

## VIEWPOINT

## Nephrology and COVID-19

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**Initial reports** about the new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) epidemic suggested that the incidence of kidney complications was low.<sup>1,2</sup> Few would have anticipated the profound effect that the coronavirus disease 2019 (COVID-19) pandemic would have on the field of kidney health care. Early in the pandemic, it became apparent that patients with kidney disease were particularly vulnerable to SARS-CoV-2.<sup>3</sup> In addition, it also became apparent that acute kidney injury (AKI) was occurring at several-fold higher rates in hospitalized patients with COVID-19 in the US than in earlier series in China.

The etiologies underpinning the high incidence of AKI need to be better understood. Several pathologic series suggest that acute tubular necrosis is the predominant form of kidney injury.<sup>4-6</sup> However, proteinuria, hematuria, and leukocyturia appear to be common with COVID-19-associated AKI; megakaryocytosis, thrombosis, and pigmented casts (possibly consistent with rhabdomyolysis) have been observed pathologically, and collapsing glomerulopathy has been reported. It is probable that the pathophysiology of COVID-19-associated AKI is more multifaceted than AKI observed with other causes of sepsis and critical illness. It is likely that this excess AKI may lead to chronic kidney disease in some patients; however, follow-up data on longer-term deteriorations in kidney health due to COVID-19 are currently lacking.

### Improvisation and Innovation

During the wave of patients with COVID-19 who were treated at hospitals in New York City, the severity of disease and especially the incidence of AKI were unexpected and overwhelming for both nephrologists and health care systems.<sup>7</sup> In one study, 34% of the 815 patients who were admitted to the intensive care unit (ICU) in a New York City hospital system required extracorporeal kidney support, usually continuous kidney replacement therapy (CKRT).<sup>8</sup> Overall, an estimated 9% of 3235 patients admitted with COVID-19 required CKRT. Acute kidney injury was associated with an in-hospital mortality of 45% compared with a mortality of 7% among those without AKI. Very little is known about the long-term consequences of AKI associated with COVID-19.

What usually was a consult service list of 25 to 45 patients in one hospital quickly increased to more than 90 patients. With a higher proportion of patients than usual requiring CKRT, more dialysis and CKRT machines were needed but were not always readily available for purchase. In some hospitals, the availability of ICU nurses to provide CKRT was affected by changes in staffing ratios necessary to increase the number of ICU beds, while a number of hospital personnel, particularly dialysis nurses, became infected with COVID-19. These factors pushed the limit in terms of nephrology workforce.

While most medical centers focused on the availability of ICU beds, respirators, and extracorporeal membrane

oxygenation machines, kidney health care professionals were challenged to expand dialysis capacity to meet the needs of all patients with COVID-19 and to secure dialysis nursing staff and dialysis machines. Manufacturers of dialysis filters and replacement fluids for CKRT and peritoneal dialysis (PD) supplies and fluids also had difficulties in rapidly increasing production or in directing supplies from regions with low need to COVID-19 hot spots, resulting in significant mismatches between institutional needs and critical supplies in multiple New York City institutions. While the situation was similar in other early-surge regions (eg, Boston), the incidence of AKI seemed lower in later-surge areas (eg, Houston), and no shortages of dialysis equipment and supplies were reported.

Several innovative approaches were utilized to help counteract these challenges. Exposure of nurses and dialysis technicians to patients infected with SARS-CoV-2 was reduced by threading tubing for CKRT or PD under the threshold of the doors to patient rooms or through newly created openings so that direct patient contacts during kidney replacement therapy could be minimized. Video and audio monitors were used in some centers to allow visualization of hemodialysis machines without staff being in the room.

Shortages of CKRT machines were further addressed by using traditional hemodialysis machines to deliver more easily tolerated slow low-efficiency dialysis. Additionally, the capacity of CKRT machines was extended in many centers by utilizing them for accelerated venovenous hemofiltration/hemodialysis in which flow rates were increased and the duration of CKRT sessions reduced to 10 to 12 hours, thereby allowing 1 machine to be used to treat 2 patients daily. Use of the latter modality was limited in some centers as filter supplies declined because this approach required use of 2 dialysis filters per patient-day (compared with 1 every 2.5 to 3 days with standard CKRT). As the supply of premixed, bagged CKRT fluids became limited, several centers explored generating dialysate using their standard intermittent dialysis machines, dialysate concentrates, and dialysis water systems. In addition, because of the hypercoagulability of patients with COVID-19, anticoagulation protocols rapidly evolved.

Although PD has rarely been used in recent years for treatment of AKI in the US, it is widely used in other parts of the world. No machines are required, and the principles and technique of PD can be taught to health care personnel with limited experience with dialysis more rapidly than hemodialysis or CKRT. Furthermore, supplies for PD were less constrained than those for CKRT in the spring of 2020. Thus, several centers successfully created de novo acute PD programs over the course of days to weeks. Transition of stable patients who required kidney replacement therapy to be treated with PD as well as use of PD as an initial alternative to CKRT or intermittent hemodialysis also unloaded those modalities to better ensure availability.

As centers became more adept, PD protocols were modified to more rapidly increase fill volumes (increasing the dose and efficiency of dialysis), to use PD cyclers (facilitating delivery of a higher dialysis dose with less nursing time), and to place PD catheters laterally so that PD could continue even in patients in prone position. Overall, an important lesson learned for dealing with a pandemic was the need to maintain proficiency in multiple dialysis modalities to maintain flexibility and reduce reliance on any single set of nursing, machinery, or source of consumable supplies.

In the outpatient dialysis setting, in which treatment stations are not physically set up to accommodate isolation for most patients, only limited preventive measures could be established. Patients who tested positive for SARS-CoV-2 had to be cohorted with other infected patients because most facilities have only 1 or a few isolation rooms. Dialysis centers and clinicians collaborated in establishing COVID-19 shifts, or even COVID-19 units, to prevent further viral spread.

### Kidney Transplant

Despite the Centers for Medicare & Medicaid Services' ongoing consideration of transplant surgeries as high priority that should not be delayed during the COVID-19 pandemic, kidney transplant programs essentially halted during the height of the pandemic.<sup>9</sup> This was due to hospital-specific directives to avoid elective procedures, COVID-19 testing limitations early in the pandemic preventing timely identification of infected donors and recipients, incomplete understanding of the mode of transmission of SARS-CoV-2 and whether bloodborne transmission through solid organ transplants was a risk, and concerns about the effects of de novo immunosuppression on COVID-19 severity.

Furthermore, patients who received a kidney transplant experienced significant changes to their usual care as most centers switched to telehealth. The frequency of required laboratory testing, the urgency to perform biopsies, and the choice of maintenance immunosuppression in patients who were infected with SARS-CoV-2 were also being reconsidered. Most centers discontinued use of the antimetabolite mycophenolic acid in patients with kidney transplants who developed COVID-19, whereas calcineurin inhibitors were generally continued.

COVID-19 has also affected the field of kidney transplantation indirectly and possibly long term. The numbers of patients listed for kidney transplant declined by 18% (incidence rate ratio, 0.82; 95% CI, 0.80-0.84) while the waitlist mortality in states most affected

by COVID-19 (such as Louisiana, Michigan, New Jersey, New York, and Washington) was more than double the expected rates (incidence rate ratio, 2.22; 95% CI, 1.88-2.62).<sup>10</sup>

### Telehealth

Telehealth was rapidly adopted by clinicians and centers that provided care of patients with kidney disease. Although telehealth provided a crucial resource, several concerns remain about its long-term use. For example, Centers for Medicare & Medicaid Services guidelines and payment provisions incentivize physicians to see patients undergoing hemodialysis in person during dialysis 4 times per month. Although the value of such frequent visits remains uncertain, whether telehealth is ideal for this vulnerable population is unclear. It is distinctly possible that clinical examinations (crucial to determine volume status), review of dialysis-related laboratory studies, flow sheets (likely unavailable to practitioners when off-site), and communication with nursing staff will be less comprehensive if a clinician is not physically present.

For outpatients not undergoing dialysis, use of telehealth offers important convenience and provides physicians with crucial insights into patients' home environments. Additionally, use of telehealth has forced reconsideration of the optimal frequency of follow-up and laboratory testing for nephrology patients. However, as with patients receiving hemodialysis, better data are needed to understand whether further reducing reliance on physical examination and laboratory studies is appropriate. Furthermore, assessment and management of blood pressure is a cornerstone of nephrology care but is not always feasible via telehealth as many patients lack home devices for blood pressure measurement or do not have them accessible at the time of telehealth visits. The long-term financial aspects of telehealth are uncertain but, as in other clinical areas, are likely to significantly influence the role of telehealth in nephrology practice going forward.

During the past several months of the COVID-19 pandemic, nephrologists have witnessed unfathomable patient morbidity and mortality, and also have learned many lessons on emergency preparedness, supply chain management, professional improvisation, and technical and health care delivery innovation. Many of these lessons and changes implemented in response will remain, even when—hopefully—an efficacious and widely adopted vaccine becomes available, and the pandemic begins to resolve.

#### ARTICLE INFORMATION

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