



An Interprofessional Approach in Caring for a Patient on Maintenance Hemodialysis with COVID-19 in Toronto, Canada: An Educational Case Report

Canadian Journal of Kidney Health and Disease
Volume 7: 1–6
© The Author(s) 2020
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/2054358120957473
journals.sagepub.com/home/cjk

Elizabeth M. Hendren^{1*}, Nicola Matthews^{1*},
Mathew Oliver^{1,2}, Julie Rice², Sheldon W. Tobe^{1,2,3},
and Bourne L. Auguste^{1,2}

Abstract

Rationale: Hemodialysis patients are at significant risk from COVID-19 due to their frequent interaction with the health care system and medical comorbidities. We followed up the trajectory of the first COVID-19–positive maintenance hemodialysis patient at Sunnybrook Health Sciences Centre in Toronto. We present the lessons learned and changes in practices that occurred to prevent an outbreak in our center.

Presenting concerns of the patient: The patient, a 66-year-old woman on in-center hemodialysis, initially presented with a 2-day history of a productive cough. She subsequently developed a fever, was placed on contact and droplet isolation, and admitted to hospital.

Diagnoses: On March 13, 2020, the patient tested positive for COVID-19. Within the next 48 hours, she developed hypoxia and acute respiratory distress syndrome as a complication of her illness requiring an extended critical care stay. This extended critical care stay resulted in critical illness–associated secondary sclerosing cholangitis.

Interventions: An interprofessional team was established, performing rapid Plan-Do-Study-Act quality improvement cycles to improve screening practices and promote the safety of patients and staff in the hemodialysis unit.

Outcomes: We present here the lessons learned, the changes to our screening protocols, and the clinical course of our first in-center hemodialysis patient with SARS-CoV-2.

Teaching points: Regular review of the infection screening processes is paramount in preventing outbreaks of COVID-19, particularly in hemodialysis units. Hospital admission should be arranged if a patient exhibits any clinical signs of hemodynamic compromise or hypoxia. Early education for health care practitioners caring for patients with COVID-19 and refresher information regarding personal protective equipment helped promote the safety of staff and prevent health care–associated outbreaks.

Keywords

critical illness, illness trajectory, infectious diseases, quality improvement, hemodialysis

Received June 4, 2020. Accepted for publication August 1, 2020.

Introduction

In December 2019, an outbreak of the novel SARS-CoV-2 virus (COVID-19) began in China, and by March 2020, the World Health Organization officially declared COVID-19 a

global pandemic.¹ Maintenance hemodialysis (HD) patients have multiple risk factors for serious COVID-19 infection, including advanced age, medical comorbidities (eg, hypertension, diabetes, cardiovascular disease), and an underlying immunocompromised state driven by the uremic milieu of



end-stage renal disease.² In-center HD patients are within close proximity to each other and health care workers and may be exposed in transit, in waiting rooms, or on dialysis multiple times per week. As a result, these patients are at significant risk of acquiring or transmitting the infection and the risk of outbreak and infection within a dialysis unit will remain prevalent throughout this pandemic.

On January 23, 2020, a 2-step screening protocol for case finding of COVID-19 was rolled out across all patient care areas at Sunnybrook Health Sciences Centre. The initial screening algorithm incorporated known clinical symptoms of COVID-19 (cough, shortness of breath, or fever) along with a recent travel history to China. This screening was performed by administrative assistants upon patient registration. On January 25, 2020, our institution identified the first known case of COVID-19 in Canada.³

In this case report, we describe the lessons learned in caring for a 66-year-old female patient on HD with COVID-19 infection at Sunnybrook Health Sciences Centre in Toronto, Canada. She initially presented with a mild cough on March 11, 2020, but did not report this on screening. However, on March 13, 2020, she was found to be febrile during her dialysis session and tested positive for COVID-19.

From the time of diagnosis and throughout her prolonged admission, this novel viral infection created unanticipated challenges in care and management plans. It required concerted efforts of the interprofessional team and implementation of rapid Plan-Do-Study-Act (PDSA) cycles to continuously adapt our screening and infection control protocols as the COVID-19 pandemic progressed, implementing knowledge of viral transmission patterns in each cycle to maintain the safety of our staff and patients in the early phases of this pandemic. Our early experiences may provide insight into the importance of maintaining an interprofessional approach in caring for HD patients with COVID-19.

Presenting Concerns

The first HD patient at our center with COVID-19 presented to dialysis with a mild cough and sore throat on March 11, 2020. At that time, screening was being conducted by a personal administrative assistant. The patient had a history of asthma and told the screener her cough was attributed to symptoms of her chronic disease, so she did not receive further investigation or isolation. On March 13, 2020, she

presented to HD with the same symptoms and was once again not isolated. The dialysis nurse detected a fever of 38°C about 90 minutes into her session, and she was then placed on droplet and isolation precautions. This was reported to the dialysis physician, and a nasopharyngeal (NP) swab for detection of COVID-19 was ordered. On further history, she had no personal travel history, but had attended an extended family gathering 5 days before the onset of symptoms and 2 family members living in the same household had traveled outside of Canada and had developed respiratory symptoms. She was discharged in stable condition after her session and instructed to self-isolate at home along with her family. That evening, her NP swab was positive for COVID-19. Because it was early on in the pandemic, we had not yet established a COVID-19 dialysis protocol in our institution; thus, arrangements were made to have the patient admitted to hospital until isolation practices could be put into place in the outpatient dialysis setting.

On March 14, the patient was admitted to the nephrology inpatient service, as our dedicated COVID-19 ward had not yet been established. This admission required collaboration with nursing, hospital management, and infection prevention and control (IP & C) about how to safely arrange transport. Ultimately, the patient was asked to arrive at an adjacent hospital parking lot (Supplemental Figure 1) where a medical team in full personal protective equipment (PPE) met and escorted her to a private room. The family member dropping the patient off was instructed beforehand to wear a mask and not exit the vehicle on drop off.

Clinical Findings

On admission, the patient remained on droplet and contact isolation precautions with all health care staff wearing a surgical mask and face shield while providing care to the patient. Initially, she denied dyspnea but reported an ongoing productive cough. Blood pressure was 113/65 mm Hg with an oxygen saturation of 91% on room air, with a low-grade fever of 38°C, and bibasilar crackles on lung auscultation.

Diagnostic Focus and Assessment

Chest X-ray at the time of admission showed diffuse patchy infiltrates bilaterally. The laboratory investigations from throughout the patient's hospital stay are summarized in

¹Division of Nephrology, Department of Medicine, University of Toronto, ON, Canada

²Division of Nephrology, Department of Medicine, Sunnybrook Health Sciences Centre, Toronto, ON, Canada

³Northern Ontario School of Medicine, Sudbury, Canada

*E.M.H. and N.M. contributed equally to the preparation of this article.

Corresponding Author:

Bourne L. Auguste, Sunnybrook Health Sciences Centre, Kidney Care Centre at the CNIB Centre, 1929 Bayview Avenue, Third Floor, Toronto, ON, Canada M4G 3E8.

Email: Bourne.auguste@sunnybrook.ca

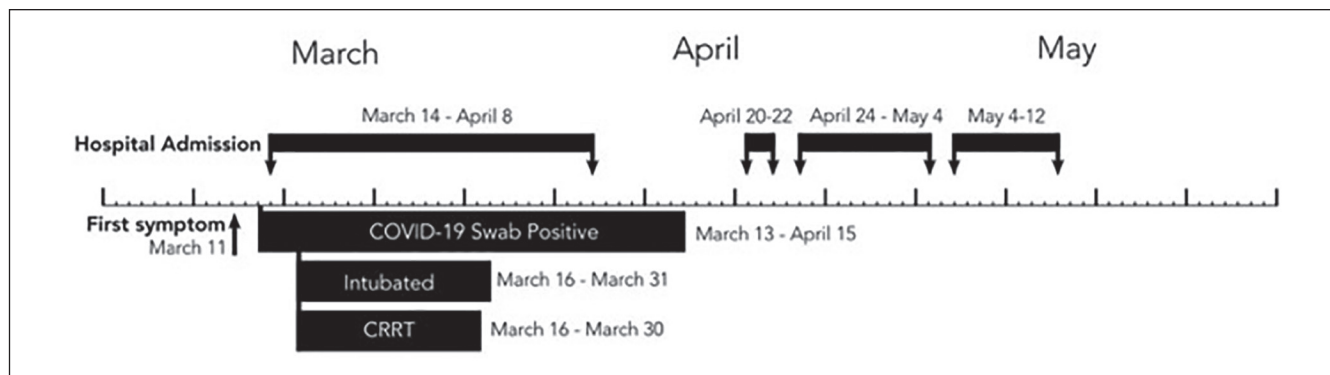


Figure 1. Timeline of events for hemodialysis patient with COVID-19 infection.

Table 1. Laboratory Parameters.

Lab test	Baseline/hospital admission (day 0)	ICU admission (day 2)	ICU discharge (day 21)	Hospital discharge (day 25)	Readmission (day 37)	Normal range
Hemoglobin	95	101	75	81	85	115-165 g/L
White blood cell	6.5	8	10	10	21.7	$4.0-11 \times 10^9/L$
Neutrophil count	5.2	6.5	6.3	6.7	18.7	$2-7.5 \times 10^9/L$
Lymphocyte count	2.2	0.6	1.3	1.5	1.5	$1.0-4 \times 10^9/L$
Platelets	157	217	246	231	319	$150-400 \times 10^9/L$
Ferritin	39	275		298		20-400 $\mu\text{g/L}$
Lactate		0.7				<1.7 mmol/L
C-reactive protein			72			0-5 mg/L
Aspartate aminotransferase		93		35		
Alanine aminotransferase		63	99	46	255	<31 U/L
Alkaline phosphatase	100	380	987	754	1381	40-120 $\mu\text{mol/L}$
Bilirubin		7	14	10	46	<20 $\mu\text{mol/L}$

Note. ICU = intensive care unit.

Table 1. Notable laboratory investigations include an initial lymphopenia, progressive anemia, and a normal lactate. Tests of hypercoagulability and prognostic markers for severe COVID-19 included a ferritin of 275 $\mu\text{g/L}$ (range: 20-400 $\mu\text{g/L}$) and a mildly elevated partial thromboplastin time of 39.4 seconds. AD-dimer was not performed. Echocardiography demonstrated normal biventricular function.

Therapeutic Focus and Assessment

On March 15, further hypoxia was noted with an oxygen saturation of 86% on room air, which improved with oxygen 2 L/min by nasal cannula. The patient was dyspneic with difficulty completing full sentences. The following day, there was respiratory deterioration requiring 50% FiO_2 then subsequently a nonrebreather mask to maintain the oxygen saturation >90%. The intensive care team was consulted, and they made a decision to pursue early invasive ventilation. She was intubated in a protected fashion with only essential personnel in the room, and all personnel wearing fit-tested N95 masks and face shields, as well as surgical gowns and nonsterile

gloves. The patient was transferred to the intensive care unit (ICU) for ongoing management.

Over the next 24 hours, the patient developed septic shock and was treated with ceftriaxone and ciprofloxacin for superimposed pseudomonas pneumonia. She was started on hydroxychloroquine 400 mg once then 200 mg daily for 6 days based on a theoretical benefit of this agent in patients with COVID-19. The patient's NP swab was negative for influenza, and therefore, she was not treated with oseltamivir. She was not a candidate for the COVID-19 clinical trial run out of our center (Canadian Treatments for COVID-19 trial) because of her baseline use of salmeterol for asthma.

Due to hemodynamic instability, dialysis was switched to continuous renal replacement therapy (CRRT) with regional citrate anticoagulation on the second day in the ICU. Our hospital offers CRRT and sustained low-efficiency dialysis; however, CRRT was chosen due to the need for multiple vasopressors to maintain perfusion pressure. Our center runs CRRT with replacement fluid primarily in the prefilter position, with only 200 mL in the postfilter position. She did not develop any challenges with bleeding or thrombosis while

on CRRT with a standard citrate nomogram, and there was no indication for systemic anticoagulation. The critical care nursing staff members were offered additional training on donning and doffing of PPE. A care bundle approach was used so multiple tasks would be performed by 1 health care staff to limit the in-and-out traffic for the room. Finally, CRRT dosing was reduced to limit the manual bag changes for nursing staff while still providing adequate clearance (total effluent dose was 15 mL/kg/h).

Continuous renal replacement therapy was required for 13 days until the patient's hemodynamic status improved and she could be transitioned to intermittent hemodialysis (IHD). Early and ongoing education regarding PPE donning and doffing was offered to all dialysis nurses, and a safety leader was implemented to coach staff to ensure proper PPE protocols were followed. A collaborative review of best practices for critical care dialysis by ICU and nephrology leads was undertaken to establish practice standards moving forward in the pandemic. After 19 days of mechanical ventilation, the patient was successfully extubated and was discharged home 4 days later after 25 days in hospital (Figure 1).

Follow-up and Outcomes

After hospital discharge, the patient returned to in-center dialysis in an isolation room and remained on droplet and contact precautions. She was met by a nurse in full droplet and contact PPE at a designated hospital entrance and transported to her room to minimize exposure to other patients and staff. Surveillance COVID-19 NP swabs were sent once a week. Although the patient remained clinically well with no return of respiratory symptoms, there was persistently detectable COVID-19 polymerase chain reaction (PCR) on 5 NP swabs taken over a span of 42 days, which included both her 25-day hospitalization (3 swabs) and 2 subsequent swabs done in the outpatient HD unit. She finally had 2 negative COVID-19 NP swabs and was cleared by IP & C on April 20, 2020.

The patient's laboratory results were followed up on each session, including transaminase levels and synthetic liver function tests which had been elevated at the time of hospital discharge. Two weeks after hospital discharge and 6 weeks after the initial presentation, the patient was readmitted for persistent laboratory abnormalities (see Table 1). The patient was clinically well and afebrile with no abdominal symptoms; however, she was in sinus tachycardia and found to have biliary obstruction on imaging and biochemistry. After 3 readmissions and multiple endoscopic retrograde cholangiopancreatographies, the patient was diagnosed with critical illness-associated secondary sclerosing cholangitis with multiple infected liver abscesses requiring a 6-week course of antimicrobial therapy (fluconazole and moxifloxacin).

On March 14, our program conducted extensive contact tracing to identify staff and HD patients who were exposed to this patient in the week prior to her admission. In total, 4 HD nurses, 1 technician, and 1 environmental specialist were

exposed and underwent 14-day self-isolation. Three chronic HD patients were exposed and placed into isolation on subsequent HD and also informed to maintain 14-day self-isolation at home. Fortunately, none of those exposed experienced any symptoms, and surveillance NP swabs were negative. All were cleared to return to work at the end of their self-isolation. Since April 2020, universal PPE precautions with a mask and visor have been put in place hospital wide, and asymptomatic staff members are no longer required to self-isolate after a potential exposure to COVID-19.

Discussion

This case of COVID-19 infection in an HD patient was the first in our institution and, at every step, required novel approaches to management that were only possible with interprofessional and interdisciplinary cooperation. There were multiple lessons learned from this experience, including complications of COVID-19 critical illness, strategies for discharge planning, and infection control for a novel infectious agent in the outpatient HD setting. This experience also highlights the importance of implementing quality improvement methodology to continuously modify best practices and identify potential gaps in care.

Patients on IHD have schedules which place them at risk of acquiring or transmitting infection due to their regular transfers between the acute care environment and home or institutional residential setting.⁴ The consequences of this were seen early on in the COVID-19 pandemic; the first 2 deaths from COVID-19 in the United States were patients receiving chronic HD.⁵ Because this patient presented early on in the pandemic, we erred on the side of caution to admit her for observation and coordination of dialysis, despite the fact that she was relatively asymptomatic. In hindsight, this admission was fortunate as it allowed for a rapid resuscitation when her clinical status deteriorated. However, we have subsequently seen that not all dialysis patients with COVID-19 require admission. If patients can reliably self-isolate and they are asymptomatic, then consideration should be given to follow up them in the outpatient setting to avoid nosocomial spread.

In this case, we highlight features of this patient's critical illness including the need for CRRT along with the delayed complication of secondary sclerosing cholangitis, a rare but serious complication of prolonged critical illness that occurs due to inflammation and subsequent stricture formation in the biliary tract.⁶ Despite case series demonstrating hypercoagulability in critically ill patients with COVID-19,⁷ this patient did not have any challenges with thrombosis or bleeding, despite using a normal target regional citrate nomogram. Although COVID-19 has been shown to directly infect hepatocytes, and is associated with cholangitic injury, no cases of COVID-19-associated sclerosing cholangitis have been published.^{6,7} After the patient's initial recovery from critical illness, her hospital discharge involved a coordinated effort from infectious diseases, gastroenterology, and nephrology

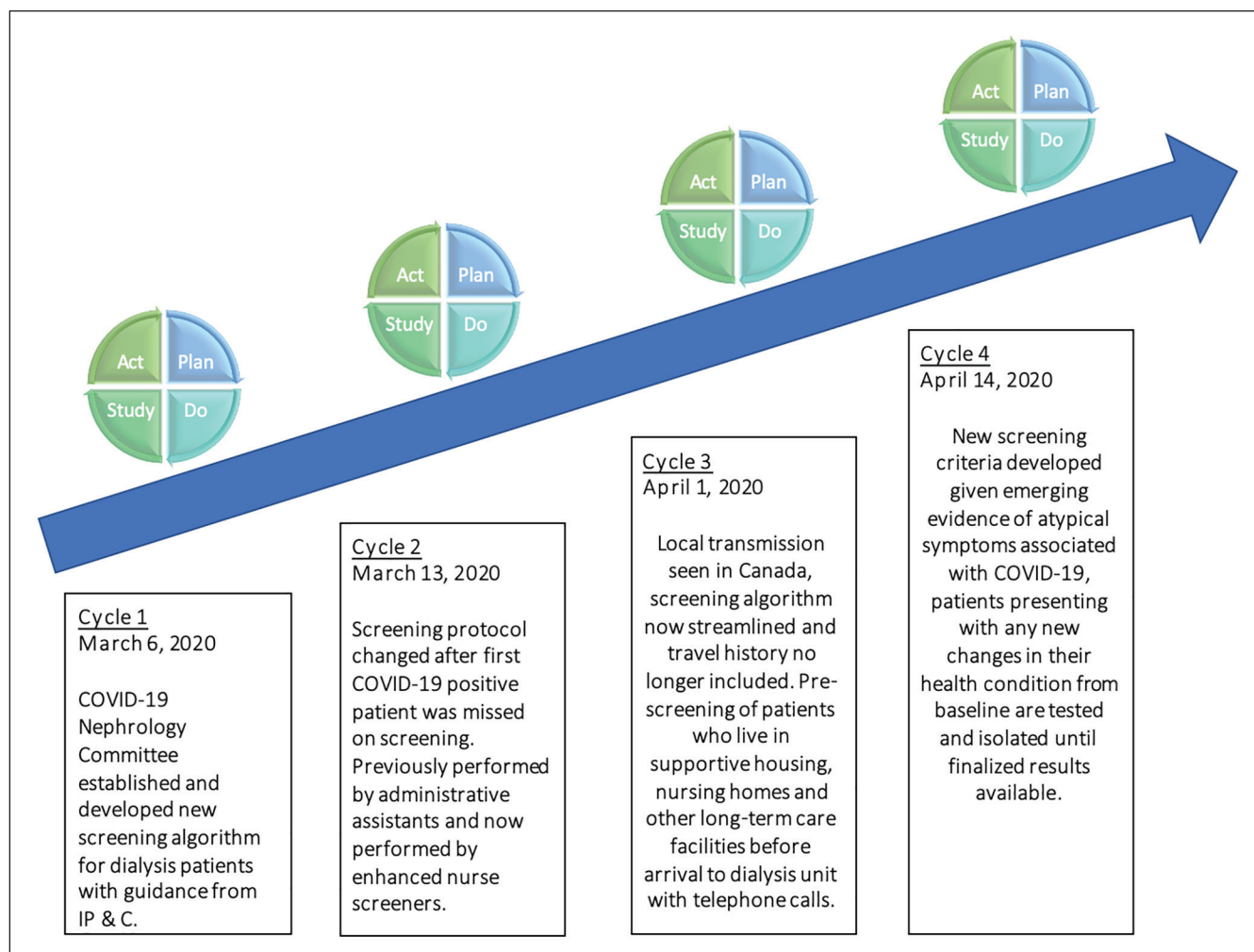


Figure 2. Rapid PDSA cycles of COVID-19 screening evolution at Sunnybrook Health Sciences Centre.

Note. PDSA = Plan-Do-Study-Act.

along with 7 days of advanced planning to ensure she could be safely dialyzed and followed up as an outpatient.

This patient had detectable viral PCR on her NP swab for a period of 42 days. This is consistent with the upper range of what has been seen in the general population^{8,9} and in the in-center HD patient population.¹⁰ Hypertension, diabetes, and older age have been shown to be associated with a longer duration of detectable virus on PCR, though it is unknown whether this translates to ongoing viral transmission after the first 14 days of illness.⁸

As the COVID-19 outbreak progressed, our institution's screening algorithm was continuously modified using PDSA cycles to reflect evolving knowledge related to viral transmission patterns (Figure 2). For example, from March 6 to 16, 2020, the screening protocol included symptoms of respiratory tract infection and travel outside of Canada or contact with someone who had traveled outside of Canada. However, as evidence of community spread within Canada emerged, the protocol was updated to remove the requirement for

travel. Additional changes to this protocol included mandatory droplet and contact PPE for the nurse in the screener role, physically distant areas marked on the floor for patients to stand while awaiting screening, and universal masking for patients (implemented on April 23, 2020). Communication to all HD staff and patients was provided after each cycle of changes. Essential visitors accompanying patients to the dialysis unit were also screened and required to wear a mask. Finally, dialysis patients were informed of each change in the screening protocol with a printed letter provided in the HD unit, along with updated signs posted at the entrance of the dialysis unit.

Adapting screening protocols to identify infection from a novel pathogen has required local, national, and international collaboration, along with a flexible, rapid-cycle approach to identify and improve gaps in clinical practice. On a local level, we relied on infectious disease specialists and infection control practitioners to incorporate local disease transmission patterns into our screening algorithm. Our response to

COVID-19 included the creation of a dedicated team (COVID-19 Nephrology task force) to meet daily to review any possible cases. This task force includes the HD director, the nephrology division director, administrative support personnel, nursing team leads, and dialysis-specialized nurse practitioners. The task force would also liaise regularly with IP & C to ensure that divisional practices remained aligned with hospital-wide policy.

On a national level, we relied on information from the Canadian Society of Nephrology COVID-19 Rapid Response Team which incorporated up-to-date information and shared best practices from across the country to publish the inaugural recommendations for the management of outpatient HD during the COVID-19 epidemic.¹¹ Finally, on an international level, we have learned from the experiences of other clinicians. For example, Wang et al identified that HD patients with COVID-19 often present with nonrespiratory complaints such as abdominal pain and diarrhea and may not be identified with screening protocols that target respiratory symptoms.¹² Using the model for improvement framework with rapid PDSA cycles, evolving information about disease symptoms and spread will improve future screening protocols as more is learned about this virus.

At each stage of the pandemic, lessons learned were quickly adopted into the dialysis unit, reducing the impact of further cases on the staff and other patients. As this virus continues to spread in the community and within institutions, we must continue to screen for cases in our vulnerable populations—including patients on in-center HD. Application of quality improvement methodology with rapid PDSA cycles will ensure that screening protocols are continuously evolving with new knowledge and best practices such as to limit the risks of a potential outbreak in a dialysis unit. Finally, in our patients who develop symptoms of COVID-19, we must be fastidious at monitoring for acute and delayed complications of the virus.

Ethics Approval and Consent to Participate

The authors have no ethical conflicts to disclose. The patient has provided written informed consent for the publication of her anonymized clinical course.

Consent for Publication

Consent for publication has been provided by all authors.

Acknowledgments

The authors would like to acknowledge Michael D. Jones, PhD, for his assistance with Figure 1.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Elizabeth M. Hendren  <https://orcid.org/0000-0003-0905-4585>

Supplemental Material

Supplemental material for this article is available online.

References

1. WHO. *Coronavirus Disease 2019 (COVID-19): Situation Report—51*. WHO; 2020. <https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200311-sitrep-51-covid-19.pdf>. Accessed May 18, 2020.
2. Ikizler TA. COVID-19 and dialysis units: what do we know now and what should we do? *Am J Kidney Dis*. 2020;76:1-3. doi:10.1053/j.ajkd.2020.03.008.
3. Silverstein WK, Stroud L, Cleghorn GE, Leis JA. First imported case of 2019 novel coronavirus in Canada, presenting as mild pneumonia. *Lancet*. 2020;395:734.
4. Holroyd-Leduc JM, Laupacis A. Continuing care and COVID-19: a Canadian tragedy that must not be allowed to happen again. *CMAJ*. 2020;192:E632-E633. doi:10.1503/cmaj.201017.
5. Durvasula R, Wellington T, McNamara E, Watnick S. COVID-19 and kidney failure in the acute care setting: our experience from Seattle. *Am J Kidney Dis*. 2020;76:4-6. doi:10.1053/j.ajkd.2020.04.001.
6. Gudnason HO, Björnsson ES. Secondary sclerosing cholangitis in critically ill patients: current perspectives. *Clin Exp Gastroenterol*. 2017;10:105-111.
7. Klok FA, Kruip JHA, van der Meer NJM, et al. Incidence of thrombotic complications in critically ill ICU patients with COVID-19. *Thromb Res*. 2020;191:145-147.
8. Xiao AT, Tong YX, Zhang S. Profile of RT-PCR for SARS-CoV-2: a preliminary study from 56 COVID-19 patients [published online ahead of print April 19, 2020]. *Clin Infect Dis*. doi:10.1093/cid/ciaa460.
9. To KK-W, Tsang OT-Y, Leung W-S, et al. Temporal profiles of viral load in posterior oropharyngeal saliva samples and serum antibody responses during infection by SARS-CoV-2: an observational cohort study. *Lancet Infect Dis*. 2020;20:565-574.
10. Dudreuilh C, Kumar N, Moxham V, Hemsley C, Goldenberg S, Moutzouris D-A. De-isolation of COVID-19-positive hemodialysis patients in the outpatient setting: a single-center experience. *Kidney Int*. 2020;98:236-237.
11. Suri RS, Hemmett J, MacRae JM, et al. Management of outpatient hemodialysis during the COVID-19 pandemic: recommendations from the Canadian Society of Nephrology COVID-19 rapid response team. *Can J Kidney Health Dis*. 2020;7:2054358120928153.
12. Wang R, Liao C, He H, et al. COVID-19 in hemodialysis patients: a report of 5 cases. *Am J Kidney Dis*. 2020;76:141-143. doi:10.1053/j.ajkd.2020.03.009.