



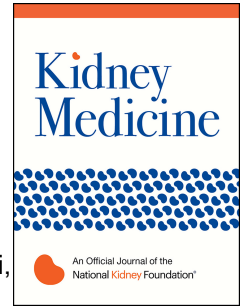
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Osama El Shamy, MD, Shuchita Sharma, MD, Jonathan Winston, MD, Jaime Uribarri, MD



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The COVID-19 pandemic has presented healthcare professionals with extraordinary challenges. As of April 13, 2020, there are ~555,000 confirmed cases in the United States and ~22,000 deaths; almost half of the deaths to date are in the state of New York. In New York City, with a population density of 26,430 people per square mile, the densest of any American municipality with a population above 100,000¹, social distancing may mitigate the strain on existing health care systems. Furthermore, the absence of widely available testing has resulted in additional use of already limited resources, including hospital beds, personal protective equipment and staff. As nephrologists, we see our primary goals as twofold: 1) keeping our existing patients safe both at home and in their dialysis units, and 2) meeting the needs of patients who do require hospitalization, both COVID related and unrelated.

The Mount Sinai Hospital, located in East Harlem, NY, has been at the forefront of patient care during the COVID-19 pandemic. It is also home to a large home dialysis unit with 80 peritoneal dialysis and 20 home hemodialysis patients. We report our experience with caring for this patient population during this crisis in the outpatient setting, as well as our procedures to use acute peritoneal dialysis to combat the inexorable rise in the number of admitted patients requiring kidney replacement therapy (KRT) in the inpatient setting.

Home Dialysis

As of March 16th, a number of changes were implemented in the home dialysis unit in order to avoid the unnecessary exposure of staff and patients to infection while still continuing to provide care and support to our patients. Within a span of a few days, our peritoneal dialysis unit obtained two iPads, arranged courier services, and contracted with a laboratory company to obtain, deliver and process patients' monthly bloodwork in order to effectively provide telemedicine services.

Each patient was contacted 24-48 hours prior to their scheduled appointment by a clinic coordinator to confirm their appointment date and time and to explain that their monthly visits would be conducted in the comfort of their own homes with the use of our telehealth capabilities. Since the government expanded telehealth capabilities and waived penalties for HIPAA violations, we used platforms such as FaceTime, WhatsApp and Zoom to expedite this process. A contracted laboratory company provided home visits, with laboratory results available within 24 hours of the blood draw.

Dialysis staff called patients on the day and time of their clinic appointments. Patients were asked to take their temperature, pulse and blood pressure. Visual exams were performed, including inspection of the exit site and evaluation for respiratory distress and edema. A thorough review of systems was also performed. The majority of our patients use Baxter's Amia cyclor with the remote Sharesource connectivity platform, which has been an invaluable resource to get patients' daily treatment information. Patients also spoke with the dietician and social worker. Patients' medications and prescriptions were adjusted. Monthly medications for anemia and mineral bone disease provided by the dialysis unit were delivered to patients' homes by a contracted courier

company. The same company picked up urine and dialysate samples if needed to assess dialysis adequacy (Kt/V) and delivered them to the dialysis unit.

Situations where it was deemed necessary for the patient to be physically present in the clinic included incident home patients, patients with PD catheter complications (such as exit site infections or tunnel infections), patients with suspected peritonitis, and patients deemed unstable. These patients were triaged over the phone by the clinical staff for potential COVID risk factors and symptoms, and if negative they were instructed to come in to the dialysis unit for further evaluation. Once this system was implemented, we successfully managed over 80% of our patients remotely.

Inpatient Dialysis

There has been an increase in hospital demands for hemodialysis (HD), due to maintenance HD patients being admitted with COVID-19 disease, severe acute kidney injury (AKI) with COVID-19 requiring urgent dialysis, and the increasing number of maintenance dialysis patients throughout the city who missed their regularly scheduled dialysis sessions and present to hospitals. Given this surge in dialysis needs as well as a rise in the number of clotted dialysis systems resulting in either prolonged treatment time or inadequate treatments due to the prothrombotic nature of COVID-19,² and decreased hemodialysis nursing staff availability due to COVID-19, our current dialysis setup has been insufficient to handle the load. As a result, we developed an acute peritoneal dialysis program at the Mount Sinai Hospital with the major goal of maximizing our ability to provide dialysis resources for this surge.

Acute peritoneal dialysis

Acute PD is a viable alternative to hemodialysis, not only reducing the number of central venous catheters being placed and therefore the number of central line associated blood stream infections but also providing patients with a viable long-term solution for their dialysis needs if they continue to require it in the outpatient setting at the time of discharge.

As of April 14, 2020, we have treated 10 patients with acute PD. This program is mainly focused on transitioning hospitalized patients with new dialysis needs to PD (Figure 1). Targeted patient groups include: 1) Admitted patients with CKD stage 4-5 who were transitioned to hemodialysis during their current admission and who are expected to have a prolonged hospital stay; and 2) Patients with unresolved AKI who have not been started on KRT and who are appropriate candidates for PD. In the event that we still cannot meet our dialysis demands we would then consider switching maintenance hemodialysis patients temporarily to PD while in the inpatient setting. The acute PD program is being applied to all admitted patients, regardless of their COVID-19 status. AKI patients who require urgent clearance (hyperkalemia – $K > 6.0\text{mEq}$, severe uremic symptoms – such as pericardial effusions or seizures, and severe acidosis – $\text{pH} < 7.2$), as well as prone patients were not considered good candidates for acute PD and it was recommended that they have hemodialysis catheters placed instead. A major challenge was timing, specifically when the acute PD program would be implemented. We elected to transition to acute PD once we reached 75% of maximal hemodialysis (including continuous hemodialysis) capacity.

A major advantage of PD in this crisis was our ability to train non-nursing staff in the PD procedure, which is not technically challenging but requires strict sterile

technique. This differs from the technical requirements needed to provide HD and is particularly important should we encounter staff shortages of existing dialysis nurses and technicians.

We are using an automated cycler which can be set up in 10-15 minutes and allows for daily retrospective monitoring of the patients' treatments. We also plan to use manual exchanges if the demand for dialysis exceeds our supply of cyclers. In that situation fairly minimal dialysis with 3-4 exchanges per day (starting with a low volume fills such as 1L and gradually increasing to 1.5-2L in a couple of days) may be necessary. We have had extensive experience with the use of a manifold system – a multi-line tubing set that allows for the connection of 5-9 dialysate bags (any volume bags may be employed)³.

An acute PD program is a 24/7 operation; as a result, we proposed the training of licensed practical nurses (LPNs) and technicians to help troubleshoot treatments overnight. The LPNs/technicians are available to the hospital nurses during the cycler treatments and can communicate any issues directly with the nephrologist on-call. We have surgeons and an interventional nephrologist on staff at Mount Sinai with expertise in PD catheter placement. They are committed to providing their support through the timely placement of double cuff peritoneal dialysis catheters.

Patients who are on room air or nasal cannula are transported to the interventional radiology suite for fluoroscopic catheter placement by the interventional nephrologist, while patients who are intubated have their catheters placed at the bedside by the surgery team. Patients who are on high flow nasal cannula, bi-level positive airway pressure (Bi-PAP), or a non-rebreather mask would be assessed by the radiology team for suitability

of catheter placement given their high risk of decompensation with sedation, potentially resulting in intubation and mechanical ventilation. A decision would then be taken by them as to whether the patient is a suitable candidate for the procedure or not.

Our acute PD implementation protocol is below:

- 1) The nephrologist(s) assess the patient's suitability for PD then communicate with the surgeon/interventional radiologist for catheter placement
- 2) PD catheter insertion followed by initiation within 48-72 hours with low volumes and a high number of exchanges
- 3) PD is performed overnight or throughout the day (according to individual patient needs)
- 4) At the end of each treatment session, an LPN collects data from the cyclers (initial drain, ultrafiltration, average dwell time, number of cycles, and average drain time) and documents this information in the electronic medical record, which can be reviewed by the covering nephrologist, with prescription changes made accordingly.

For patients treated with acute PD catheter who are still dialysis dependent at the time of discharge, the nephrology team will evaluate their suitability for outpatient PD. If deemed suitable, the patient would have an urgent appointment scheduled with the home dialysis unit. If the patient is deemed an unsuitable candidate, a tunneled hemodialysis catheter will be placed and the patient would be set up with an outpatient hemodialysis unit. The PD catheter would then be removed prior to discharge. Further access plans will depend on the likelihood of kidney recovery.

The COVID-19 pandemic is rapidly evolving, and these planning steps have helped prepare us for the surge that we have been confronted with in April 2020. Circumstances will continue to change in the coming weeks, and we will pursue finding creative ways to combat and deal with them. The success of our proposed changes remains to be seen, but it is a work in progress that will hopefully meet the demands that we are anticipating.

Article Information

Authors' Affiliations: Division of Nephrology, Icahn School of Medicine at Mount Sinai, New York, NY

Address for Correspondence: Osama El Shamy, Division of Nephrology, Icahn School of Medicine at Mount Sinai, 1 Gustave L. Levy Place, PO 1243, New York, NY 10029; E-mail: omelshamy@gmail.com

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Figure Legend

Figure 1: Dialysis Decision Tree

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