Authors: Paul M Palevsky, MD, Jai Radhakrishnan, MD, MS, Raymond R Townsend, MD
Section Editors: Jeffrey S Berns, MD, George L Bakris, MD
Deputy Editors: Shveta Motwani, MD, MMSc, FASN, John P Forman, MD, MSc

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INTRODUCTION

At the end of 2019, a novel coronavirus (ie, SARS-CoV-2) was identified as the cause of a cluster of pneumonia cases in Wuhan, a city in the Hubei Province of China. By 2020, it led to a pandemic that has spread throughout most countries of the world. SARS-CoV-2 disease (COVID-19) primarily manifests as a lung infection with symptoms ranging from those of a mild upper respiratory infection to severe pneumonia, acute respiratory distress syndrome, and death. COVID-19 disproportionately affects patients with pre-existing comorbidities, such as patients with various types of kidney disease. All medical professionals, including nephrology clinicians, are tasked with rapidly adjusting their practice to curtail the spread of the virus, while providing life-sustaining care to their patients.

This topic will discuss issues related to COVID-19 and delivery of nephrology care in patients with end-stage kidney disease (ESKD), acute kidney injury (AKI), chronic kidney disease (CKD), and hypertension. Issues related to the care of patients who are candidates for or have a kidney transplant are discussed separately. (See "Coronavirus disease 2019 (COVID-19): Issues related to solid organ transplantation".)

Other important aspects of COVID-19 that may affect this population are discussed at length elsewhere:

- (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention".)

- (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings".)
- (See "Coronavirus disease 2019 (COVID-19): Management in hospitalized adults".)
- (See "Coronavirus disease 2019 (COVID-19): Critical care and airway management issues", section on 'Fluid and electrolytes management'.)
- (See "Coronavirus disease 2019 (COVID-19): Myocardial infarction and other coronary artery disease issues".)
- (See "Coronavirus disease 2019 (COVID-19): Questions and answers".)

END-STAGE KIDNEY DISEASE

Patients with end-stage kidney disease (ESKD) are particularly vulnerable to severe COVID-19 due to the older age and high frequency of comorbidity, such as diabetes and hypertension, in this population [1]. Management of patients with ESKD varies based upon whether they are hospitalized or are in the outpatient setting.

Outpatients with ESKD — A majority of patients with ESKD are treated with some form of dialysis. These include in-center hemodialysis, home hemodialysis, or peritoneal dialysis.

Patients receiving in-center hemodialysis — Patients receiving in-center hemodialysis typically present to an outpatient facility three times per week to undergo dialysis. This limits their ability to observe physical isolation for infection control. Thus, the Centers for Disease Control (CDC), American Society of Nephrology (ASN), and International Society of Nephrology (ISN) have issued interim guidelines and a list of resources to guide nephrology clinicians providing life-sustaining dialysis care [2,3]. These resources continue to evolve and are frequently updated. At a minimum, all dialysis organizations are urged to follow the recommendations from these guidelines. Some dialysis organizations may choose to follow additional measures to protect the health care staff and patients, depending upon their access to personal protective equipment and other resources.

Early recognition/isolation of individuals with respiratory symptoms — Outpatient dialysis facilities should, at minimum, heed the following guidance [4]:

- Implement non-punitive and flexible sick leave policies that permit ill health care personnel to stay home. Health care personnel should be reminded to not report to work when they are ill.

- Identify patients with signs and symptoms of respiratory infection (eg, fever, cough) **before** they enter the treatment area.
    - Instruct patients to call ahead to report fever or respiratory symptoms so the facility can be prepared for their arrival or triage them to a more appropriate setting (eg, an acute care hospital).
    - Patients should inform staff of fever or respiratory symptoms immediately upon arrival at the facility (eg, when they check in at the registration desk).
    - Patients with symptoms of a respiratory infection should put on a facemask at check-in and should wear it until they leave the facility.
- Provide patients and health care personnel with instructions (in appropriate languages) regarding hand hygiene, respiratory hygiene, and cough etiquette.
    - Instructions should include how to use facemasks, how to use tissues to cover the nose and mouth when coughing or sneezing, how to dispose of tissues and contaminated items in waste receptacles, and how and when to perform hand hygiene.
    - Signs should be posted at clinic entrances with instructions for patients to alert staff so appropriate precautions can be implemented for patients who have a fever or symptoms of a respiratory infection.
- Position hygiene-related supplies in close proximity to dialysis chairs and nursing stations to enable adherence to hand and respiratory hygiene. These supplies include tissues and no-touch receptacles for disposal of tissues as well as hand hygiene supplies (eg, alcohol-based hand sanitizer).

Patient placement — Outpatient dialysis facilities should, at minimum, heed the following guidance:

- Provide sufficient space in waiting areas for patients to sit separated from other patients by at least six feet. Medically stable patients might opt to wait in a personal vehicle or outside the health care facility where they can be contacted by mobile phone when it is their turn to be seen.
    - Patients with respiratory symptoms should be brought back to an appropriate treatment area as soon as possible in order to minimize time in waiting areas.
    - If possible, facilities should maintain at least six feet of separation between patients. If not possible, then six feet of separation should be maintained between masked, symptomatic

patients and other patients during dialysis treatments. Ideally, symptomatic patients would be dialyzed in a separate room (if available) with the door closed.

- Hepatitis B isolation rooms should be used for dialysis patients with symptoms of respiratory infection only if the room is not needed to dialyze a hepatitis B infected patient.

- If a separate room is not available, masked patients should be dialyzed in corner or end-of-row stations and be separated from other patients in all directions by at least six feet.

Personal protective equipment — In general, health care personnel caring for patients with undiagnosed respiratory infections should follow standard, contact, and droplet precautions with eye protection unless the suspected diagnosis requires airborne precautions (eg, tuberculosis). This includes the use of:

- Gloves
- Facemask
- Eye protection (eg, goggles, a disposable face shield that covers the front and sides of the face). Personal glasses and contact lenses are **not** considered adequate eye protection.
- Isolation gown

  - The isolation gown should be worn over or instead of the cover gown (ie, laboratory coat, gown, or apron with incorporate sleeves) that is normally worn by health care personnel. If the supply of such gowns is low, then they should be prioritized for the initiation and termination of the hemodialysis treatment, manipulation of access needles or catheters, and for aiding the patient into and out of the station. They should also be used for cleaning and disinfection of patient care equipment and the dialysis station.

  - When gowns are removed, place the gown in a dedicated container for waste or linen before leaving the dialysis station. Disposable gowns should be discarded after use. Cloth gowns should be laundered after each use.

Additional measures for COVID-19 — When COVID-19 is suspected or confirmed in a patient receiving hemodialysis at the facility, the following additional measures apply:

- If a hemodialysis facility is dialyzing more than one patient with suspected or confirmed COVID-19, **an attempt should be made to cohort these patients**, as well as the health care

personnel caring for them, together in the same section of the unit and/or on the same shift (eg, schedule all such patients for the last shift of the day). If the etiology of respiratory symptoms is known, patients with different etiologies should not be cohorted together; as an example, patients with confirmed influenza and COVID-19 should **not** be cohorted together.

- The health department should be notified about the patient.
- Health care personnel should follow the Interim Infection Prevention and Control Recommendations for Patients with Confirmed Coronavirus Disease 2019 (COVID-19) or Persons Under Investigation for COVID-19 in Healthcare Settings. This includes recommendations on personal protective equipment. Routine cleaning and disinfection are appropriate for COVID-19 in dialysis settings. Any surface, supplies, or equipment (eg, dialysis machine) located within six feet of symptomatic patients should be disinfected or discarded.
    - Products with Environmental Protection Agency (EPA)-approved emerging viral pathogens claims are recommended for use against SARS-CoV-2. Refer to List N on the EPA website for EPA-registered disinfectants that have qualified under EPA's emerging viral pathogens program from use against SARS-CoV-2.
    - When using products from List N, facilities should ensure the products also have a bloodborne pathogen claim (eg, hepatitis B, HIV).

Patients receiving home hemodialysis or peritoneal dialysis — Our approach to patients receiving home dialysis is as follows:

- In general, during the COVID-19 pandemic, patients receiving dialysis at home (ie, home hemodialysis or peritoneal dialysis) should have their regular follow-up visits performed via telemedicine rather than via in-person, in-clinic visits. In addition, home visits by health care professionals should be minimized or stopped.

  Patients should have at least two weeks of dialysis supplies and sufficient medications in case they have to self-isolate, or in case there is a break in the supply chain (eg, due to delivery staff sickness).

  Staff nurses should communicate with patients frequently to distinguish and handle the most dangerous and severe cases in a timely manner and by referring patients to the emergency department, when appropriate. Unexpected or emergency visits to the clinic should be avoided as much as possible.

- However, patients occasionally may need to be seen in-person for various issues (eg, home hemodialysis training, suspected exit-site infection, suspected peritonitis). If an in-person visit is

clinically indicated:

- Attempt to limit transmission of SARS-CoV-2 in patients with suspected or documented COVID-19. This includes early identification and isolation of patients with suspected disease, as well as the use of appropriate personal protective equipment. A detailed discussion of infection control practices for the health care setting is presented separately. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Infection control in the health care setting'.)

- Attempt to limit the number of patients seen in-person during a given day in order to avoid crowded waiting areas and to minimize contact.

- Avoid non-essential procedures in order to minimize unnecessary patient contact. In the peritoneal dialysis unit, for example, procedures such as peritoneal equilibration test (PET) testing and clearance measurements should be deferred. However, procedures that are necessary for placement and maintenance of adequate dialysis access (eg, arteriovenous fistula procedures, placement of a peritoneal dialysis catheter) are considered **essential** and should **not** be deferred. (See 'Dialysis access planning in advanced CKD' below.)

Hospitalized patients with ESKD — The American Society of Nephrology has issued guidelines for nephrology clinicians caring for hospitalized patients requiring dialysis for ESKD. In addition, the CDC has issued interim guidance for care of hospitalized patients, which are applicable for those hospitalized with kidney disease. These guidelines continue to evolve and are frequently updated. Understandably, the execution of some of these guidelines will be limited by policies enforced at the level of any institution. However, when possible, adherence to these guidelines is encouraged.

- Patients with COVID-19 should be co-localized on a floor or intensive care unit, when possible. Co-localization within adjacent rooms can enable one dialysis nurse to simultaneously deliver dialysis for more than one patient.

- When possible, patients with suspected or confirmed COVID-19 who are not critically ill should be dialyzed in their own isolation room rather than being transported to the inpatient dialysis unit.

- Where available, telemedicine interfaces with a camera should be used to troubleshoot alarms from outside the room and to minimize the need for the dialysis nurse or the nephrologist to enter an isolation room.

Patients receiving intermittent peritoneal dialysis who have multiple organ dysfunction can be temporarily switched to automated peritoneal dialysis or continuous renal replacement therapy

(CRRT). As in patients on hemodialysis, it is advisable to prevent hypervolemia, so increased ultrafiltration may be needed if remaining on peritoneal dialysis.

It is possible that the peritoneal dialysate is infectious among patients with COVID-19, considering that many have viremia [5,6]. There are a variety of opinions for disposal of drained peritoneal dialysate from patients with COVID-19 ranging from only performing standard methods to additional disinfection with mixture of 500 mg/L chlorine-containing solution with the dialysate and disposing the dialysate into the toilet after one hour. It is important to emphasize the need to prevent accidental splash when disposing of drained dialysate.

ACUTE KIDNEY INJURY

Patients with suspected or confirmed COVID-19 may present with acute kidney injury (AKI) as part of their overall illness. In observational data from the United States and China, AKI has been reported in 3 to 37 percent of patients [7-11]. The incidence seems to vary by geographic location and proportion of critically ill patients included in each study.

Clinical characteristics and histopathology — Kidney disease among patients with COVID-19 can manifest as AKI, hematuria, or proteinuria, and portends a higher risk of mortality [9,12-15]. It remains unclear if AKI is largely due to hemodynamic changes and cytokine release or if the virus also leads to direct cytotoxicity.

In a large observational study of 5449 COVID-19 patients from New York, AKI was diagnosed in 37 percent [10]. Mild AKI (1.5- to 2-fold increase in serum creatinine) was noted in 47 percent, moderate AKI in 22 percent, and severe AKI (more than tripling in serum creatinine) in 31 percent. Hematuria and proteinuria were noted in 46 and 42 percent of patients with AKI. Dialysis was required in 15 percent of all patients with AKI, and 97 percent of patients requiring dialysis were mechanically ventilated. AKI was noted on or within 24 hours of admission in one-third of the patients. AKI correlated with severity of illness; AKI was nearly universal among mechanically ventilated patients (90 percent) but was less common in patients who were not critically ill (22 percent). Independent predictors of AKI included older age, black race, diabetes, hypertension, cardiovascular disease, mechanical ventilation, and use of vasopressor medications.

Kidney histopathology was examined in an autopsy series of 26 patients who died of respiratory failure secondary to COVID-19 [13]. Mean age of the patients included was 69 years (range, 39 to 87 years); 11 patients had diabetes, hypertension, and/or chronic kidney disease at baseline, and nine had new kidney injury during hospitalization in the form of creatinine elevation or new-onset proteinuria. All patients had evidence of acute tubular injury (of varying severity); a range of other histopathology findings, such as erythrocyte clusters and pigmented casts, were also present. Of

the nine samples tested for intracellular virus, particles resembling coronaviruses were identified in seven. Of these seven patients, immunostaining was positive for SARS-CoV nucleoprotein antibody in three.

Two separate case reports have also described collapsing glomerulopathy among black patients presenting with severe AKI and nephrotic-range proteinuria [12,14].

Evaluation of AKI in hospitalized patients — In patients with suspected or confirmed COVID-19 who develop AKI, an emphasis should be placed on optimization of volume status to exclude and treat prerenal (functional) AKI while avoiding hypervolemia, which may worsen the patient's respiratory status.

The evaluation for other AKI etiologies should be undertaken in a manner similar to other critically ill patients with AKI. As an example, manual urine sediment examination should be performed, if appropriate, since urine samples are not considered to be highly infectious. However, some testing that is typically available may not be possible in patients with suspected or confirmed COVID-19. As an example, kidney and bladder ultrasound may not be able to be performed due to exposure concerns.

Management of AKI in hospitalized patients

Patients with dialysis-requiring AKI — The indications for renal replacement therapy (RRT) for AKI remain the same regardless of the COVID-19 status of any given patient. Alterations in RRT management that might be undertaken during the COVID-19 outbreak include the following:

- Patients with COVID-19 and AKI who require RRT should be co-localized on a floor or intensive care unit, when possible. Co-localization within adjacent rooms can enable one dialysis nurse to simultaneously deliver dialysis to more than one patient. If a patient is in a negative-pressure isolation room, then one hemodialysis nurse will need to be dedicated for the care of that patient in a 1:1 nurse-to-patient ratio.

- If at all possible, patients with suspected or confirmed COVID-19 who are not critically ill but who have AKI requiring RRT should be dialyzed in their isolation room rather than being transported to the inpatient dialysis unit.

- Continuous renal replacement therapy (CRRT) remains preferred among critically ill patients with AKI. Even among patients who are hemodynamically stable and could tolerate intermittent hemodialysis (IHD), CRRT or prolonged intermittent renal replacement therapy (PIRRT; also called sustained low-efficiency dialysis or SLED) should be performed instead, depending upon machine and staffing availability. This is because CRRT or PIRRT can be managed without 1:1

hemodialysis nursing support. This would potentially help minimize wastage of personal protective equipment and limit exposure among hemodialysis nurses.

- CRRT machines can either be placed inside an isolation room as per standard practice or outside the room with the use of extended tubing. Placing the machine outside of the room minimizes the need for repeated entry to troubleshoot and manage the machine, and therefore reduces wastage of personal protective equipment. However, extended tubing is a scarce resource. In addition, use of extended tubing requires additional tubing connections and increases the likelihood that tubing will become disconnected. Extended tubing also decreases the sensitivity of pressure alarms to detect disconnection of the venous lines, and potentially increases the risk of clotting due to the longer tubing length.

- If CRRT capacity at an institution is overwhelmed, CRRT machines can be used to deliver prolonged intermittent treatments (eg, 10 hours rather than continuous) with higher flow rates (eg, 40 to 50 mL/kg/hour). Alternatively, the machine can be rotated between patients every 24 hours or whenever the circuit clots, so that use of new filter sets is minimized. This will enable the CRRT machine to become available sooner for care of another patient after terminal cleaning.

- Institutions facing scarcity of replacement fluid for CRRT can lower the delivered dose to 15 mL/kg/hour from the standard 20 to 25 mL/kg/hour, especially among patients who are not hypercatabolic. When supplies of commercially prepared replacement fluid are exhausted, institutional pharmacies may develop their own replacement fluid by mixing all of the following (in a sterile fashion) [16]:

  - 1 L of 0.9 percent saline with potassium chloride as needed
  - 1 L of 5 percent dextrose water with 150 mEq sodium bicarbonate
  - 1 L of 0.9 percent saline with 1 g magnesium chloride
  - 1 L of 0.9 percent saline with 1 g calcium chloride

  This will yield a 4 L solution containing 153 mEq/L sodium, 37.5 mEq/L bicarbonate, 2.6 mmol/L magnesium, 2.25 mmol/L calcium, and a variable amount of potassium.

  Another option for preparation of a dialysate solution is the Cleveland Clinic method.

- Anecdotal evidence suggests that circuit thrombosis during RRT occurs more frequently in patients with COVID-19 than in other patients. In the absence of contraindications, patients with COVID-19 should receive anticoagulation during RRT. This can be in the form of regional anticoagulation using unfractionated heparin or citrate, or systemic anticoagulation with unfractionated or low-molecular weight heparin. Institutions that have no prior experience with

regional citrate anticoagulation should avoid adopting a new citrate protocol during this crisis in order to minimize risks of treatment errors that can lead to citrate toxicity. Additional details regarding anticoagulation for the hemodialysis procedure are presented separately. (See "Anticoagulation for the hemodialysis procedure" and "Anticoagulation for continuous renal replacement therapy".)

- Where available, remote monitoring with audio and video streams should be used to troubleshoot alarms from outside the room and to minimize the need for the dialysis nurse or the nephrologist to enter an isolation room.

- No special provisions or methods for disposal of the CRRT effluent are necessary. This is because neither presence of SARS-CoV-2 nor other similar viruses have been demonstrated in the effluent.

- When available hemodialysis or CRRT machines are scarce, clinicians may need to consider treatment of AKI with peritoneal dialysis. Important considerations include:

  - Patients with AKI who are treated with peritoneal dialysis have similar rates of all-cause mortality, kidney function recovery, and infectious complications compared with patients treated with other modalities. (See "Use of peritoneal dialysis (PD) for the treatment of acute kidney injury (AKI) in adults", section on 'Outcomes with PD for AKI'.)

  - Peritoneal dialysis requires relatively less equipment, infrastructure, and resources relative to other forms of RRT. Nurses and clinicians can be trained expeditiously to provide peritoneal dialysis. (See "Use of peritoneal dialysis (PD) for the treatment of acute kidney injury (AKI) in adults", section on 'Outcomes with PD for AKI'.)

  - Peritoneal dialysis can increase intra-abdominal pressure, interfere with respiratory mechanics [17], and may theoretically worsen respiratory failure, particularly among mechanically ventilated patients. However, it can be used among mechanically ventilated patients when other options such as intermittent hemodialysis and CRRT are not available. Performing peritoneal dialysis in a mechanically ventilated patient who requires a prone position may be challenging, although one case report found it to be feasible and safe [18]. (See "Use of peritoneal dialysis (PD) for the treatment of acute kidney injury (AKI) in adults", section on 'Complications of PD for AKI'.)

  - When peritoneal dialysis is used for management of AKI in patients with COVID-19, automated peritoneal dialysis with a cycler should be used, if available. This minimizes the contact between health care personnel and the patient. (See "Use of peritoneal dialysis

(PD) for the treatment of acute kidney injury (AKI) in adults", section on 'Selecting PD modalities for AKI'.)

- Similar to disposal of peritoneal dialysis effluent for patients with end-stage kidney disease, there are a range of opinions for safe disposal of the effluent in the setting of AKI. Data suggesting that peritoneal dialysis effluent is infectious are lacking. (See 'Hospitalized patients with ESKD' above.)

- Extracorporeal hemoperfusion devices for cytokine removal, such as Cytosorb, have had no clear role in management of sepsis prior to the COVID-19 pandemic. Due to lack of proven benefit, we do not use Cytosorb or other similar devices among critically ill COVID-19 patients with or without dialysis-requiring AKI. (See "Investigational and ineffective therapies for sepsis", section on 'Cytokine and endotoxin inactivation or removal'.)

Data regarding the threshold for SARS-CoV-2 testing (eg, benefits of testing patients with mild symptoms not requiring hospitalization), or about safety of antiviral agents for treatment of COVID-19 among patients with kidney disease remains unknown.

Patients with AKI that is not dialysis-requiring — Patients who have AKI that is not dialysis-requiring should be managed with limited contact as much as possible. Physical examination and ultrasound evaluations should be coordinated with the primary/consulting teams to minimize contact, when possible.

Differences in management of AKI among patients with COVID-19 may include limited use of intravenous fluids. Most patients with COVID-19 characterized by pneumonia have variable degree of oxygen requirements and/or airway control. Fluid resuscitation goals are understandably conservative as per various acute respiratory distress syndrome criteria. Thus, fluid resuscitation should be individualized and based on trackable objective measures (eg, inferior vena cava collapse on ultrasound). (See "Coronavirus disease 2019 (COVID-19): Critical care and airway management issues", section on 'Fluid and electrolytes management'.)

CHRONIC KIDNEY DISEASE AND HYPERTENSION

Among patients with COVID-19, both chronic kidney disease (CKD) and hypertension are risk factors for more severe disease [19-22]:

- In a meta-analysis of four studies and 1389 infected patients (including 273 patients with severe disease), the prevalence of underlying CKD was more frequent among those with severe disease (3.3 versus 0.4 percent; odds ratio 3.03, 95% CI 1.09-8.47) [22].

- In the same cohort of 1389 patients from these four studies, history of hypertension was more common among those who had severe, as compared with nonsevere, COVID-19 (15 versus 32 percent) [22]. Similarly, in a separate cohort of 1590 hospitalized patients in China, underlying hypertension was independently associated with severe COVID-19 (hazard ratio 1.58, 95% CI 1.07-2.32) [19]. Studies conducted in the United States and Italy reveal broadly consistent findings [20,21].

Renin angiotensin system inhibitors — Patients receiving angiotensin-converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) should continue treatment with these agents (unless there is an indication for discontinuation such as hyperkalemia or hypotension). There is no evidence that stopping ACE inhibitors or ARBs reduces the severity of COVID-19 [23-25]. This approach is supported by multiple guideline panels [26-30].

There is speculation that patients with COVID-19 who are receiving these agents may be at increased risk for adverse outcomes [31,32]. ACE2 is a receptor for SARS-CoV-2 [33], and renin angiotensin system inhibitors may increase ACE2 levels [34-36]. In addition, patients with cardiovascular disease, hypertension, and diabetes (a disorder with a high prevalence of renin angiotensin system inhibitors-treated use) often have a more severe clinical course in the setting of infection with SARS-CoV-2.

However, there is no evidence to support an association between renin angiotensin system inhibitor use and more severe disease; some large studies indicate no relationship between the use of these agents and severity of COVID-19 [20,21,23-25], whereas other data suggest that these drugs may attenuate the severity of disease [37-40]. As examples:

- In a large cohort of 4357 infected hypertensive patients in New York City, rates of severe COVID-19 were the same among those taking an ACE inhibitor or ARB compared with those using a different antihypertensive drug (24.7 versus 25.3 percent) [20].

- Similarly, among 3632 Italian patients with COVID-19 who were treated with antihypertensive medications, there was no association between ACE inhibitor or ARB use with severe illness (adjusted odds ratios 0.91 [95% CI 0.69-1.21] and 0.83 [95% CI 0.63-1.10], respectively) [21].

- By contrast, in one large retrospective cohort of 1128 Chinese adults hospitalized with COVID-19, hypertensive patients taking an ACE inhibitor or ARB had a lower mortality at 28 days compared with those treated with alternative antihypertensive agents (adjusted hazard ratio 0.29, 95% CI 0.12-0.69) [39].

In addition, studies conducted prior to the COVID-19 pandemic suggested that discontinuing ACE inhibitors and ARBs in some patients may exacerbate underlying cardiovascular or kidney disease

and lead to increased mortality [41-43].

Dialysis access planning in advanced CKD — Patients with stage 4 or 5 CKD who are referred for dialysis access placement should undergo these procedures as planned (and not have their planned procedure deferred).

Although nonessential surgeries should be delayed during the COVID-19 pandemic, guidance from the United States has clarified that placement of arteriovenous fistulas or grafts for hemodialysis and peritoneal dialysis catheters for peritoneal dialysis are **essential** procedures.

INFECTION CONTROL PRACTICES

Infection control practices specific to the care of patients with kidney disease requiring dialysis are presented in the preceding discussions.

The general approach to infection control in the health care setting, in the home, and in non-hospital institutional settings, as well as the approach to discontinuation of COVID-19 precautions and return-to-work for health care personnel, are presented in detail elsewhere. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings".)

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Coronavirus disease 2019 (COVID-19) – International and government guidelines for general care" and "Society guideline links: Coronavirus disease 2019 (COVID-19) – Guidelines for specialty care" and "Society guideline links: Coronavirus disease 2019 (COVID-19) – Resources for patients".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Coronavirus disease 2019 (COVID-19) overview (The Basics)")

SUMMARY AND RECOMMENDATIONS

- Patients with end-stage kidney disease (ESKD) are particularly vulnerable to severe COVID-19 due to the older age and high frequency of comorbidity, such as diabetes and hypertension, in this population. (See 'End-stage kidney disease' above.)

- The Centers for Disease Control (CDC), American Society of Nephrology (ASN), and International Society of Nephrology (ISN) have issued interim guidelines and a list of resources to guide nephrology clinicians providing life-sustaining dialysis care. These resources, which continue to evolve and are frequently updated, include guidance about the following: early recognition and isolation of individuals with respiratory symptoms; patient separation and cohorting within waiting areas and within the dialysis unit; use of personal protective equipment in the dialysis unit; and additional measures for patients with confirmed or suspected COVID-19. (See 'Early recognition/isolation of individuals with respiratory symptoms' above and 'Patient placement' above and 'Personal protective equipment' above and 'Additional measures for COVID-19' above.)

- In general, during the COVID-19 pandemic, patients receiving dialysis at home (ie, home hemodialysis or peritoneal dialysis) should have their regular follow-up visits performed via telemedicine rather than via in-person, in-clinic visits. In addition, home visits by health care professionals should be minimized or stopped. Patients should have at least two weeks of dialysis supplies and sufficient medications in case they have to self-isolate, or in case there is a break in the supply chain. If an in-person visit is clinically indicated, appropriate infection control procedures for the outpatient unit should be followed, an attempt should be made to limit the number of patients seen per day, and non-essential procedures should be avoided. (See 'Patients receiving home hemodialysis or peritoneal dialysis' above.)

- The American Society of Nephrology has issued guidelines for nephrology clinicians caring for hospitalized patients requiring dialysis for ESKD and acute kidney injury (AKI). These guidelines continue to evolve and are frequently updated. Although policies enforced at the level of the institution may vary, when possible, adherence to these guidelines is encouraged (see 'Hospitalized patients with ESKD' above and 'Patients with dialysis-requiring AKI' above):

- Patients with COVID-19 should be co-localized on a floor or intensive care unit, when possible. Co-localization within adjacent rooms can enable one dialysis nurse to simultaneously deliver dialysis for more than one patient. If a patient is in a negative-pressure isolation room, then one hemodialysis nurse will need to be dedicated for the care of that patient in a 1:1 nurse-to-patient ratio.

- When possible, patients with suspected or confirmed COVID-19 who are not critically ill should be dialyzed in their own isolation room rather than being transported to the inpatient dialysis unit.

- Where available, video and audio streams should be used to troubleshoot alarms from outside the room to minimize the need for the dialysis nurse or the nephrologist to enter an isolation room.

- Continuous renal replacement therapy (CRRT) is preferred among critically ill patients in the intensive care unit who have ESKD or AKI. Even among patients who are hemodynamically stable and who could tolerate intermittent hemodialysis (IHD), CRRT or prolonged intermittent renal replacement therapy (PIRRT), also called sustained low-efficiency dialysis (SLED), should be performed instead, depending upon machine and staffing availability. This is because CRRT or PIRRT can be managed without 1:1 hemodialysis support. This would potentially help minimize wastage of personal protective equipment and limit exposure among hemodialysis nurses.

- If CRRT capacity at an institution is overwhelmed, CRRT machines can be used to deliver prolonged intermittent treatments (eg, 10 hours rather than continuous) with higher flow rates (eg, 40 to 50 mL/kg/hour). This will enable the CRRT machine to become available sooner for care of another patient after terminal cleaning.

- When available hemodialysis or CRRT machines are scarce, clinicians may need to consider treatment of AKI with peritoneal dialysis. (See "Use of peritoneal dialysis (PD) for the treatment of acute kidney injury (AKI) in adults".)

- In patients with suspected or confirmed COVID-19 who develop AKI, an emphasis should be placed on optimization of volume status to exclude and treat prerenal (functional) AKI while avoiding hypervolemia, which may worsen the patient's respiratory status. Patients who have AKI that is not dialysis-requiring should be managed with limited contact as much as possible. Physical examination and ultrasound evaluations should be coordinated with the primary/consulting teams to minimize contact, when possible. (See 'Evaluation of AKI in hospitalized patients' above and 'Patients with AKI that is not dialysis-requiring' above.)

- Patients receiving angiotensin-converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) should continue treatment with these agents (unless there is an indication for discontinuation such as hyperkalemia or hypotension). There is no evidence that stopping ACE inhibitors or ARBs reduces the severity of COVID-19. (See 'Renin angiotensin system inhibitors' above.)

- Patients with stage 4 or 5 CKD who are referred for dialysis access placement should undergo these procedures as planned (and not have their planned procedure deferred). (See 'Dialysis access planning in advanced CKD' above.)

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