


## ORIGINAL ARTICLE

### Infection

# The impact of COVID-19 in hemodialysis patients: Experience in a hospital dialysis unit

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#### Abstract

**Introduction:** COVID-19 is a very high transmission disease with a variable prognosis in the general population. Patients in hemodialysis therapy are particularly vulnerable to developing an infectious disease, but the incidence and prognosis of hemodialysis patients with COVID-19 is still unclear. The main objective is to describe the experience of our dialysis unit in preventing and controlling the spread of SARS-CoV-2 infection.

**Methods:** Preventive structural and organizational changes were applied to all patients and health care personnel in order to limit the risk of local transmission of SARS-CoV-2 infection.

**Findings:** The Nephrology department at Sant Joan Despí Moises Broggi Hospital-Consorci Sanitari Integral is a reference for two satellite hemodialysis centers caring for 156 patients. We combine our own hemodialysis maintenance program for 87 patients with hospitalized patients from peripheral hemodialysis centers. In this area, the reported incident rate of COVID-19 in these peripheral hemodialysis centers was 9.5% to 19.9% and the death rate 25% to 30.5%. In our hemodialysis program, the incidence rate was 5.7%. Three out of five required hospitalization (60%) and nobody died.

**Discussion:** Although the risk of local transmission of the disease was very high due to the increase in hemodialysis patients from peripheral centers admitted to hospital, the incidence rate of COVID-19 was very low in our own hemodialysis patients. We believe that the structural and organizational changes adopted early on and the diagnosis algorithm played an important role in minimizing the spread of the disease.

**Keywords:** dialysis, COVID-19, SARS-CoV-2

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## INTRODUCTION

COVID-19 is caused by the SARS-CoV-2 virus that originated in Wuhan (China) in December 2019. This novel virus characterized by its rapid spread has turned COVID 19 into a pandemic and a global health problem.

COVID-19 is a very high transmission disease with a variable prognosis in the general population, and risk factors such as age, hypertension, diabetes, cancer, and chronic respiratory and cardiovascular disease are associated with the worst prognosis.<sup>1-2</sup>

Patients affected by end-stage renal disease undergoing hemodialysis therapy are particularly vulnerable to developing an infectious disease because they are usually older and have several comorbidities as well as an impaired immune system.<sup>3</sup>

Moreover, hemodialysis patients are exposed to a higher risk than the general population because they must attend the dialysis center by collective transport three times a week for 4 hours, where many patients are treated at the same time in overcrowded areas, thus favoring cross contamination.

Although it has been described as a more severe disease in dialysis patients, the incidence and prognosis of hemodialysis patients with COVID-19 is still unclear, and further knowledge is needed.

Currently, there are no antiviral drugs of proven efficacy against COVID-19 and, therefore, the implementation of strategies to prevent and control the spread of SARS-CoV-2 infection is of great need, particularly in hemodialysis centers.

Many organizations, such as the ERA-EDTA European Dialysis (EUDIAL) Working Group, have produced guidelines for the prevention, mitigation and containment of COVID-19 in hemodialysis centers,<sup>4</sup> which each dialysis organization must adapt to its own protocols.

## OBJECTIVE

The main objective is to describe the experience of our Dialysis Unit at Sant Joan Despí Moises Broggi Hospital – Consorci Sanitari Integral in preventing and controlling the spread of SARS-CoV-2 infection in patients undergoing dialysis therapy and in health care personnel.

## METHODS

### General measures

The Nephrology department at Sant Joan Despí Moises Broggi Hospital- Consorci Sanitari Integral is located in an area of 420,000 citizens, and our dialysis unit is a reference for two satellite hemodialysis centers caring for 156 patients. We combine our own hemodialysis maintenance program for 87 patients with hospitalized patients from peripheral hemodialysis centers.

SARS-CoV-2 infection spreads very quickly, increasing the number of patients, and a more severe prognosis has been reported in dialysis patients. Therefore, prevention and isolation measures were applied to minimize the risk of the spread of SARS-CoV-2 infection among dialysis patients and health care staff.

The ERA-EDTA European Dialysis (EUDIAL) Working Group has published guidelines for the prevention, mitigation and containment of COVID19 in hemodialysis centers. We generally followed these recommendations and added local adjustments based on our experience and level of available resources.

All procedures were conducted according to the 1964 Declaration of Helsinki, as revised in 2013, and all patients gave written informed consent.

Prevention measures were implemented in several scenarios:

First of all, just before the state of emergency was declared, preventive structural changes were implemented, for example the dialysis unit was transformed into an isolation area separate from the rest of hospital with a temporary wall made of PIR-ALU (pre-insulated aluminum duct boards, Figure 1). Furthermore, one entrance to the hospital was reserved for dialysis outpatients only, and one lift was reserved for inpatients on hemodialysis. Hospitalized dialysis patients were located on the nearest floor to the hemodialysis Unit to avoid unnecessary movements and reduce inter-patient contact.

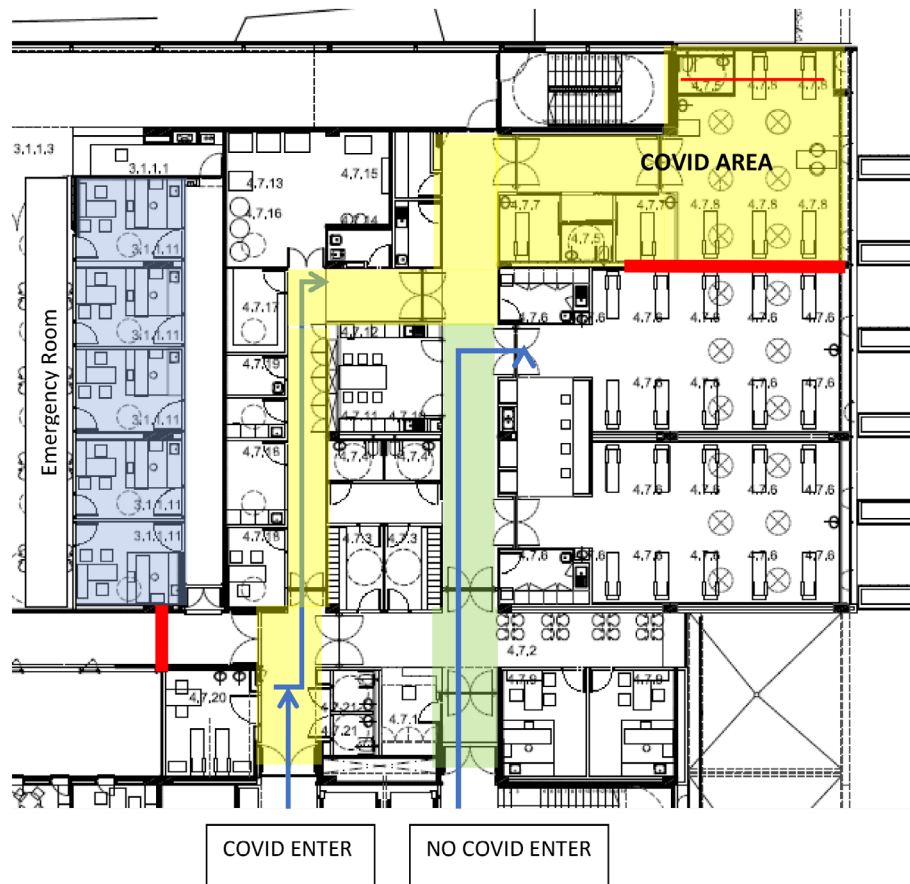
The dialysis unit is divided into four areas with 27 places for hemodialysis treatment. Rooms A and B with 10 places each, room C with 5, and room D with 2 places. Room C was separate from rooms A and B, and was reserved for hemodialysis patients with COVID-19. Room D was reserved for suspected patients (Figure 1). Moreover, five isolated rooms were used for several purposes: such as the administering of renal treatments in patients with chronic kidney disease, attention to emergency situations in dialysis patients on either hemodialysis or peritoneal dialysis and, finally, one of these rooms was reserved to evaluate symptomatic patients before they started hemodialysis in order to prevent patients from remaining in the emergency department or in the Day Hospital Unit for a long time.

Mobile dialysis equipment is not available in our center, so hospitalized patients were unable to receive hemodialysis in an individual room.

The waiting room is not an appropriate place for safe distancing, so we tried to adapt the waiting room by placing chairs at a safe distance of 2 m between each patient, and asked patients and transport companies for progressive arrival and departure times to avoid overcrowded areas.

Moreover, two routes were designed to enter the dialysis unit, one for patients with COVID-19 (outpatient and inpatients) and another for asymptomatic patients, in order to avoid cross contamination.

Organized changes were also applied, switching the shift schedule. The schedule was changed from two shifts



**Figure 1** Hemodialysis unit divided into COVID and non-COVID areas. [Color figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

from 08:00 to 20:00 hours to three shifts from 07:00 to 21:00 hours. This kind of change led to fewer patients during each shift, allowing enough safe distance between them during the hemodialysis session.

In line with the schedule change, the time prescribed to hemodialysis was reduced to three and a half hours to adjust to the time schedule in a proportion of patients.

Each room reserved for hemodialysis was cleaned according to disinfection procedures, leaving the COVID room as the last room, and this area was cleaned by personnel wearing the appropriate personal equipment.

Regarding ventilation and air conditioning, the hospital dialysis unit follows the recommendation by UNE100713:2005 (Spanish Standard). In the dialysis area, outside air is filtered by filters type F5 and F9 and evenly distributed throughout the dialysis unit previously conditioning by a climate system. After this, air is drawn outside through an exhaust duct. In this area, the air is continuously being renewed. There is a separation in ventilation and air conditioning between dialysis area

and the rest of the hospital. In the nurses and the medical staff offices, the air is partially renovated, the supplied air (renovated) is filtered by F5 and F9 filters. For climate comfort, there are local fan coils that recirculate the air inside the room and regulate the temperature (filtered by G4 filter). There is an exclusive air conditioning fan coil for each working area. There are no rooms with negative pressure in the dialysis unit.

## Management of dialysis patients

### General rules

During the pandemic, our hemodialysis unit had to be prepared to deal with patients with COVID-19 from peripheral dialysis centers. Therefore, general management strategies were applied to all patients in order to limit the risk of local transmission of SARS-CoV-2 infection.

It has been described that one of the main risk factors for SARS-CoV-2 infection was sharing health care transportation.<sup>5</sup> Either the Hospital dialysis unit or satellite dialysis units provide institutional transport for patients unable to travel to dialysis, with up to six patients sharing a vehicle. During lockdown, the Government Health Department (CatSalut) provided safety recommendations to control the spread of infection during transport to the dialysis units.

All dialysis centers should apply the following recommendations:

We recommended patients attend the dialysis units in their own vehicle avoiding public transport. If this was not possible, a transport service was organized to transfer patients with COVID and patients without COVID separately. Ambulances must have an isolated cab for the driver and the appropriate personal protective equipment. Moreover, patients and ambulance drivers wear a surgical mask and gloves when traveling from home to the dialysis unit or hospital. The number of patients was limited to 4 on transfers to dialysis units and, once the transfer was complete, the ambulance must be cleaned according to disinfection procedures to avoid the spread of infection. We also informed the transport providers that two separate routes had been designed to enter our dialysis unit in order to avoid cross contamination among patients.

In the waiting room, patients were asked about clinical symptoms such as a fever, cough or flu-like symptoms, and body temperature was taken for all patients before the start of the dialysis session.

Patients entered the locker room one by one and left all their clothes inside the locker.

All patients, both outpatient and hospitalized patients, wore surgical masks during the hemodialysis session and washed their hands and fistula arm before starting dialysis.

Eating was not allowed during the dialysis session, but in diabetic patients glucose was measured to avoid hypoglycemia.

Another main objective was to identify patients affected by COVID-19 to be isolated early on to prevent the spread of infection to other patients and health care personnel, so we applied different approaches.

Initially, diagnosis by reverse transcriptase polymerase chain reaction test (RT-PCR) was performed on patients with clinical symptoms of COVID-19, both outpatients and patients from our own hemodialysis program. In addition, recent reports indicate that people who are infected but do not have symptoms are also likely to play a role in the spread of COVID-19. Bearing in mind that dialysis patients with SARS-CoV-2 infection can develop

mild symptoms, we decided to apply RT-PCR screening to all patients in the hemodialysis unit to prevent the transmission of SARS-CoV-2 by asymptomatic patients.

## Patients with suspicious clinical symptoms

To limit the spread of COVID-19, it is important to promptly identify and separate ill patients, so a special algorithm was designed for the management of COVID-19 in the dialysis population (Figure 2).

Dialysis patients with suspicious clinical symptoms should be evaluated before they are allowed to enter the dialysis room. These patients were sent to the isolated area to be evaluated by a nephrologist. An RT-PCR test by nasopharyngeal swab and a chest X-ray was performed.

While awaiting the RT-PCR result, patients received dialysis sessions in a separate isolation room D.

## Patients with positive SARS-CoV-2 infection

If the RT-PCR result was positive, patients were given their dialysis session in a COVID area (room C) with other patients with SARS-CoV-2 infection. In the COVID area, all patients wore surgical masks and gloves throughout the dialysis session.

Hospitalized COVID-19 patients in hemodialysis were moved to the dialysis unit using a reserved lift for these patients only.

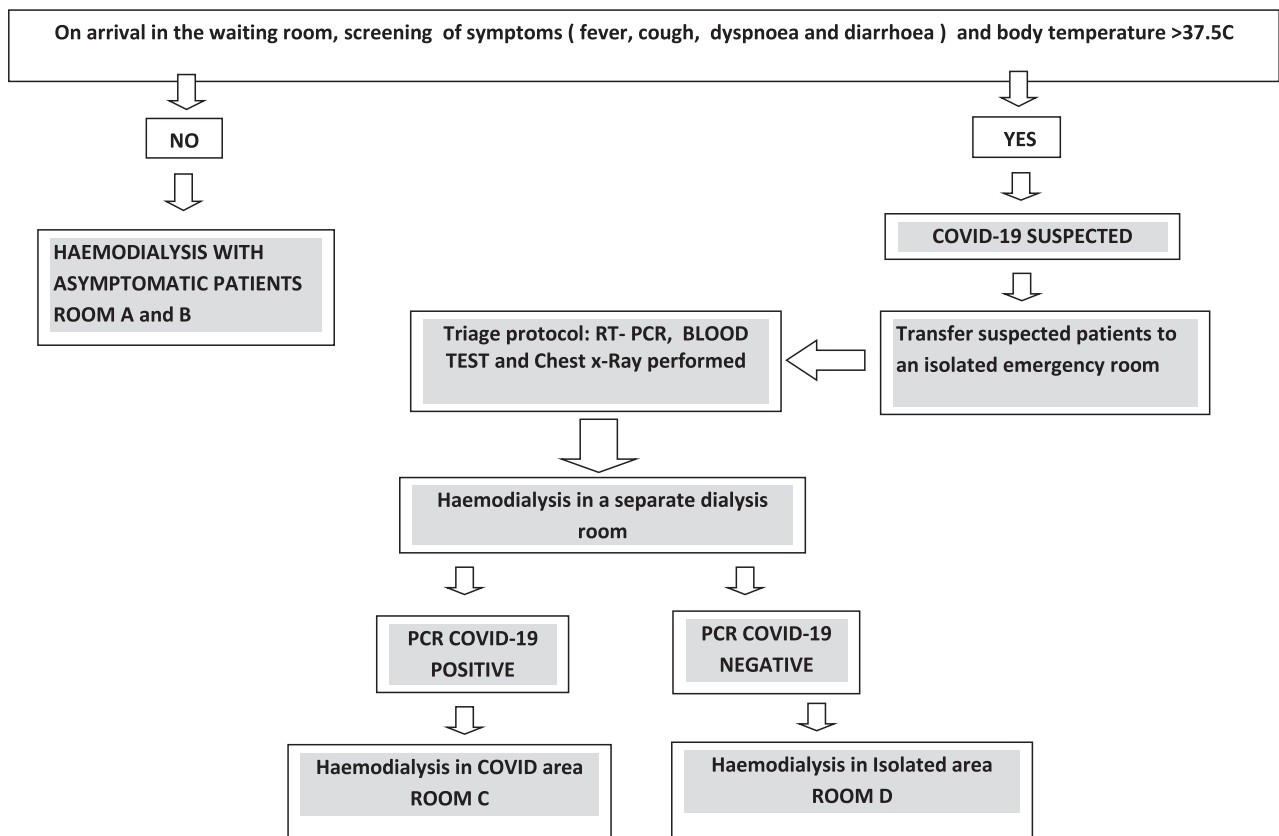
Critically ill COVID-19 patients in the intensive care unit who required renal replacement therapy were treated with continuous renal replacement therapy to avoid cross-contamination among health care personnel.

## Peritoneal dialysis patients

During the months of March and April, no new patients started on peritoneal dialysis. Routine controls were stopped and patients had to remain at home. Telemedicine or other electronic systems were used to assist peritoneal dialysis patients. An isolated room was reserved for any peritoneal dialysis patients developing an emergency situation.

## Health care team

The health care team is a population at risk of nosocomial infection and they can also be a vector for the transmission of infection. Therefore, protecting health care workers from SARS-CoV-2 infection was another main goal. Some preventive measures were applied to avoid



**Figure 2** Algorithm for managing patients on hemodialysis with suspected COVID-19.

the spread of SARS-CoV-2 infection from patients to health care personnel and among health care workers.

According to our standard protocol, nurses are used to wearing single-use uniforms, surgical masks, nitrile gloves and eye protection to deal with hemodialysis patients, and to washing their hands after every patient. The bed sheets for patients are also single use. During March and April, all health care personnel further increased the preventive measures by wearing two masks at the same time; FFP2 mask and a surgical mask, which were regularly removed. They also wore waterproof coats.

In the Covid area, all health care workers in direct contact with patients infected with COVID-19 wore appropriate personal protective equipment, FFP2 masks, protective goggles, gloves, and shoe covers.

In order to avoid the cross-transmission of SARS-CoV-2 infection, (RT-PCR) testing was performed on symptomatic health care personnel. If it was positive, they remained at home until negative RT-PCR testing. They came back to work after symptoms ceased and an RT-PCR test was negative.

Furthermore, the antibody test was prioritized for dialysis personnel. A rapid antibody test with 74% sensitivity and 95% specificity (2019 nCoV IgG/IgM rapid test cassette, Hangzhou Clongene Biotech Co Ltd Ref: 018-1078) was first applied.

In a second round, a serological test for detection of antibodies against SARS-CoV-2 by Elisa (Euroimmun Medizinische Labordiagnostika AG Lübeck, Germany) was applied.

## RESULTS

In our area, the overall population of 494 patients on hemodialysis is split into two peripheral centers and one hemodialysis unit at Sant Joan Despi Hospital.

To further clarify the geographical location of all three centers, we have added a map that shows the geographical distribution of health areas in Catalonia (Spain) (Figure 3). All three centers are located in Barcelona, particularly in the South Metropolitan Area of Barcelona, which is divided into 3 regions. The Hospital Dialysis



**Figure 3** The geographical distribution of sanitary areas in Catalonia (Spain). [Color figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

Unit and both peripheral units belong to the same region located in Baix Llobregat Centre – L'Hospitalet Nord in the South Metropolitan Area of Barcelona. Hospital Sant Joan Despí Moises Broggi (Consorci Sanitari Integral) provides renal assistance for an overall population of 420,000 in Baix Llobregat – L'Hospitalet Nord in Barcelona, including over 156 patients on dialysis. According to the data published by the Catalan Quality and Assessment Health Agency (Agència de Qualitat i Avaluació Sanitàries de Catalunya AQUAS), the infection rate in Baix Llobregat Centre – L'Hospitalet Nord confirmed by real-time reverse-transcriptase polymerase chain reaction (RT-PCR) assay was 82 cases per 100,000 population on 13 March, but increased to 149 cases per 100,000 population.<sup>6</sup> It should be considered that RT-PCR was only performed on symptomatic patients during the period of March and April in Spain.

The reported incident rate of COVID-19 in these peripheral hemodialysis centers was 9.5–19.9% and the death rate 25–30.5%. During this period, 21 patients

with COVID-19 on hemodialysis were attended in our hemodialysis unit and 18 out of 21 (85.7%) were hospitalized. Sixteen out of 21 came from peripheral dialysis centers, they were  $75 \pm 10$  years old (range: 57–88) and 63% were male; 15 patients required hospitalization (93%), and 5 out of 16 died (3 women and 2 men). The death rate was 31.2%.

When we analyze our own hemodialysis program, SARS-CoV-2 was diagnosed in 5 patients out of 87 (average age was  $81 \pm 2.8$ , range: 79–85) and 60% were female. The incidence rate was 5.7%. 3 out of 5 required hospitalization (60%) and nobody died. The two patients who did not develop clinical symptoms were managed as outpatients and they were diagnosed in the RT-PCR screening (one at a residential home and the other in the screening performed in the hemodialysis unit).

Three patients were hospitalized due to respiratory symptoms: one patient was admitted to the emergency room with RT-PCR COVID positive, and two patients were admitted directly from the hemodialysis unit with

RT-PCR COVID negative, and acquired SARS-CoV-2 infection by nosocomial transmission due to close contact with patients with SARS-CoV-2 infection unknown.

Before the start of the pandemic, one patient was sent to another hospital due to a hemorrhagic stroke, where he acquired and died of COVID.

There were no cases of COVID in Peritoneal dialysis patients.

One nurse and two nephrologists from a health care team of 32 were infected by SARS-CoV-2 (9.3%) but their outcome was favorable. Serological tests to detect antibodies against SARS-CoV-2 by immunochromatography technique and by Elisa reaction were performed on all health care workers, the positive results of which were only found in those affected by COVID 19. Both antibody tests agreed with the results of the RT-PCR test.

## DISCUSSION

SARS-CoV-2 has shown a high incidence and mortality rate in hemodialysis patients,<sup>7-8</sup> so limiting the transmission of COVID19 in dialysis centers is a particular challenge. This report describes our experience in managing patients with COVID19 from peripheral centers or from hemodialysis in our own maintenance program.

The incidence rate of COVID disease in patients from our own maintenance program was lower than in patients from peripheral centers, 5.7% vs 9.5–19.9%). This result is remarkable when it has been observed that recent reports in Wuhan and Brescia (Italy) have reported an incidence rate in hemodialysis patients of 15% and 16%.<sup>7,9</sup>

One factor to explain the low incidence observed might be related to all structural and organizational measures that were applied early on to limit the spread of infection.

Regarding structural changes, both peripheral dialysis units are not spacious centers and the waiting areas are small. During the pandemic, a safe distance among patients in the waiting room, locker room and treatment area was highly recommended, but was difficult to apply especially at shift change times when the size of the dialysis center is small. All authorized hemodialysis centers or units in Catalonia apply the regulations that set forth structural requirements for facilities and hygienic-sanitary conditions agreed by law (DOGC 5398/2009)<sup>10</sup> but it can be considered that dialysis units with less space may favor a higher number of infections. Regarding the ventilation and air conditioning system, dialysis units should have a ventilation and air conditioning system to ensure

hygienic safety and climate comfort according to recommendation UNE100713:2005 (Spanish Standard). Outside air is filtered and evenly distributed throughout the dialysis unit. After this, air is drawn outside through an exhaust duct. The air conditioning system conditions the temperature of the recirculated air.

Another factor to explain the low incidence observed is that all these efforts were followed by a triage algorithm to detect and isolate patients with COVID-19 before starting the hemodialysis session. All the hygiene protocols and protection barriers that health care workers reinforced to avoid infection and enhancing cross-infection were also important.

Another interesting factor to be considered is the effectiveness of the RT-PCR screening test, although only two asymptomatic patients were diagnosed with SARS-CoV-2 infection. It is well known that hemodialysis patients can be asymptomatic but can spread infectious disease,<sup>11</sup> so it is important to apply screening tests in dialysis centers for the early diagnosis of asymptomatic patients and to apply isolation measures to reduce the risk of transmitting disease.

Neither hemodialysis patients nor peritoneal dialysis patients from our program died during the pandemic, in comparison with the death rate of 25.6% to 30% in patients from peripheral hemodialysis centers.

The mortality rate in hemodialysis patients is higher than that of the general population. Series of cases in China and Italy reported a mortality rate of 16% and 25% in patients undergoing hemodialysis therapy.<sup>7,9</sup> Besides, the risk of mortality increases when patients require hospitalization, especially in the intensive care unit.<sup>12</sup> A Spanish observational study involving 282 patients in hemodialysis reported 30.5% mortality in hospitalized patients.<sup>8</sup>

One explanation of the lower death rate in our hemodialysis program might be the low percentage of patients requiring hospitalization who were diagnosed earlier by screening or when they developed mild symptoms.

Age and other comorbidities are considered risk factors associated to worse prognosis in COVID-19, but the average age of our cohort was older than patients from peripheral dialysis centers, as well as in China and Italy, suggesting that classic risk factors are not the only factors associated to higher mortality in hemodialysis patients.<sup>8</sup>

The death rate of the entire group of hemodialysis patients attended by this hemodialysis unit (5 out of 21) was 23.8%, quite similar to the results described in other reports. The COVID-19 registry of the Spanish Society of Nephrology also described a 23% mortality rate in patients undergoing renal replacement therapy, with over 60% patients undergoing hemodialysis.<sup>13</sup>

The incidence rate of COVID-19 among health care workers was 9.3%, lower than in China and Lombardy (Italy), (12% and 33%),<sup>9,14</sup> 1 out of 32 nurses acquired and developed COVID19, and she was in close contact with an infected relative. Of the two nephrologists infected by SARS-CoV-2, one was asymptomatic and the other developed clinical symptoms. One of the nephrologists combines her job in the Nephrology department with the emergency room, but the other nephrologist works out of the hemodialysis unit. Likewise, in terms of the infected health care workers working with dialysis patients, no increase was observed in the number of patients with COVID.

In this dialysis unit, nurses and patients always wear surgical masks during dialysis connection. Furthermore, a preventive protocol for infectious disease is followed by all health care workers; each nurse washes his/her hands after every patient, gloves, eye protection, and a plastic apron are worn for each patient.

Considering that SARS-CoV-2 has shown a high transmission and mortality rate, we believe that is very important to quickly apply preventive and isolation measures to prevent the spread of infection and the death rate.

Our dialysis unit was able to maintain the hemodialysis program and deal with hospitalized patients with COVID-19 from the dialysis area. Although the risk of local transmission of the disease was very high due to the increase in hemodialysis patients from peripheral centers admitted to hospital, the incidence rate of COVID-19 was very low in our own hemodialysis patients. We believe that the structural and organizational changes adopted early on and the diagnosis algorithm played an important role in minimizing the spread of the disease.

We also believe that protection barriers for health care workers are essential to minimize the high risk of infection among personnel and the spread of infection to patients.

Despite the low incidence and mortality rates observed in this cohort, this observational study must be considered a descriptive report where it cannot provide a prognosis on maintenance dialysis patients due to the limited number of cases and the lack of information on the characteristics of patients, such as the time over which clinical symptoms evolved in dialysis patients from peripheral centers. Nevertheless, the results of this observational study recognize the effectiveness of early diagnosis, good hygiene protocols and self-isolation, which are essential in controlling the infection.

In conclusion, taking these results in account, we have learned that applying early preventive measures against SARS-CoV-2 infection could decrease the risk of spreading COVID-19 in vulnerable patients and, consequently,

their admission to hospital where the risk to exposure and death is high. This knowledge along with all the information reported can be useful if a similar situation arises in the future.

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