



ORIGINAL ARTICLE

Operational considerations for peritoneal dialysis management during the COVID-19 pandemic

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ABSTRACT

Background. Coronavirus disease 2019 (COVID-19) is an infectious respiratory disease caused by a novel coronavirus—severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It is spread from human to human and has resulted in a global pandemic, posing a disastrous public health risk worldwide. Patients with chronic kidney disease, especially those on dialysis, are considered to be at higher risk of developing severe COVID-19 due to their immunocompromised status and frail condition. The home treatment setting of peritoneal dialysis (PD) has advantages in terms of implementing self-care when routine hospital visits and social activities are restricted, thus greatly reducing exposure of PD patients to the virus.

Methods and Results. We outline general operational considerations in PD management during the COVID-19 pandemic, including precautionary measures for PD patients and healthcare staff. Precautionary measures for PD patients include education on prevention of, and screening for, COVID-19, preclinic screening, in-clinic management, meticulous remote patient management and special hospitalization arrangements. The diagnosis and treatment of PD patients with COVID-19 are discussed. Precautionary measures for PD staff include continuous education on, and training in, COVID-19, exposure history surveillance and self-monitoring for COVID-19 among healthcare personnel, appropriate personal protective equipment and hand hygiene, organization of medical activities and staffing, and adequate environment cleaning.

Conclusions. This is a battle of the entire human society against the novel coronavirus. Integrated teamwork among healthcare providers, supported by society as a whole, is needed as part of the ongoing public health response to try to slow the spread of COVID-19.

Keywords: COVID-19, management, peritoneal dialysis

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an infectious respiratory disease caused by a novel coronavirus—severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It is spread from human

to human and has resulted in a global pandemic, posing a disastrous public health risk worldwide. By 18 May 2020, the global cumulative number of confirmed COVID-19 cases had exceeded 4 747 608, with >313 617 deaths. According to published data, patients with underlying medical conditions are more

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susceptible to significant illness associated with the virus [1, 2], and death rates among the elderly and patients with chronic disease are higher [3]. Patients with chronic kidney disease, especially those on dialysis, are thus considered to be at higher risk of developing serious COVID-19 illness due to their immunocompromised status and frail condition.

Compared with patients on hemodialysis, who need to attend the dialysis center twice or thrice a week, even during a quarantine period, those on peritoneal dialysis (PD) possibly have a lower risk of COVID-19 exposure, given the home setting of PD treatment, which also has advantages of implementing self-care when routine hospital visits and social activities are restricted.

Although a total of 593 confirmed COVID-19 cases were identified in Beijing by 18 May 2020 [4], it is fortunate that there have been no cases reported among the population of over 2300 PD patients. In order to answer the question of how to manage patients on PD to prevent infection with SARS-CoV-2, here we propose general operational considerations. We recommend that integrated strategies based on close cooperation between PD patients and their family and healthcare facilities should be implemented as early as possible. Taking all necessary precautions is crucial in order to conquer this pandemic.

PRECAUTIONARY MEASURES FOR PD PATIENTS

Strengthening education on prevention of, and screening for, COVID-19

Essential information needs to be provided and updated in a timely manner via multiple channels, including posters and information leaflets available in clinic waiting areas, as well as face-to-face consultations, telephone communication and online messaging. We initiated a timely education campaign on COVID-19 on a one-to-one basis (Table 1).

Based on the adult learning theory [5], clinical staff must discuss with PD patients, as well as the patients' families, their personal opinions on, and experiences of, contagious diseases and determine their willingness and level of motivation for learning. Patients should be required to repeat all key messages on prevention of COVID-19 to ensure their understanding. Concurrently, close attention should be paid to patients' mood disturbances, as well as to any specific barriers to implementing these measures, especially those with depression and cognitive impairment [6].

Table 1. Information topics on COVID-19 given to patients

Information topic
What is COVID-19?
How does COVID-19 spread?
What are the basic measures to prevent transmission?
What are the signs of infection with COVID-19?
What can we do if we have suspected signs of COVID-19?
How do we detect and diagnose COVID-19?
When can an individual with confirmed or suspected COVID-19 visit the PD unit?

Preclinic screening for suspected cases

All patients with planned clinic visits are screened for COVID-19 by telephone consultations prior to hospital attendance, using a set of screening criteria on epidemiological history and clinical manifestations of COVID-19, as shown in Table 2. Patients with any epidemiological history or clinical manifestations of COVID-19 are not allowed to attend the PD unit. Although symptomatic individuals are thought to be the most contagious, some human-to-human transmission of the virus might be possible before any symptom manifestations [1, 7, 8]. Therefore, all individuals attending the PD unit should be reminded to wear a suitable face mask.

In-clinic management

In the clinic, several strategies are adopted to prevent the potential risk of cross-infection. First, a front checking stand is set up in the clinic waiting area. It should be ensured that every individual wears a suitable face mask. Two PD nurses are assigned to the front stand to check visitors' temperature using a noncontact infrared temperature sensor, and to conduct a questionnaire survey on their epidemiological history and clinical manifestations. The items on the questionnaire are similar to those used in preclinic screening. Individuals must provide their signature to confirm the accuracy and authenticity of their screening responses, based on the Infectious Diseases Prevention Law in China [9]. If found to be a suspected case of COVID-19, the patient is referred to a designated fever clinic or

Table 2. Diagnostic classifications of COVID-19

Epidemiological history	<ol style="list-style-type: none"> i. History of travel to, or residence in, Wuhan City or its surrounding areas, or communities with confirmed COVID-19 cases within 14 days before the onset of symptoms ii. Direct contact with an individual infected with SARS-CoV-2 (positive nucleic acid test) within 14 days before the onset of symptoms iii. Direct contact with a patient who has symptoms of pyrexia or respiratory infection from either Wuhan City or its surrounding areas within 14 days before the onset of symptoms iv. Cluster onset
Clinical manifestations	<ol style="list-style-type: none"> i. Pyrexia and/or respiratory symptoms ii. Pulmonary imaging with signs of COVID-19 iii. Laboratory tests suggesting early disease stage: normal or decreased total white cell count, with decreased lymphocyte count
Suspected case	Individual who meets one of the epidemiological history criteria combined with two of the clinical manifestations, or who meets all three of the clinical manifestations
Confirmed case	Suspected case with RT-PCR detection of SARS-CoV-2 nucleic acid, or with viral gene sequence highly homologous to the known SARS-Cov-2, or serology testing showing rising titers of IgM and IgG against COVID-19

department of infectious diseases, while accompanied by PD staff wearing appropriate personal protective equipment (PPE). All patients must maintain appropriate hand hygiene by using an alcohol-based hand sanitizer before entering the clinic area. Outpatient organization and flow should be maintained by medical workers.

Since spread of the virus is thought to occur mainly via respiratory droplets and by touching contaminated surfaces or objects, clinic desks should be set at least 1.5 m apart. Patients are instructed to stand or sit at least 1 m away from each other and not to touch their face and any bare skin. Eating and chatting are limited as much as possible.

We have also designed a quick one-way workflow for PD clinic visits, such that patients can have all clinic procedures completed along a one-way pathway, including completing the questionnaire surveys, performing exit-site checks, physician consultations and prescription adjustments and drug dispensing. To avoid patient–patient contact, we reduced the number of appointments from 60 to 20 per clinic session and reduced the duration of all procedures by conducting preclinic ‘preliminaries’, including obtaining details of each individual patient’s condition either online or over the phone. This enables us to make a relatively clear plan for each patient in advance, which, in turn, helps to shorten the duration of patients’ hospital stay and avoid a crowd gathering in the waiting area. After their brief interaction with clinical staff, visitors should follow hand hygiene when leaving the clinic area.

Home PD management

Patients and their family are advised to stay at home and limit social activities in order to decrease their risk of exposure to COVID-19. Patients or their family members with suspected COVID-19 exposure should report to the PD center and begin self-quarantine if necessary.

Patients and their family members are requested to wear a disposable surgical face mask and avoid unnecessary touching when it is unavoidable to gather in public. Education on 7-step hand hygiene is reinforced [10]. Hands should be washed for at least 15 s with an alcohol-based hand sanitizer or with soap and water when they are visibly soiled. Hand hygiene should be performed: (i) after defecation and before meals; (ii) upon returning home; (iii) after being in contact with garbage or animals; (iv) before and after PD-related procedures; and (v) after disposal of PD drainage fluid.

The full clinical picture regarding COVID-19 is not fully known. The most common symptoms include fever, cough and/or shortness of breath. Nonspecific symptoms, such as sore throat, myalgia, fatigue, nausea and diarrhea, have also been reported as initial symptoms in some cases. However, failure to identify and implement appropriate precautions in a healthcare setting for persons infected with COVID-19 can contribute to widespread transmission in that facility due to the presence of susceptible patients and close interactions with healthcare personnel. Thus, a lower temperature of 37.3°C and inclusion of mild and nonspecific symptoms should be included in the alert list for suspected cases of COVID-19. Self-monitoring must be strengthened over and above assessing routine vital signs, symptoms and dialysis data. Patients should be honest when reporting about their symptoms, as well as any exposure, to their healthcare providers, who will then decide whether patients need to be tested.

Remote patient management (RPM) should be recommended as a major way to manage patients on PD, as it has been shown recently to reduce patients’ misperceptions of PD care [11], as well as hospitalization rates [12, 13]. Along with the rapid progress in telemedicine in China, we have developed and utilized a PD-specific telemedicine system, namely Manburs, since 2016. This tool has enabled healthcare providers to share real-time biochemical test results, drug prescriptions and dialysis data with patients. Similarly, patients can also share real-time data on their vital signs and dialysis volume records with healthcare providers. Primary nurses review all messages sent to the PD team at least once daily and address any abnormality that could require possible changes in medications or dialysis prescriptions, according to physicians’ guidance, which could possibly lead to a medication and dialysis prescription change. Patients can communicate with the staff using the APP by sending information in text format or photos.

Healthcare staff should communicate with patients at a given frequency, varying from daily to monthly, depending on each patient’s condition. For example, if the patient is suffering from a severe complication, such as peritonitis or volume overload, communication with the patient should be conducted daily, whereas the frequency of communication will be lower for patients in stable condition. Patients with worsening conditions should go to hospital for further management. Therefore, only patients needing medically essential attention can attend a healthcare institution. RPM ensures the most severe cases are identified and handled efficiently and in a timely manner. As a result, this ensures prolonged home stay for the majority of patients.

The key points in RPM include: (i) peritonitis prevention—the recommendations on prevention by the International Society for Peritoneal Dialysis (ISPD) guidelines [14] can never be emphasized enough; (ii) volume control—patients are encouraged to record their fluid intake and output, body weight and blood pressure, which healthcare staff should check to identify signs of volume overload or deficit, and remind patients to adjust their diet, drug and dialysis prescription in a timely manner; (iii) rational diet—any diets leading to hyper- or hypokalemia, hyperphosphatemia, malnutrition or excessive nutrition should be avoided, and primary nurses should collaborate with dietitians to assess and adjust the dietary pattern of each patient; and (iv) keeping a positive and steady state of mind and ensuring adequate rest.

Hospitalization of PD patients

Since there is a potentially high risk of cross-infection with use of hemodialysis, PD is recommended as the first-choice renal replacement therapy during the COVID-19 outbreak by the Nephrology Branch of the Chinese Medical Association ([15], [Supplementary material](#)). Patients who need to be hospitalized for catheter insertion or due to comorbidities should be screened for COVID-19 before hospitalization. Patients with a suspected epidemiological history or relevant symptoms should be first referred to a designated fever clinic or a department of infectious diseases. Suspected cases or those identified as COVID-19 should be referred to a hospital designated for treatment. Only patients without any signs or features of COVID-19 can be admitted to a general hospital. Elective and nonurgent hospital admissions should be rescheduled, and elective surgery and other procedures of those already as inpatients should be delayed.

After hospitalization, in addition to standard precautions as part of ward management, some additional special measures should be taken to reduce the risk of cross-infection between inpatients and outpatients: (i) reserving one inpatient room for each patient; (ii) not allowing patients to wander freely on the ward; (iii) no visitors to the ward area; and (iv) dividing PD healthcare staff into two groups, i.e. those involved in inpatient care and those providing outpatient care.

DIAGNOSIS AND TREATMENT OF COVID-19 IN PD PATIENTS

How to detect and diagnose COVID-19

As shown in Table 2, individuals who meet at least one of the epidemiological history criteria combined with two of the clinical manifestations, or who meet all three of the clinical manifestations, are considered suspected cases. A suspected case is confirmed as COVID-19 if: (i) SARS-CoV-2 nucleic acid is detected by reverse transcription polymerase chain reaction (RT-PCR); or (ii) a viral gene sequence highly homologous to a known sequence of SARS-CoV-2 is obtained; or (iii) serology reveals raised titers of immunoglobulin M (IgM) and immunoglobulin G (IgG). Samples can be taken from the upper (nasopharyngeal and oropharyngeal) or lower respiratory tract (expectorated sputum, endotracheal aspirate or bronchoalveolar lavage), as appropriate, for RT-PCR analysis. Of note, lower respiratory tract samples produce test results with higher accuracy.

When nucleic acid analysis is not possible or feasible, chest computed tomography (CT) is recommended for patients with relevant symptoms or epidemiological history, and typical CT findings of viral pneumonia are considered as a diagnostic criterion for confirming COVID-19. Chest CT is commonly recognized as a more sensitive and precise imaging tool than chest X-ray.

Although viral nucleic acid can be detected in stool, the pathogenicity of SARS-CoV-2 awaits confirmation [16]. To date, there has been no reported detection of the virus in PD effluents.

What can we do in confirmed cases of COVID-19?

Confirmed cases of COVID-19 must be reported in a timely manner, in accordance with regulations set by relevant authorities, and referred to a hospital designated for COVID-19 treatment. With the lack of a vaccine or specific drugs, supportive care and nonpharmaceutical interventions have become the most important treatment strategy. Several antiviral agents (e.g. interferon- α , lopinavir/ritonavir, ribavirin, arbidol and remdesivir) are being tested since the outbreak of COVID-19. Among the antiviral drug candidates, there are high hopes for remdesivir, which currently is being trialed in a multicenter, randomized controlled study, although firm conclusive results are yet to be available. Anti-malarials (e.g. chloroquine phosphate), anti-inflammatory drugs (e.g. tocilizumab) and Chinese traditional medicine are also being widely used for treatment. Physicians should beware of adverse drug effects, drug interactions and contraindications for specific medications. It is not recommended to administer more than three different antiviral agents concurrently. In PD patients, careful dosage adjustments

are mandatory to optimize drug exposure and reduce the risk of adverse events due to the lack of accepted recommendations.

Patients with mild or moderate COVID-19 illness can maintain their PD treatment as usual. Severe or critically ill cases requiring life support due to multi-organ dysfunction syndrome should be temporarily switched to bedside automated PD or continuous renal replacement therapy. Drainage fluid from PD patients with COVID-19 should be mixed with 500 mg/L of a chlorine-containing solution for 1 h for disinfection before disposal.

When can an individual with confirmed or suspected COVID-19 attend the PD unit?

Confirmed cases of COVID-19 can attend the PD unit after self-quarantine and medical observation for at least 14 days after recovery, defined as resolution of pyrexia without use of antipyretics, amelioration of respiratory symptoms (e.g. cough, shortness of breath and oxygen saturations of >95%), improved chest CT findings and negative COVID-19 nucleic acid assays from at least two consecutive nasopharyngeal swab samples collected ≥ 24 h apart (a total of two negative samples).

Suspected cases of COVID-19 can visit the PD unit after self-quarantine and medical observation for 14 days and having been ruled out as COVID-19 carriers.

PRECAUTIONARY MEASURES FOR PD STAFF

Continuous education and training about COVID-19

Healthcare personnel should be educated regularly on the latest knowledge about COVID-19, since information on the disease is continually being updated. They should be kept informed about the local COVID-19 situation and develop or review their facility's emergency plan. Online training is recommended.

Epidemiological history surveillance and self-monitoring for healthcare personnel

An honest approach should be adopted to report any suspected epidemiological history among the healthcare personnel to dialysis center management and infectious diseases experts. Any staff member suspected of having COVID-19 should be subjected to self-quarantine for at least 14 days in accordance with set guidelines.

All healthcare staff should monitor their body temperature twice daily. Any staff member with fever (>37.3°C on two consecutive occasions) or suspected respiratory tract infection should remain at home and be placed under close medical observation or referred to a designated department, if necessary.

PPE and hand hygiene

Appropriate PPE should be worn according to the level of exposure risk of healthcare personnel in contact with patients with COVID-19 [17]. In the consulting room, healthcare staff should wear at least a disposable surgical face mask or an N95 mask and a disposable cap. When performing procedures that require an aseptic technique, disposable gloves should be worn. When in contact with high-risk patients, it is recommended to wear a gown and goggles throughout the interaction. When providing PD to subjects who are being observed for possible, but with no definitive diagnosis of, COVID-19, PPE should be worn, including

an N95 mask, cap and protective gown, goggles or a face shield, shoe covers and gloves. When providing PD to suspected or confirmed cases of COVID-19 in an isolation room, additional PPE in the form of a powered air-purifying respirator should be worn. PPE should be removed upon leaving the workplace, while following appropriate hand hygiene. It is not recommended to reuse PPE; only equipment that can be disinfected without losing their protective effect, e.g. nondisposable goggles and face shields, and gowns can be reused after appropriate disinfection. It is recommended to change N95 masks every 4 h. Once contaminated or damp, N95 masks should be replaced with new ones. Administrative and environmental measures should be implemented concurrently to enhance PPE compliance.

According to the 'My 5 Moments for Hand Hygiene' recommendations from the World Health Organization [10], a standard 7-step hand hygiene routine should be performed: (i) before and (ii) after every patient contact; (iii) after exposure to body fluid exposure and risk; (iv) after touching a patient's immediate environment; and (v) before clean/aseptic procedures. Furthermore, hand hygiene should also be performed before wearing, as well as after removing, PPE. The dialysis unit should provide continuous education and supervision regarding the importance of, and the recommended approach to, hand hygiene and provide the necessary equipment, including sufficient numbers of sinks with soap dispensers, paper towels, hand lotions and alcohol-based hand sanitizers.

Medical activities and staffing

Activities involving group gatherings, including shift meetings, centralized learning and case discussions, should be minimized. Instead, telephone discussions and WeChat work group chats can be used for communication if necessary. Should group gatherings be absolutely essential and unavoidable, PPE should be worn. Precautions should be taken in daily life as recommended, e.g. maintaining appropriate distancing between two persons and avoiding casual conversation while eating.

Healthcare staff should receive adequate rest. Sick personnel should be encouraged to stay at home. Staffing should be organized in terms of area-based assigning of duties and responsibilities. Flexible commuting should be encouraged according to workload. Hospital and dialysis center management should pay close attention to, and address any deterioration in, the mental and physical health of their staff.

Environment cleaning

Environment cleaning is an easily ignored, but vital, aspect of infection control. Environment service personnel responsible for daily cleaning and disinfection of high-touch surfaces in the PD unit should also be trained in self-protection and wearing all recommended PPE when cleaning and disinfecting the environment. PPE should be removed upon leaving the PD unit, immediately followed by the performance of hand hygiene.

Rooms should be ventilated by opening windows as frequently as possible, for at least 30 min each time, to allow adequate air changes. Air conditioning with a fresh air or purification system should be turned on to ensure air circulation. To disinfect the air, rooms should be disinfected using ultraviolet light ($\geq 1.5 \text{ W/m}^3$) for >30 min before and after patient visits [18].

Object and floor surfaces should be wiped and disinfected thoroughly with 500 mg/L of chlorine-containing disinfectant before and after patient visits, and the surroundings, objects

and medical equipments related to patients should be disinfected thoroughly. Disinfection of desk surfaces, computer screens and keyboards in office areas should be carried out. Any surfaces contaminated with blood or any other secretions should be cleaned and then disinfected using a 2000 mg/L of chlorine-containing disinfectant for >30 min.

Terminal disinfection should be performed immediately, under the guidance of infection control experts, if there are confirmed or highly suspected cases of COVID-19 attending the dialysis center. The dialysis center can become operational again only after passing an inspection carried out by infection control experts.

All medical wastes related to confirmed or suspected cases of COVID-19 should be handled by infectious medical wastes management and disposed of in accordance with the relevant regulations.

NATIONAL POLICIES AND SOCIAL SUPPORT FOR PD MANAGEMENT

Success of the battle against this pandemic cannot solely depend on healthcare institutions alone. Practical convenience policies at a national level and comprehensive social support are both indispensable.

During the pandemic, which has rendered patients' hospital visits perilous and difficult, the Chinese government has issued a number of policies and measures to ensure the practical convenience and safety of patients: (i) long-term prescriptions are allowed [19], so physicians can prescribe routine medicines for use over 2-3 months; and (ii) online medical services are covered by healthcare insurance [20], so patients are encouraged to have consultations using online healthcare platforms, which have been under extensive development in recent years. It has proved impressive that thousands of Chinese doctors have demonstrated selfless dedication by providing healthcare services to patients free of charge over the past 2 months.

Businesses, manufacturers and distributors of PD solution and PD-related equipment have overcome a range of difficulties and contributed to guaranteeing the supply of these items. Long-term prescriptions inevitably led to a sharp surge in demand for PD solution, risking a supply shortage in the short term. Furthermore, with the COVID-19 outbreak during the Spring Festival holiday and quarantine, a resulting shortage of workers in factories manufacturing PD solution made it impractical to reallocate staff from other provinces back to affected production plants. However, businesses and manufacturers, such as Baxter, have been able to handle this difficult challenge through urgent deployment of extra shifts and mobilizing local workers. Moreover, nationwide lockdown measures unavoidably disrupted the distribution of PD solution. However, PD-related businesses, together with distributor partners, ensured timely supply of PD solution to every single patient. Implementing additional sanitization measures, systematic adjustment of distribution, and organizing extra staffing and working hours are only some of the stories reflecting the dedication of society in protecting this vulnerable group of patients.

CONCLUSIONS

The entire human society is fighting an ongoing battle against the spread of this new coronavirus. Integrated teamwork across society as a whole is needed to strengthen the ongoing public health response to this pandemic. The entire population of

patients on PD is relatively small, but these are frail individuals who deserve attention and care. By using precautionary measures for PD patients and healthcare staff, together with social support, it is possible to maintain a low, or even a zero, infection rate of COVID-19 among patients on PD.

SUPPLEMENTARY DATA

Supplementary data are available at ckj online.

CONFLICT OF INTEREST STATEMENT

None declared.

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