion and exclusion criteria for patient enrollment.

1. Inclusion Criteria: Patients were included if they had end-stage chronic kidney disease requiring maintenance hemodialysis (for more than one month) and were receiving treatment at participating hemodialysis centers (University Hospital, public, or private) in the Marrakech-Tensift-Alhaouz region, provided their data and follow-up information were available. COVID-19 diagnosis was confirmed based on the recommendations from the Ministry of Health. During the first wave, diagnosis relied on positive RT-PCR or serological tests. For the second wave, and in line with the Ministry of Health's surveillance and response manual, a confirmed case, in the absence of RT-PCR or serological tests, could be based on suggestive thoracic computed tomography (CT) images combined with a suggestive epidemiological context.

2. Exclusion Criteria: Patients were excluded if their medical records were incomplete, if they were lost to follow-up, or if their COVID-19 diagnosis was considered doubtful.

III. Data Collection

Data were gathered prospectively by visiting participating centers and reviewing patient medical records using a pre-established, standardized data collection form. Collection initially focused on Mohammed VI University Hospital, the primary center during the first wave, and later expanded to include IBN TOFAIL Hospital (severe cases), IBN ZOHR Hospital (moderate cases), and peripheral hemodialysis centers managing mild or paucisymptomatic cases.

IV. Parameters Analyzed

For each patient, the following data were collected and analyzed:

- **Demographic and Socioeconomic Data:** Age, sex, health coverage, occupation.
- **Hemodialysis Characteristics:** Dialysis vintage, weekly dialysis dose, and etiology of chronic kidney disease.
- **Comorbidities:** Presence of conditions associated with poor COVID-19 prognosis (e.g., diabetes, hypertension, respiratory diseases, cardiovascular diseases, immunosuppression, obesity).
- **COVID-19 Diagnosis:** Method used (RT-PCR, serology, CT scan). For CT scans, the extent of lung lesions was visually assessed and

categorized (<10%, 10-25%, 26-50%, 51-75%, >75%).

- **Clinical Data:** Presenting symptoms, clinical examination findings (including oxygen saturation), and routine laboratory results (e.g., complete blood count, C-reactive protein [CRP], ferritin, kidney function).
- **Radiological Data:** Findings from chest X-rays and CT scans.
- **Treatment Regimen:** Details of prescribed COVID-19 therapies (e.g., Hydroxychloroquine, Azithromycin, Lopinavir), anticoagulants, antibiotics for superinfections, and symptomatic treatments (vitamins, zinc, paracetamol).
- **Hemodialysis Management:** Adjustments or specifics related to dialysis sessions during infection.
- **Outcomes:** Short-term sequelae observed after recovery.

V. Statistical Analysis

Descriptive analysis was performed using Excel, with quantitative variables summarized as means ± standard deviations (SD) or medians and interquartile ranges (IQR), and qualitative variables as frequencies and percentages. Analytical statistics were conducted using Minitab software and verified by a biostatistician. Univariate and multivariate logistic regression analyses were used to assess the association between various demographic, clinical, biological, and radiological factors and adverse outcomes (defined as transfer to intensive care unit [ICU] and/or death). Odds ratios (OR) with 95% confidence intervals and P-values were calculated. A P-value < 0.05 was considered statistically significant. Chi-square tests or Fisher's exact tests were used for comparing categorical variables where appropriate.

RESULTS

I/Descriptive Results:

1. Epidemiological Characteristics

A total of 76 chronic hemodialysis patients with COVID-19 were included in the study. The mean age was 57 ±16 years, with 54% aged 60 or older (Figure 1).

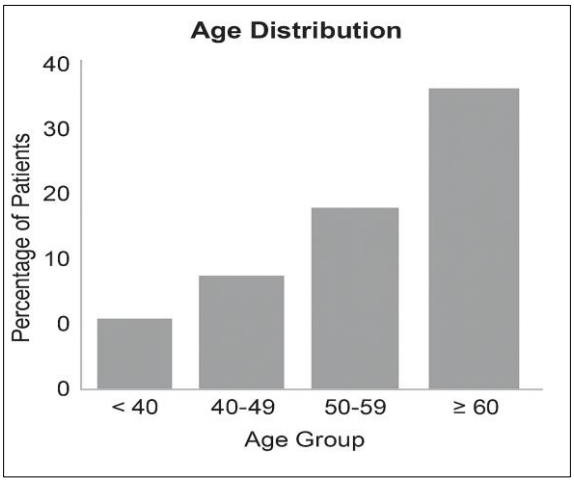

Figure 1

Gender distribution showed a male predominance: 59% male (n=45) and 41% female (n=31), with a male-to-female ratio of 1.45.

In terms of geographical origin, all first-wave patients were from urban areas. In the second wave, 24 patients (38%) were from rural areas.

2. Hemodialysis Characteristics

Diabetic nephropathy (27.6%) and hypertensive nephropathy (21%) were the leading causes of end-stage renal disease. (Figure 2)

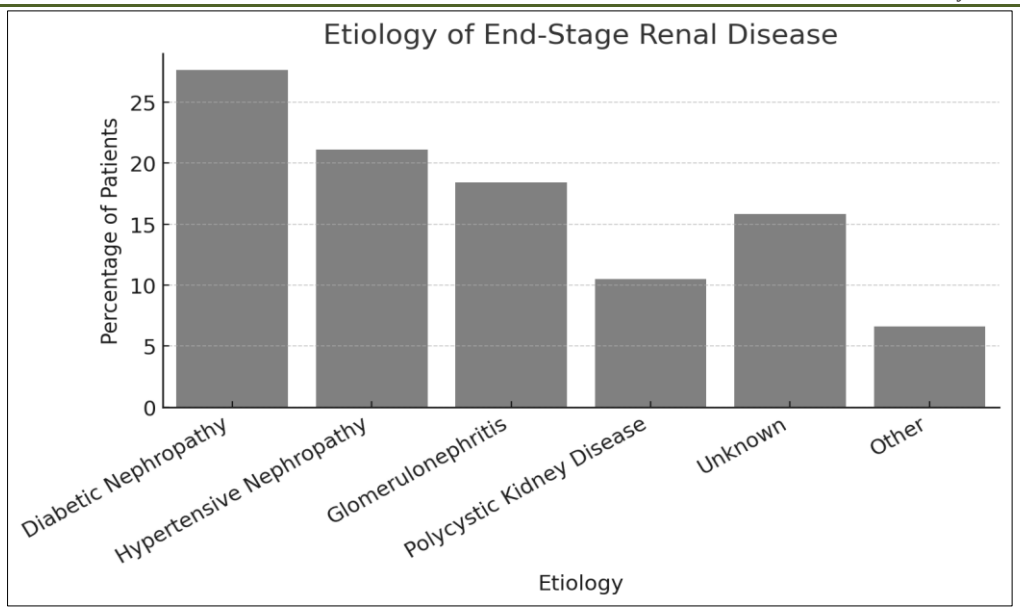

Figure 2

The median dialysis vintage was 45 months (IQR: 24–109). Most patients (61%) received 12 hours of hemodialysis per week (three 4-hour sessions), primarily in private centers (59%).

3. Comorbidities

The majority of patients (77.6%) had at least one comorbidity. Hypertension was the most frequent (55.3%), followed by diabetes mellitus (28.9%), cardiovascular disease (17.1%), and obesity (BMI >30) (17.1%). Chronic respiratory disease affected 11.8%. (Figure 3)

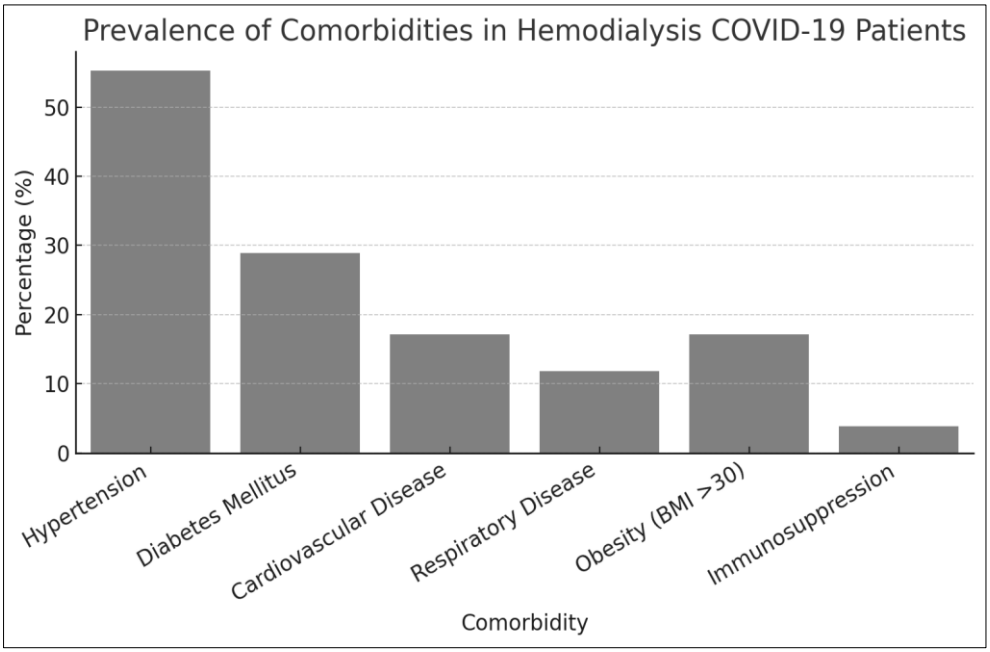

Figure 3

4. Clinical Presentation

Most patients (93.4%) were symptomatic at diagnosis. Fever (84.2%), cough (55.3%), headache (51.3%), and dyspnea (51.3%) were the most common symptoms. Only 6.6% were asymptomatic. (Table 1)

Table 1: Clinical Symptoms at Presentation

Clinical Features	Number of Patients	Percentage (%)
Fever	64	84.2%
Cough	42	55.3%
Headache	39	51.3%
Dyspnea	39	51.3%
Asthenia	32	42.1%
Myalgias	32	42.1%
Anosmia	19	25.0%
Ageusia	17	22.4%
Chest Pain	14	18.4%
Respiratory Distress	11	14.5%
Diarrhea	12	15.8%
Asymptomatic	5	6.6%

At admission, 32.8% had hypoxemia (SaO_2 < 92%), including 21% with severe hypoxemia (SaO_2 < 90%). (Table 2)

Table 2: Oxygen Saturation at Admission

Oxygen Saturation Level	Number of Patients	Percentage (%)
Normal (>92%)	51	67.1%
Mild Hypoxemia (90–92%)	9	11.8%
Severe Hypoxemia (<90%)	16	21.0%

6. Diagnostic Findings

Diagnosis was primarily confirmed by RT-PCR (performed in 92.1%, positive in 95.7% of those tested). In 9.2% of cases, diagnosis relied on suggestive chest CT findings in a compatible clinical context. Key laboratory findings included elevated C-reactive protein (CRP) in 88% (mean 109 ± 78 mg/L), lymphopenia in 80.2% (median 980.5/µL), and elevated ferritin (>500 ng/mL) in 65.2% of those tested. Blood group O was most common (63.2%).

7. Radiological Findings

Chest CT scans were performed in 73.6% of patients, showing abnormalities (typically ground-glass opacities) in 89.3%. The extent of pulmonary involvement found on these scans is illustrated in Figure 4.

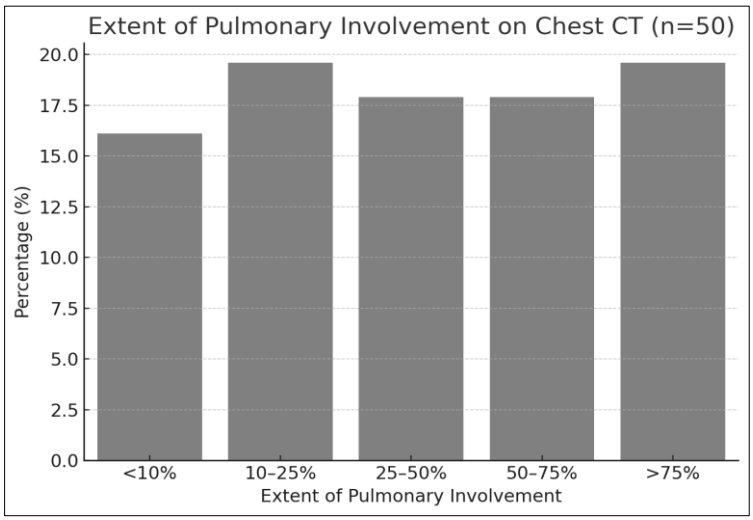

Figure 4

8. Therapeutic Management

Almost all patients (97.4%) received COVID-19 treatment adjusted for renal function, primarily based on national protocols involving chloroquine or lopinavir/ritonavir, usually combined with azithromycin. Antibiotics were administered for suspected superinfections. All patients received symptomatic care (vitamins, zinc, paracetamol) and systematic anticoagulation outside dialysis sessions; corticosteroids and oxygen therapy were used based on severity.

9. Dialysis Logistics and Intensive Care Management

Patients received 12 hours of hemodialysis weekly. Management locations (dedicated wards, ICU,

peripheral centers) varied by pandemic wave and clinical severity, with strict infection control measures. ICU admission followed national criteria. Respiratory support included non-invasive ventilation (25%), invasive mechanical ventilation (21%), or high-concentration oxygen mask alone (10.5%). Mean ICU stay was 23 ± 4 days.

10. Clinical Outcomes

- Recovery was achieved in 78.9% of patients (n=60), with a mean time to symptom resolution of 10 ± 3 days. The overall mortality rate was 21.1% (n=16), typically associated with ARDS progression. Among survivors followed for 1-3 months, common sequelae included dyspnea (17.1%), asthenia/fatigue (15.7%), and persistent cough (9.2%).

II Analytical Results

Univariate and subsequent multivariate analyses identified several factors significantly associated ($P<0.05$) with an increased risk of ICU admission and/or mortality. Key risk factors included:

- **Demographics:** Advanced age (>60 years).
- **Comorbidities:** Diabetes mellitus, cardiovascular disease, chronic respiratory disease. Hypertension was linked to ICU admission but not significantly to mortality in the final analysis.
- **Clinical Presentation:** Fever, dyspnea, respiratory distress, chest pain, and hypoxemia (especially severe).
- **Laboratory Markers:** Elevated CRP (> 50 mg/L) and ferritin (> 500 ng/mL).
- **Radiological Findings:** Chest CT involvement > 25%.
- **Other:** Blood group A.

Multivariate analysis revealed that combining age with cardiometabolic comorbidities significantly improved the prediction of adverse outcomes. Notably, the combination of age and diabetes had the strongest association with ICU admission ($R^2 = 83.4\%$), while age and cardiovascular disease showed the highest predictive value for mortality ($R^2 = 91.1\%$). These and other combinations are summarized in Table 3.

Table 3: Predictive Value of Risk Factor Combinations (R^2)

Combination	R^2 (ICU Admission)	R^2 (Mortality)
Age + Diabetes	83.4%	88.6%
Age + Hypertension	77.0%	87.6%
Age + Cardiovascular Disease	80.1%	91.1%
Age + Obesity	64.4%	81.3%
Age + Diabetes + Cardiovascular Disease	75.1%	63.5%
Age + Hypertension + Cardiovascular Disease	70.2%	63.5%
Age + Diabetes + Hypertension	73.6%	58.9%
Age + Diabetes + Obesity	70.2%	50.6%

DISCUSSION

This study provides valuable insights into the characteristics and outcomes of COVID-19 among chronic hemodialysis (HD) patients in the Marrakech region. Consistent with global reports, we observed high mortality in this population compared to the general public [6], underscoring their vulnerability due to both intrinsic factors like comorbidities and extrinsic factors like frequent healthcare exposure [7].

Our cohort's mean age (57 ±16 years) was lower than reported in many European or Chinese series [8], but higher than some African cohorts [9], likely reflecting local demographics. The male predominance (59%) aligns with most COVID-19 studies in both general and HD populations [10]. The emergence of rural cases during the second wave likely relates to population movements post-lockdown. Diabetic nephropathy was the leading cause of ESRD (27.6%) [10], differing from reports elsewhere [11], but reflecting the local burden of diabetes and hypertension. Dialysis vintage was comparable to other reports [10].

A high prevalence of comorbidities (77.6%) was noted [7], with hypertension (55.3%) and diabetes (28.9%) being most common, consistent with other series [10].

The majority of patients (93.4%) were symptomatic. Fever (84.2%) was the most frequent symptom, contrasting with some studies [8] but aligning with others [12]. Dyspnea prevalence (51.3%) was relatively high compared to most series except one Turkish study [13]. Anosmia/ageusia affected 25%. The low rate of asymptomatic cases (7%) compared to some studies (e.g., Wuhan 54% [8], Italy 49% [14]) might reflect differences in screening protocols [8]. Notably, cardiovascular [11], neurological [15], or thromboembolic complications reported in other HD cohorts [11] or ICU patients [16] were not observed in our series, potentially influenced by routine anticoagulation [17]. The rate of hypoxia (<92%) upon admission (32.8%) falls within ranges reported by others [18].

Diagnostic findings aligned with expectations: lymphopenia (80.2%) and elevated CRP (88%) [19], were frequent, consistent with literature [10] Hyperferritinemia (>500 ng/L) was common (65.2%), consistent with other cohorts [20]. RT-PCR was the primary diagnostic method [10], consistent with WHO recommendations and literature [17]. Chest CT (used in 73.6%) showing typical ground-glass opacities in most (89.3%) aligned with guidelines [17], and other findings [8].

Treatment largely followed national protocols adjusted for renal function, primarily involving hydroxychloroquine/azithromycin or lopinavir/ritonavir [21], alongside systematic anticoagulation [17], and supportive care. This approach aligns with some international practices, although specific regimens varied across studies [10]. Management strategies, including dialysis logistics and ICU care (with 46% requiring ventilation support), were adapted to the pandemic context, with ventilation rates comparable to or lower than some studies [10].

The recovery rate of 78.9% and mortality rate of 21.1% are comparable to findings in other international HD cohorts (mortality typically 18.5-33% [7]), confirming the significantly elevated risk in this population [6]. Short-term sequelae like dyspnea and fatigue were noted [22]. Our analytical study corroborated known risk factors for severe outcomes, including advanced age, diabetes, cardiovascular and respiratory disease, clinical signs like dyspnea and hypoxia, elevated inflammatory markers (CRP, ferritin), extensive CT lung involvement, and notably, blood group A. These findings are largely consistent with existing literature [20], although the significance of specific factors may vary between studies [23]. The link between blood group and COVID-19 severity remains debated [24]. Immunological factors, potentially including a blunted immune response in uremia as suggested by Yiqiong *et al*., [11], may also influence clinical presentation and outcomes in HD patients.

CONCLUSION

This multicenter study outlines the clinical and epidemiological profile of COVID-19 in chronic hemodialysis patients from the Marrakech-Tensift-Alhaouz region. Mortality was significantly higher than in the general population, primarily due to frequent healthcare exposure and existing comorbidities. Symptoms such as fever, chest pain, hypoxia, and respiratory distress were strongly associated with severe outcomes. Additionally, blood group a appeared linked to increased mortality, suggesting a potential immunological role. These findings highlight the urgent need for early intervention strategies and reinforce the importance of preventive measures, particularly vaccination, in this high-risk group.

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