Providing Care to Patients with AKI and COVID-19 Infection: Experience of Front Line Nephrologists in New York

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Introduction
Governor Cuomo recently stated, “We will lose people, the virus takes the most vulnerable. The challenge is to make sure we don’t lose anyone else we could have saved.”

Severe acute respiratory syndrome coronavirus 2, known as COVID-19, was first described in China in December 2019 (1). A global pandemic followed in the months to come, leading to devastating consequences. By April 26, 2020, COVID-19 had spread to >200 countries, infecting >2.9 million people, and resulting in >200,000 deaths globally (2). The suspected index case of COVID-19 infection leading to the New York City/Westchester outbreak was described in a man who became ill on February 22. By the third week of March, New York City had become an epicenter of the COVID-19 outbreak in the United States. Nearly 1 million Americans have been infected with the virus and New York accounts for 29% of these infections. Never in our lifetime have so many people fallen ill simultaneously. The rapid increase in hospitalizations has challenged the delivery of health care in unprecedented ways. AKI has been reported in up to 25% of patients with severe COVID-19 infection (3,4). The volume of patients with severe AKI in a single hospital poses unique challenges for the nephrologist including (1) infection prevention (2) workforce (3) dialysis resources, and (4) communication. We report our experience of providing care to hospitalized patients with AKI in the Bronx during the first month of the outbreak.

The Bronx Experience: AKI in COVID-19-Infected Patients
Montefiore Medical Center (MMC), located in the North Bronx in close proximity to Westchester County, has been one of the main urban tertiary care centers for patients in New York City with COVID-19 infection. MMC’s two main campuses are the Moses and Weiler Hospitals. Moses Hospital is a 726-bed hospital with five intensive care units (ICUs) (47 beds) and Weiler Hospital is a 431-bed hospital with two ICUs (32 beds). Each hospital has ten clinical nephrology faculty and four nephrology fellows. The Moses and Weiler Hospitals have 20 and 12 full-time dialysis nurses, respectively. Before COVID-19, there were two nephrology consult services and two ESKD services at Moses Hospital, and one nephrology consult service and one ESKD service at Weiler Hospital. One nephrologist with a fellow or physician assistant staffed each service. The average number of consultations for AKI was 10–15 per day at each hospital and the average census of each consult service was 20–25 patients.

On March 10, 2020, the first confirmed COVID-19-infected patient was transferred from Westchester to MMC. This patient had AKI and immediately required RRT. By April 6, the number of COVID-19 patients had increased to 877. Simultaneously, there was a significant increase in the number of consultations for AKI associated with COVID-19 infection and in those who needed acute RRT. (Table 1) Between March 10 and March 30, 2020, there were 112 nephrology consultations for AKI. The average age of these patients was 63 years; 69% were men, the majority were black or Hispanic, and diabetes mellitus, hypertension, CKD, and obesity were prevalent comorbidities. Most presented to the emergency department with AKI or started to develop AKI within 24 hours of admission, underscoring their severity of illness at presentation. The average time to RRT was 7 days and the most common indications for RRT were hyperkalemia and volume overload. Approximately 54% required ICU admission and 46% required RRT. To handle these high-acuity patients, the number of ICU beds increased by 60% and the number of nephrology services was expanded (Table 1).

Infection Prevention
Mitigating transmission of COVID-19 infection to other patients and hospital staff has been a major priority. To prevent the spread of infection, initially all COVID-19-infected patients requiring RRT received hemodialysis (HD) treatments at bedside. In order to expand the capability of providing bedside HD, hospital rooms were replumbed for access to the central reverse osmosis system, portable reverse osmosis was used, and ten additional HD machines were purchased.

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A limitation in providing bedside HD was the requirement of 1:1 nursing. As the number of COVID-19-infected patients increased, there was also a two- to threefold increase in the number of patients requiring bedside HD. To accommodate the increase in patients requiring bedside HD, patients with ESKD were placed on a twice-weekly schedule and treatments were shortened using higher blood and dialysate flow for those who could tolerate it. Those with AKI were managed with maximal medical management to delay RRT initiation. A novel approach to prevent or slow hyperkalemia from developing was initiation of potassium binders (patiromer or sodium zirconium cyclosilicate) in patients with a serum potassium between 4.0 and 5.0 meq/L that was rising. Nonoliguric patients were placed on diuretics to maintain euvoolemia.

Whenever possible, the number of staff entering infected patient rooms was limited to minimize exposure and preserve personal protective equipment (PPE). Nephrology teams performed remote assessment by reviewing the electronic record, laboratory data, and imaging. The most common reason for the nephrologist to directly interact with a COVID-19-infected patient was to discuss initiation of RRT or to place acute dialysis access. Telemonitoring was piloted using baby monitors with two-way video and audio, positioned next to the patient and dialysis machine, allowing the nurse to monitor the patient remotely during treatment. Tubing extension for continuous RRT (CRRT) was purchased to allow positioning of CRRT machines outside of the ICU rooms so the nurses could adjust ultrafiltration rates and check on machine alarms without the need to put on PPE to perform this task. Despite these interventions, capacity was reached in providing bedside HD near the end of March. After consultation with infection control, the Centers for Disease Control and Prevention’s recommendation to cohort COVID-19-infected patients together on the last shift of the day in the inpatient HD unit was used (5,6).

**Dialysis Resources**

The availability of dialysis resources decreased due to the surge in patients with COVID-19 with AKI requiring RRT (7). CRRT is the preferred treatment modality in patients presenting with acute respiratory distress syndrome requiring intubation and prone positioning. However, patients with this presentation quickly depleted the ability to provide CRRT for 24-hour periods per patient. Treatment times were reduced and dialysate flow rates were increased to convert CRRT to prolonged intermittent renal replacement treatments (PIRRT). PIRRT was performed for 6–12-hour treatments with effluent flow rates of 40–50 ml/kg per hour. This permitted the use of one machine for two to three patients with time for disinfection in between patients. Despite these adaptations, the surge in patients required the creation of 11 additional ICUs. As a result, the nurse-to-patient ratio increased significantly, which made it impossible for ICU nurses to manage 1:1 nursing requirements for PIRRT. Perfusionists who ordinarily manage extracorporeal membrane oxygenation procedures were reassigned and assumed the role of PIRRT management during the day. Before the International Society of Thrombosis and Hemostasis guidance for the recognition and management of the hypercoagulable state in patients with COVID-19, ICU patients on CRRT were observed to have increased clotting of catheters and filters despite therapeutic heparin infusion (partial thromboplastin time 2× normal), which led to frequent treatment interruptions and difficulty in achieving adequate clearance (8). To resolve the issue with clotting on CRRT, a nonvalidated bivalirudin protocol was initiated with close monitoring of partial thromboplastin time (8).

By early April, our COVID-19 RRT census included 25–30 patients with AKI on CRRT or PIRRT, 20 patients with AKI on HD, and 65 patients with ESKD on HD. To meet the increasing need for acute RRT, an acute peritoneal dialysis (PD) service was created. Transplant surgeons placed Tenckhoff catheters at bedside in intubated patients and...
interventional radiologists placed catheters in floor patients via fluoroscopy. Within 1 week, 18 patients were initiated on acute PD. Manual PD exchanges were initiated immediately after catheter placement using 1–2-L dwells with exchanges every 2–3 hours. Major barriers identified in effective delivery of this modality were nurse training and frequent prone positioning of ventilated patients. To overcome these barriers, nephrologists and fellows received in-service training on how to perform manual PD exchanges, and assisted nursing staff with limited experience. Additionally, PD cyclers were purchased from Baxter that reduced workload and staff exposure. The majority of patients with AKI
requiring acute RRT who were selected for PD were non-intubated, hemodynamically stable patients. CRRT or PIRRT was preferentially used in patients who were hemodynamically unstable, those requiring prone positioning for acute respiratory distress syndrome, and those with severe electrolyte abnormalities.

Communication
Bedside evaluation plays an important role in AKI management. However, during the COVID-19 pandemic, there has been a shortage of PPE. In an effort to preserve PPE, daily patient contact by specialists has been minimized. This has been a challenge, because intravascular volume assessment is important in determination of the need for intravenous fluids, diuretics, or RRT in those with AKI. Many patients with COVID-19-associated AKI also present with respiratory failure and chest x-ray findings of bilateral lung opacities with a ground glass appearance that is difficult to distinguish from pulmonary edema. In these patients, the desire to reduce hypervolemia to optimize respiratory status must be balanced against overdiuresis, which may further exacerbate AKI. Point-of-care ultrasound has been useful in assessing intravascular volume status, as well as frequent communication with the primary teams and reliance on their physical examination findings. To limit indwelling bladder catheters, nurses have been performing bladder scans to rule out urinary retention and determine urine output for intake and output assessment. “Often out of periods of losing come the greatest strivings toward a new winning streak.”

Despite the enormous challenges faced during the COVID-19 pandemic, this experience has taught us how to be resourceful in maximizing the availability of acute AKI and RRT services to meet the needs of our patients, even in the most trying circumstances. The best advice we can offer from New York to nephrologists across the world where COVID-19 may still be in its early stages is the following: plan ahead, get creative, support each other, and work together. Hopefully, we will never see another pandemic in our lifetime, but if we do we will be prepared (Figure 1).

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M. Fisher conceptualized the study, and was responsible for resources and visualization; M. Fisher, L. Golestaneh, and K. Prudhvi wrote the original draft; and all authors reviewed and edited the manuscript.

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References