Coronavirus Disease 2019 in Patients With End-Stage Kidney Disease on Hemodialysis in Guatemala

Check for updates

Regina Sosa[1,3], Pablo Garcia[2,3], Ever O. Cipriano[1], Agualuz Hernández[1], Elmer E. Hernández[1], Paola I. Chavez[1], Angélica Manchinelli[1], Oscar A. Morales[1], Lourdes E. Flores[1], Hair J. Romero[1], Yulany Raquec[1], Byron F. Sapón[1], Kevin E. Soch[1], Shuchi Anand[2] and Vicente Sánchez-Polo[1]

[1]Department of Nephrology, Guatemalan Institute of Social Security, Guatemala City, Guatemala; and [2]Stanford University School of Medicine, Palo Alto, California, USA

Introduction: Coronavirus disease 2019 (COVID-19) is public health concern across the world. Data on the epidemiology among patients on hemodialysis in Latin America and low- and middle-income countries are limited.

Methods: Using electronic medical records from the second largest dialysis network in Guatemala, we performed a retrospective analysis of all adult patients on hemodialysis with the diagnosis of COVID-19 to estimate incidence of infection and to describe the demographics, comorbidities, and outcomes. We stratified incidence rate by region. We reviewed data from May 1 to July 31, 2020, with outcome data ascertained up to August 28, 2020.

Results: Of 3201 patients undergoing hemodialysis, 325 patients were diagnosed with COVID-19 (incidence rate 102/1000 patients on hemodialysis, compared with 3/1000 in the general population). Incidence was higher in the Central region (207/1000) and lowest in the Southeast region (33/1000), and unlike in the general population, the incidence was lower in Guatemala City. The mean age of patients diagnosed with COVID-19 was 51.1 years (standard deviation [SD] 14.8 years), and 84 (25.8%) were female. The median length of hospital stay was 12 days (interquartile range [IQR] 10–16 days). Two hundred twenty-nine (69.8%) of the patients recovered, 90 patients died (27.7%), and 6 (1.8%) patients were still in the hospital at the time of last follow-up.

Conclusion: The incidence of diagnosed COVID-19 in Guatemalan patients on hemodialysis was much higher than reported in the general population, with outcomes similar to those described in high-income countries. Rural regions had higher incidence rates than the major metropolitan area.

C OVID-19 infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first recognized in December 2019 in Wuhan, China.[1] Since then, SARS-CoV-2 has affected >200 countries across the world, causing >2,500,000 deaths globally, >700,000 deaths of which have occurred in Latin America.[2] On March 13, 2020, the Guatemalan Ministry of Health (MoH) reported the first case of COVID-19 in Guatemala City. This was followed by several interventions to mitigate the effect of the outbreak. However, as of March 1, 2021, there have been >150,000 cases, 6500 deaths, and an overall excess in mortality attributed to COVID-19.[2–4]

Patients on in-center hemodialysis face extreme threats to their health during the COVID-19 pandemic: not only do their comorbidities (older age and diabetes) place them at a higher risk for severe illness, but by the nature of their illness they cannot shelter in place, and instead require routine interactions with health care personnel and other patients in a shared space. These threats are further compounded in low- and middle-income countries by (i) protective equipment shortages for patients and staff, (ii) public transport required to arrive at a central unit from far-flung areas,[5] and (iii) decreased

Correspondence: Vicente Sanchez-Polo, Department of Nephrology, Instituto Guatemalteco de Seguridad Social, 9a calle 7-55, zona 9, Ciudad de Guatemala, Guatemala. E-mail: visanpolo@gmail.com

[3]RS and PG are co-first authors.

access to immediate testing to prevent further infection among health care staff or household members.[6]

Data from patients on dialysis in Europe, China, and the United States indicate that the incidence of infection ranges from 11% to 19.3%, and estimates for mortality range from 6.5% to 52%,[7–13] far exceeding estimates in the general population. In the United States, the odds of death among hospitalized patients on dialysis are 40% higher than in the general population.[14] Little is known about incidence and outcomes of COVID-19 in patients on dialysis in Latin America and in low-middle– and middle-income countries around the world.

To address this knowledge gap, we conducted a retrospective review of all patients diagnosed with COVID-19 at the Guatemalan Social Security Institute (IGSS) in the second largest health care system and dialysis provider in Guatemala. We determined the incidence rate of symptomatic COVID-19 infection among patients on hemodialysis, described the infection control practices, and delineated the demographics, comorbidities, and outcomes of the affected patients.

METHODS

Study Design

We enrolled all adults with a diagnosis of COVID-19 and end-stage kidney disease (ESKD) on hemodialysis admitted or treated at any of the 6 hospitals or 15 dialysis centers supported by the IGSS. This study was approved by the IGSS Institutional Review Board.

Setting

Guatemala is an upper-middle–income country with 16.4 million people located in Central America.[15] In Guatemala, there are 3 health care systems: public, private, and employer-based health insurance. Approximately 8% of the Guatemalan population has access to private health insurance and private health care.[16] However, most Guatemalans are unable to cover the costs of dialysis in the private sector.[17] As a result, clinical care for kidney diseases in Guatemala is primarily delivered in the public-sector institutions, which includes the Ministry of Health National Center for Chronic Renal Disease (UNAERC) and the IGSS. UNAERC is the only free-standing dialysis network for those uninsured or without access to an employer-based health insurance in Guatemala. Approximately 64% of those patients with access to kidney replacement therapy are being dialyzed by UNAERC.[18] IGSS is an employer-based health insurance system available to 18% of the overall population. IGSS provides dialytic care to approximately 34% of those with access to ESKD care in Guatemala.[16,17] There is a predominance

of men affiliated with the social security system (66.2%). As of July 31, 2020, there were 3201 patients with ESKD on hemodialysis and 551 on peritoneal dialysis receiving care at the IGSS.[17]

Those patients with ESKD on hemodialysis at IGSS get dialytic treatment 3 times a week in one of the 15 dialysis centers located across the country. Initially, all the patients diagnosed with COVID-19 infection were admitted to any of the 6 social security hospitals in Guatemala appointed for the care of patients infected with COVID-19. As of July 20, 2020, the patients without symptoms or indications for hospitalization were clinically managed as outpatients. For those patients managed outside the hospital, we developed a protocol to provide uninterrupted dialysis care. We usually have 2 shifts per day in our dialysis units. We established a third shift in the evenings only for those patients diagnosed with COVID-19. After the last shift, our staff dedicates time to clean and disinfect the dialysis center, including the machines, beds, and chairs.

Population

We included all the adult patients (≥18 years of age) with ESKD on hemodialysis with the diagnosis of COVID-19 at the IGSS dialysis centers from May 1, 2020 to July 31, 2020. We considered COVID-19 disease diagnosis if the patients had a nasopharyngeal swab positive for SARS-CoV-2 using reverse transcriptase–polymerase chain reaction or a positive SARS-CoV-2 rapid antigen test. We initially tested only those patients with symptoms suggesting COVID-19. Later, we developed a proactive testing protocol to prevent COVID-19 transmission in our dialysis units. In our testing protocol, we included those patients in close contact with another patient with a diagnosis of COVID-19. We excluded those patients who were started on dialysis because of COVID-19 infection–related complications.

Data Collection

Study investigators at each social security hospital or dialysis center collected epidemiologic, clinical, and outcomes data by manually reviewing electronic medical records and used a case report form to enter data into a secure database.

Follow-Up

We followed patients until hospital discharge, death, or August 28, 2020.

Covariates

Patient-level data included baseline information on demographics, comorbidities, symptoms, underlying

Table 1. Baseline characteristics

| Characteristics	Total cohort (N = 325)	Female (n = 84), 25.8%	Male (n = 241), 74.2%
Age, yr, mean (SD)	51.1 (14.8)	51.5 (13.9)	51 (15.4)
Comorbidities, n (%)			
Diabetes	128 (39.4)	44 (52.4)	84 (34.9)
Hypertension	252 (77.5)	68 (81.0)	184 (76.3)
Other (COPD asthma)	32 (9.8)	12 (14.3)	20 (8.3)
Underlying CKD, n (%)			
Diabetes mellitus	128 (39.4)	44 (52.4)	84 (34.9)
CKDnT	33 (10.2)	5 (6.0)	28 (11.6)
Other	11 (22.8)	2 (2.4)	9 (3.7)
Unknown	153 (47.1)	33 (39.2)	120 (49.8)
Access type, n (%)			
Temporary catheter	81 (24.9)	20 (23.8)	61 (25.3)
Tunneled vascular catheter	28 (8.6)	10 (11.9)	18 (7.5)
Fistula	203 (62.5)	50 (59.5)	153 (63.5)
Unknown	13 (4.0)	4 (4.8)	9 (3.7)
Dialysis unit location, n (%)			
Metropolitan	163 (50.2)	43 (51.2)	120 (49.8)
Central	78 (24.0)	22 (26.2)	56 (23.2)
Southwest	62 (19.1)	14 (16.7)	48 (19.9)
Northeast	17 (5.2)	3 (3.5)	14 (5.9)
Southeast	5 (1.5)	2 (2.4)	3 (1.2)
North	0 (0)	0 (0)	0 (0)

CAD, coronary artery disease; CKD, chronic kidney disease; CKDnT, chronic kidney disease of nontraditional etiology; COPD, chronic obstructive pulmonary disease; HD, hemodialysis; IGSS, Guatemalan Institute of Social Security; SD, standard deviation.

cause of chronic kidney disease, and vascular access. The nephrologists defined chronic kidney disease of nontraditional etiology among those <50 years of age, without a history of diabetes, hypertension, glomerulopathies, or other known causes of kidney disease.[19] We collected data on dialysis center location based on 6 geographic regions: Metropolitan, North, Northeast, Southeast, Central, and Southwest.

Statistical Analysis

To describe baseline characteristics and outcomes, we expressed continuous variables as means (standard deviations [SDs]) for normally distributed continuous
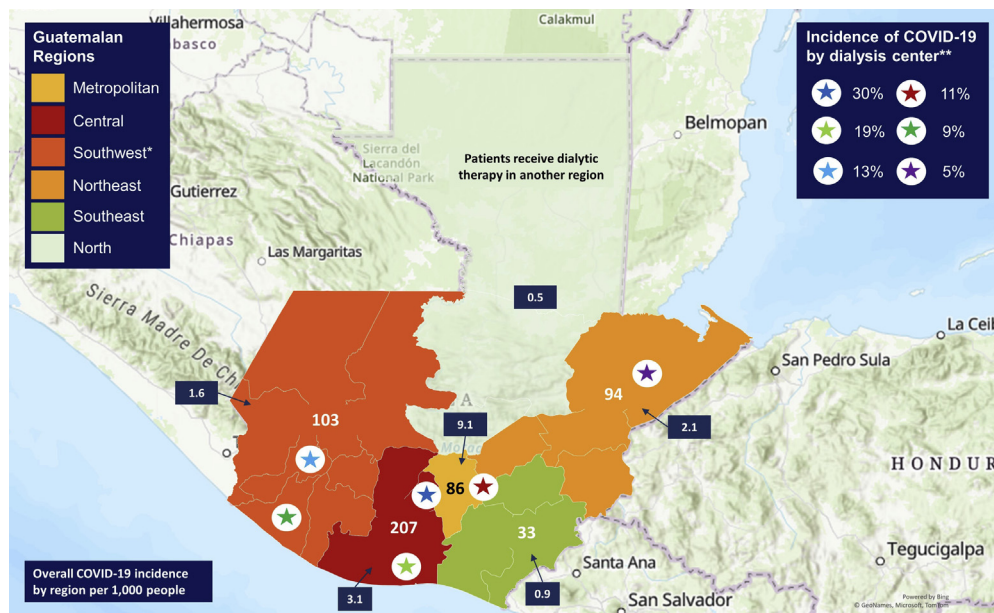
Figure 1. Incidence rates of severe acute respiratory syndrome coronavirus 2 infection by Guatemalan region and dialysis center. *Southwest region combined with the Northwest region. **Included 6 dialysis centers with the highest incidence of severe acute respiratory syndrome coronavirus 2 infection in Guatemala. (Map data courtesy 2020 INEGI/Google Maps.)
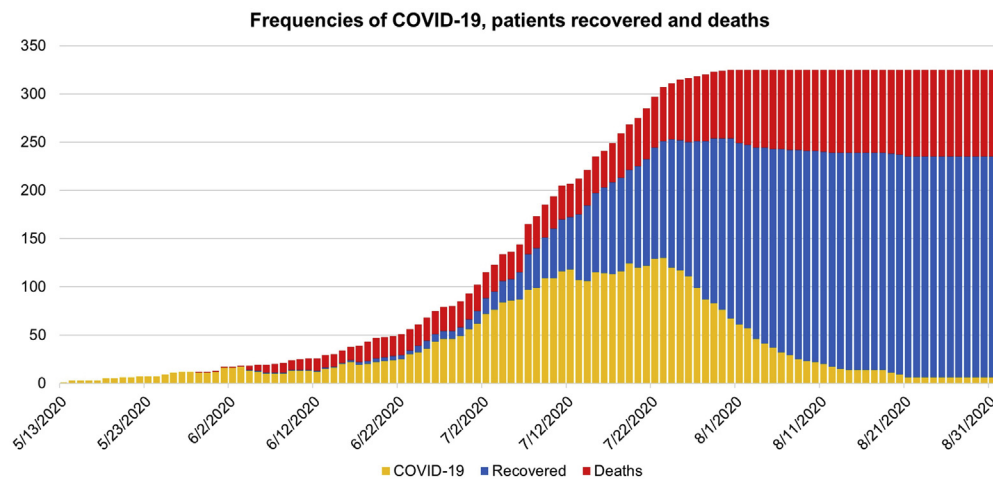
Figure 2. Cumulative counts of patients positive for severe acute respiratory syndrome coronavirus 2 by clinical status in the Guatemalan Social Security Institute (infected, recovered, or died).

measures and medians (interquartile ranges [IQRs]). Categorical variables are expressed as number (percentage). We described the proportion of death associated with COVID-19 infection during the follow-up period. We described overall incidence of SARS-CoV-2 infection, incidence of infection by geographic region, and cause of death. We used the National Statistics Institute of Guatemala projections to determine the general population estimates, which are based on the 2018 Guatemalan census.[20] To determine the number of diagnosed COVID-19 cases in the general population, we used official data derived from the Guatemalan MoH and Epidemiology Department interactive dashboard (available at https://tablerocovid.mspas.gob. gt/). We used SAS software (version 9.4; SAS Institute, Inc., Cary, NC) to perform the statistical analyses.

RESULTS

We identified a total of 325 patients on hemodialysis with diagnosis of COVID-19 infection at the IGSS. The mean age in the cohort was 51.1 years (SD 14.8 years), and 84 (25.8%) of the patients were female (Table 1).

The most common comorbidity and CKD etiology was diabetes (39.4%).

Dialysis Characteristics

All patients received 3 hemodialysis sessions per week in an outpatient clinic. From the 325 patients that had COVID-19 infection, 203 patients (62.5%) had arteriovenous fistula, 28 (8.6%) had a permanent catheter, and 73 (17.9%) had a temporary hemodialysis catheter. Most of the patients (50.2%) were receiving hemodialysis in the Metropolitan region (Guatemala City), and 49.8% received hemodialysis in the other areas of the country (Table 1). We identified a dialysis unit located in Sacatepéquez with a 30% incidence of SARS-CoV-2 infection (Figure 1).

Symptoms, Hospitalization, and Outcomes

The first case of COVID-19 in a patient on hemodialysis in Guatemala was reported on May 13, 2020 (Figure 2). Most of the patients presented with ≥1 symptom and the most common symptoms were fever (71.1%) and cough (53.2%). There were no differences in symptom presentation by gender ((Figure 3). Those patients who
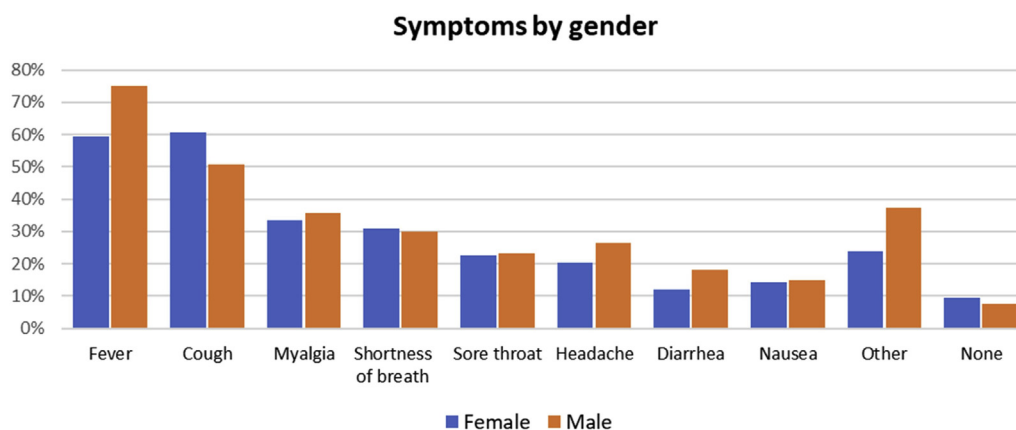
Figure 3. Symptoms by gender. Most of the patients presented with fever. Males were more prone to present with fever than females.

Table 2. Clinical characteristics and management

	Recovered (n = 229), 70.5%	Died (n = 90), 27.7%	Total cohort[a] (n = 325)
SARS-CoV-2 testing, n (%)			
RT-PCR	119 (52.0)	58 (64.4)	182 (56.0)
Antigen test	110 (48.0)	32 (35.6)	143 (44.0)
Diabetes, n (%)	68 (29.7)	58 (64.4)	128 (39.4)
Clinical symptoms, n (%)			
Fever or chills	156 (68.1)	69 (76.7)	231 (71.1)
Cough	113 (49.3)	54 (60.0)	173 (53.2)
Myalgia	71 (31.0)	37 (41.1)	114 (35.1)
Shortness of breath	52 (22.7)	40 (44.4)	98 (30.2)
Sore throat	43 (18.8)	26 (28.9)	75 (23.1)
Headache	48 (21.0)	27 (30.0)	81 (24.9)
Diarrhea	34 (14.8)	14 (15.6)	54 (16.6)
Nausea	28 (12.2)	14 (15.6)	48 (14.8)
Other	68 (29.7)	36 (40.0)	110 (33.8)
None	16 (7.0)	4 (4.4)	26 (8.0)
Hospitalized, n (%)	215 (93.9)	90 (100.0)	305 (93.8)
Admitted to the ICU, n (%)	5 (2.2)	41 (45.6)	46 (14.2)
Maximum respiratory support required, n (%)			
Nasal canula	64 (27.9)	15 (16.7)	80 (24.6)
High-flow or nonrebreather mask	27 (13.1)	27 (30.0)	57 (17.5)
BIPAP or CPAP	1 (0.4)	11 (12.2)	12 (3.7)
Mechanical ventilation	2 (0.9)	35 (38.9)	38 (11.7)
None	135 (59.0)	2 (2.2)	138 (42.5)
Medications,[b] n (%)			
Steroids	125 (54.6)	77 (85.6)	202 (62.2)
Azithromycin	26 (11.4)	28 (8.9)	54 (16.6)
Colchicine	121 (52.8)	54 (60.0)	175 (53.8)
Tocilizumab	6 (2.6)	15 (16.7)	21 (6.5)
Other	8 (3.5)	3 (3.3)	11 (3.4)
Required vasopressors, n (%)	4 (1.7)	31 (34.4)	36 (11.1)
ARDS, n (%)	11 (4.8)	45 (50.0)	69 (21.2)
Time to discharge/recovery, days, median (IQR)	12 (10–16)	—	—
Time to death, days, median (IQR)	—	9.5 (4–19)	—
Cause of death (n = 90), n (%)			
ARDS	—	45 (50.0)	—
Septic shock	—	16 (17.8)	—
Other	—	29 (32.2)	—

ARDS, acute respiratory distress syndrome; BIPAP, bilevel positive airway pressure; CPAP, continuous positive airway pressure; ICU, intensive care unit; RT-PCR, reverse transcriptase–polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.
[a]Including 6 patients (1.8%) still hospitalized by August 28, 2020.
[b]Some patients received ≥2 medications.

died were more prone to shortness of breath (44.4%) when compared with those who recovered (22.7%). Three hundred five (93.8%) patients were hospitalized and 46 (14.2%) required admission to the intensive care unit. Almost half of the patients who died (45.6) and only 2.2% of those who survived required an admission to the intensive care unit. More than half (57.5%) of the patients required oxygen support, including nasal cannula, high-flow oxygen delivery, or invasive and noninvasive ventilation. Of the patients who died, 64.4% had diabetes, and only 29.7% of the patients

who recovered had diabetes (Table 2). The median length of hospital stays for patients discharged alive was 12 days (IQR 10–16 days) and the median time to death was 12.7 days (IQR 4–19 days). Two hundred twenty-nine (69.8%) of the patients were discharged or recovered from COVID-19, 90 patients died (27.7%), and 6 (1.8%) patients were still in the hospital at the time of last follow-up (Table 1 and Figure 2). The death rate among patients ≤45 years of age was 15% and significantly higher in those >60 years of age. The death rate among those with diabetes was significantly higher at 45% (Figure 4).
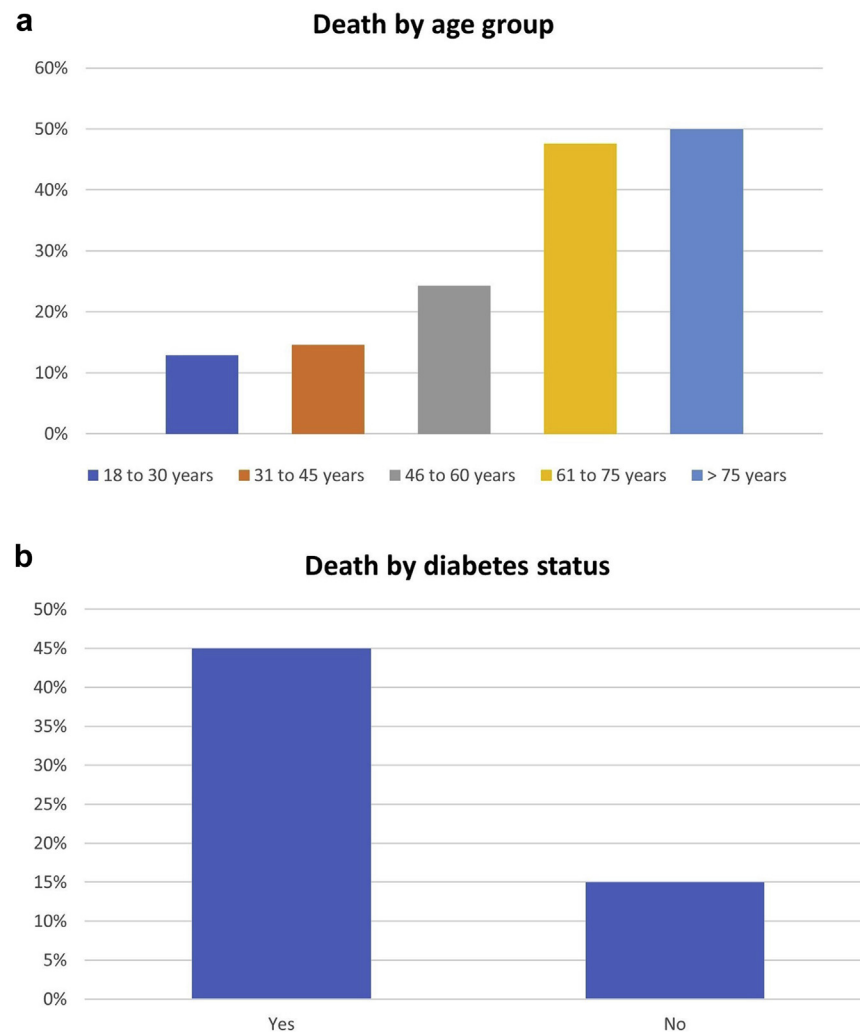
Incidence of COVID-19 in Guatemala

The overall incidence of COVID-19 among patients on hemodialysis was 102 per 1000 people (325/3201). The incidence rate was higher in the Central region (207/1000 people) and the region with the lowest incidence was the Southeast region with 33 per 1000. The incidence in the Metropolitan region, where Guatemala City is located, was 86 per 1000 (Figure 1). In the general population, the overall incidence was 3 per 1000 over the same period. We observed an outbreak in one of the dialysis units located in the central region, with an incidence of 300 per 1000 people in a single dialysis unit (Figure 1).

DISCUSSION

In this retrospective analysis of patients undergoing hemodialysis in Guatemala, we found that 1 in 10 patients had symptomatic disease. Despite their young age compared with other described cohorts of patients on dialysis,[14,21,22] more than 1 in 4 succumbed to the disease. While detection bias likely exists, compared with the general population, incidence rates were 10-fold higher. In the context of the severity of illness of a majority of patients on dialysis affected—more than half required oxygen support—the diagnosed cases likely reflect clinically significant disease. We noted a comparatively lower incidence of SARS-CoV-2 infection in Guatemala city, an unexpected finding given that densely populated areas are anticipated to have higher SARS-CoV-2 infection incidence, and this could imply risk amplification by the requirement of transportation from far flung areas to a single dialysis unit in the rural areas.[23]

Compared with the rest of the regions in Guatemala, with incidences between 33 to 103 per 1000 people, we noticed a markedly increased incidence of infection in the Central region (207/1000 people). There was an outbreak in one of the dialysis units located in the Central region, perhaps caused by contact with health care workers or acquired in the community while traveling to the dialysis unit. We favor the latter because it is known that patients in Guatemala travel long distances to have access to dialytic therapy. A study in the pediatric population in

a

Death by age group

Legend: ■ 18 to 30 years ■ 31 to 45 years ■ 46 to 60 years ■ 61 to 75 years ■ > 75 years

b

Death by diabetes status

Figure 4. Death rates by age group and diabetic status. (A) The death rate was lower among those ≤45 years of age and markedly higher among those ≥60 years of age. (B) The death rate is higher among those with diabetes.

Guatemala found that travel time to the dialysis center was 2.5 hours on average, with 17% using a combination of public transportation types.[24] Furthermore, a study including adult patients on hemodialysis in Guatemala reported a traveling distance to a dialysis center between 2 to 200 miles.[25] Therefore, we recommend that our colleagues in low, lower-middle, or upper-middle income countries, such as Guatemala, arrange transportation for each individual on dialysis at least in regions with a high incidence of infection to prevent infections while traveling on public transportation. With the possible arrival of the COVID-19 vaccine to Guatemala, we recommend that the Guatemalan MoH or IGSS prioritize patients on dialysis for 2 main reasons: (i) patients on dialysis are more susceptible to infection than the general population, and (ii) the death rate of these patients is higher than the death rate of the general population.

Our protocols initially recommended hospitalization for clinical management and monitoring when a patient was positive for SARS-CoV-2 infection. Therefore, there a greater proportion of patients were

hospitalized in our cohort compared with reports from other dialysis centers across the world.[10,21,22,26] Our cohort was significantly younger (mean 51.1 years) than European and American cohorts (66–69 years of age).[14,21,22] In general, the population in Guatemala is younger than the American and European countries.[20] In our cohort, most patients were men (74.2%), which is explained by the predominance of men affiliated with the social security system (66.2%).[27] There is also a growing body of evidence indicating sex differences in the clinical outcomes of COVID-19.[10,28–30] However, whether immune responses towards SARS-CoV-2 are different between sexes is currently unknown.

The most common clinical presentation was fever (71.1%), followed by cough and myalgia. Similar to our study, in a recent report from the Spanish Society of Nephrology Registry, including only patients with ESKD, the most common symptom was fever (75%) and only 50% shortness of breath.[22] A study on critically ill adult patients in the United States reported cough as

the most common symptom, followed by dyspnea (74.9%). Since volume overload and shortness of breath is common among patients on dialysis,[31] it may be more challenging to differentiate baseline shortness of breath from the additional symptoms caused by COVID-19, thus the difference in clinical symptoms at presentation between those with and those without ESKD.

Although the incidence we report in our patient population in much higher than in the general population in Guatemala, it is similar to reports from Europe among patients receiving dialysis. A study by the Brescia Renal COVID Task Force in Italy found that SARS-CoV-2 RNA positivity was detected in 94 of 643 patients undergoing hemodialysis (150/1000 patients).[13] One of the largest cohorts from France reported an incidence of COVID-19 from <10 to 100 per 1000 people between regions and an overall incidence of 330 per 1000 patients.[21] Interestingly, a study addressing the seroprevalence of SARS-CoV-2 antibodies in a hemodialysis population in the United Kingdom found that around 36.2% of the patients tested positive for COVID-19 and almost half were asymptomatic.[32]

Most of the patients recovered (70%) and 28% died. This death rate is consistent with the death rate reported in other studies from Europe, China, and the United States (20%–31.2%).[13,33,34] A recent study including 151 Guatemalan patients on dialysis cared at the public health system found a death rate relatively higher (37.7%) than the death rate reported in our study. This contrast in death rate may be explained by differences in access to care between the public health system and the IGSS system. These differences in care are mainly derived from an overwhelmed public health system.[18,35] However, further studies are needed to better explain the reasons for this difference in death rate. In the present study, we identified some factors potentially associated with better outcomes: (i) patients were younger in our cohort, (ii) most of the patients were admitted to the hospital with closer follow and monitorization—in these cases, health care workers were able to act promptly if the patient presented a complication associated with the disease, and (iii) IGSS hospitals and dialysis units are part of a single health care system, therefore facilitating implementation of protocols at the dialysis units to expedite referrals.

This study has some limitations. There are 2 main dialysis providers in Guatemala: the Guatemalan MoH and the IGSS. We only captured those patients affiliated with IGSS, which represents around 34% of the population with access to renal replacement therapy.[17] We did not include those patients undergoing peritoneal dialysis in our cohort. We mainly diagnosed the patients based on symptoms, and we might have missed a significant proportion of those patients with asymptomatic infection.

In summary, this is the largest study to characterize a cohort of patients with ESKD on hemodialysis with a diagnosis of COVID-19 in Latin America. The first case of COVID-19 in a patient on hemodialysis in Guatemala was reported on May 13, 2020. Meanwhile, patients on hemodialysis continued getting dialysis 3 times a week in any of our 15 dialysis units across the country. Every dialysis unit at IGSS took actions to prevent the spread of the disease. Whenever a patient had symptoms suspicious of COVID-19, the medical staff at each dialysis unit referred them to the social security reference hospital to confirm the diagnosis of COVID-19 by reverse transcriptase–polymerase chain reaction or SARS-CoV-2 antigen test. We found that among patients on hemodialysis with COVID-19 in Guatemala the lethality rate was similar to other regions across the world. There was a regional variation in the incidence of COVID-19 in Guatemala.

DISCLOSURE

ACKNOWLEDGMENTS

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)
STROBE statement

REFERENCES

1. Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in china, 2019. *N Engl J Med*. 2020;382:727–733.

2. World Health Organization website. Coronavirus disease (COVID-2019) weekly epidemiological update and weekly operational update. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports. Accessed March 6, 2021.

3. Martinez-Folgar K. Mortality trends during the COVID-19 pandemic. *SERdigital*; 2020. Available at: https://videos.files.wordpress.com/vtlTN1Hx/kevin-martinez-folger_hd.mp4. Accessed March 18, 2021.

4. Chavez O, Barrera A, Slowing K. Exceso de mortalidad durante la primera ola de COVID-19 en Guatemala. *Analisis de la Realidad Nacional*; 2020. Available at: http://ipn.usac.edu.gt/wp-content/uploads/2020/10/IPN-RD-193.pdf. Accessed March 18, 2021.

5. Flood DC, Chary AN, Austad K, Garcia P, Rohloff PJ. A patient navigation system to minimize barriers for peritoneal dialysis in rural, low-resource settings: case study from Guatemala. *Kidney Int Rep*. 2017;2:762–765.

6. Carter C, Thi Lan Anh N, Notter J. COVID-19 disease: perspectives in low- and middle-income countries. *Clin Integr Care*. 2020;1:100005.

7. Ma Y, Diao B, Lv X, et al. Epidemiological, clinical, and immunological features of a cluster of COVID-19–contracted hemodialysis patients. *Kidney Int Rep*. 2020;5:1333–1341.

8. Tortonese S, Scriabine I, Anjou L, et al. COVID-19 in patients on maintenance dialysis in the Paris region. *Kidney Int Rep*. 2020;5:1535–1544.

9. Valeri AM, Robbins-Juarez SY, Stevens JS, et al. Presentation and outcomes of patients with ESKD and COVID-19. *J Am Soc Nephrol*. 2020;31:1409–1415.

10. Corbett RW, Blakey S, Nitsch D, et al. Epidemiology of COVID-19 in an urban dialysis center. *J Am Soc Nephrol*. 2020;31:1815–1823.

11. La Milia V, Bacchini G, Bigi MC, et al. COVID-19 outbreak in a large hemodialysis center in Lombardy, Italy. *Kidney Int Rep*. 2020;5:1095–1099.

12. Roper T, Kumar N, Lewis-Morris T, et al. Delivering dialysis during the COVID-19 outbreak: strategies and outcomes. *Kidney Int Rep*. 2020;5:1090–1094.

13. Alberici F, Delbarba E, Manenti C, et al. A report from the Brescia Renal COVID Task Force on the clinical characteristics and short-term outcome of hemodialysis patients with SARS-CoV-2 infection. *Kidney Int*. 2020;98:20–26.

14. Ng JH, Hirsch JS, Wanchoo R, et al. Outcomes of patients with end-stage kidney disease hospitalized with COVID-19. *Kidney Int*. 2020;98:1530–1539.

15. Instituto Nacional de Estadistica Guatemala website. Características generales de la población. Available at: https://www.censopoblacion.gt/censo2018/poblacion.php. Accessed July 20, 2020.

16. Pan American Health Organization website. *Health in the Americas+, 2017 Edition. Summary: Regional Outlook and Country Profiles*. Washington, DC: World Health Organization; 2017.

17. Garcia P, Sanchez-Polo V. Global dialysis perspective: Guatemala. *Kidney360*. 2020;1:1300–1305.

18. Garcia P, Mendoza C, Barnoya J, et al. Chronic kidney disease care and research in Guatemala: overview and meeting report. *Kidney Int Rep*. 2020;5:1567–1575.

19. Hoy W, Giraldo G, Martinez-Piedra R, et al. *Epidemic of Chronic Kidney Disease in Agricultural Communities in Central America. Case Definitions, Methodological Basis, and Approaches for Public Health Surveillance*. Washington, DC: World Health Organization; 2017.

20. Instituto Nacional de Estadistica Guatemala. Estimaciones y proyecciones de poblacion 2020. Available at: https://www.censopoblacion.gt/proyecciones. Accessed March 4, 2020.

21. Cécile C, Florian B, Carole A, et al. Low incidence of SARS-CoV-2, risk factors of mortality and the course of illness in the French national cohort of dialysis patients. *Kidney Int*. 2020;98:1519–1529.

22. Sanchez E, Macía M, de Sequera Ortiz PJK. Management of hemodialysis patients with suspected or confirmed COVID-19 infection: perspective from the Spanish Nephrology. *Kidney360*. 2020;1:1254–1258.

23. Anand S, Montez-Rath M, Han J, et al. Prevalence of SARS-CoV-2 antibodies in a large nationwide sample of patients on dialysis in the USA: a cross-sectional study. *Lancet*. 2020;396:1335–1344.

24. Ramay BM, Cerón A, Méndez-Alburez LP, Lou-Meda R. Factors associated to acceptable treatment adherence among children with chronic kidney disease in Guatemala. *PLoS One*. 2017;12, e0186644.

25. Lou-Meda RM, Valle AL, Urla C, Mazariegos J. Epidemiologic and socioeconomic profile of Guatemalan hemodialysis patients: assessment and dissemination via a free-access information system. *Clin Nephrol*. 2020;93:76–81.

26. Medjeral-Thomas NR, Thomson T, Ashby D, et al. Cohort study of outpatient hemodialysis management strategies for COVID-19 in North-West London. *Kidney Int Rep*. 2020;5:2055–2065.

27. Instituto Guatemalteco de Seguridad Social website. Informe Anual de Labores 2019. Available at: https://www.igssgt.org/informes/informe-anual-de-labores/. Accessed March 6, 2021.

28. Goicoechea M, Sánchez Cámara LA, Macías N, et al. COVID-19: clinical course and outcomes of 36 maintenance hemodialysis patients from a single center in Spain. *Kidney Int*. 2020;98:27–34.

29. Gupta S, Hayek SS, Wang W, et al. Factors associated with death in critically ill patients with coronavirus disease 2019 in the US. *JAMA Intern Med*. 2020;1890:1–12.

30. Cummings MJ, Baldwin MR, Abrams D, et al. Epidemiology, clinical course, and outcomes of critically ill adults with COVID-19 in New York City: a prospective cohort study. *Lancet*. 2020;395:1763–1770.

31. Salerno FR, Parraga G, McIntyre CW. Why is your patient still short of breath? Understanding the complex pathophysiology of dyspnea in chronic kidney disease. *Semin Dial*. 2017;30:50–57.

32. Clarke C, Prendecki M, Dhutia A, et al. High prevalence of asymptomatic COVID-19 infection in hemodialysis patients detected using serologic screening. *J Am Soc Nephrol*. 2020;31:1969–1975.

33. Xiong F, Tang H, Liu L, et al. Clinical characteristics of and medical interventions for COVID-19 in hemodialysis patients in Wuhan, China. *J Am Soc Nephrol*. 2020;31:1387–1397.

34. 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. *Kidney360*. 2020;1:755–762.

35. Flood D, Wilcox K, Ferro AA, et al. Challenges in the provision of kidney care at the largest public nephrology center in Guatemala: a qualitative study with health professionals. *BMC Nephrol*. 2020;21:71.