



Management of peritoneal dialysis under COVID-19: The experience in Sichuan Province People's Hospital, China

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Abstract

The outbreak of coronavirus disease 2019 (COVID-19) is becoming a severe challenge to China and the whole world. By now, there is no report about medical support to peritoneal dialysis (PD) patient during COVID-19 pandemic. In this essay, we summed up our safety measures on how to protect PD patients and our staffs, and our experience on how to ensure the dialysis treatment of PD patients during the pandemic period. Using of telehealth has potential to improve patient care quality. As a result, by applying all the actions and efforts above, most of patients got enough medical support. According to the patient survey, 11 patients (3.3% of the total) reduced their treatment of dialysis exchange due to the shortage of PD solution or the affection of the pandemic. None of the PD patient and staff reported COVID-19. We successfully prevented COVID-19 transmission and ensured medical safety in our PD patients during the crisis.

Keywords

COVID-19, management, peritoneal dialysis, telehealth

By 16 April 2020, the Chinese health authority had reported 82,719 confirmed coronavirus disease 2019 (COVID-19) cases and 4632 deaths from 31 provincial-level regions in mainland China. More COVID-19 cases were confirmed outside of China including Japan, Italy, German, France, United States, and so on. The outbreak of COVID-19 is becoming a severe challenge to China and the whole world.

Fever clinics and emergency wards were set up, and outpatient service in high-risk departments was reduced to avoid nosocomial infection and aggregation in Chinese hospitals responding to COVID-19 infection.^{1,2} However, a large number of patients with chronic diseases still needed continuous medical support, especially those chronic renal failure patients who were undergoing peritoneal dialysis (PD). The correlation of COVID-19 and kidney disease was documented recently.³ It was reported that COVID-19 infection presents a special threat to patients on dialysis.⁴ The Chinese Society of Nephrology and the European Renal Association—European Dialysis and Transplant Association have developed guidelines for dialysis units during the COVID-19 outbreak.^{5,6} In 28 March 2020, the

International Society for Peritoneal Dialysis (ISPD) guideline committee published strategies for PD patients regarding COVID-19 on its website.⁷ However, there is no report about medical support for PD patients during the COVID-19 pandemic.

At present, there are a total of 2580 PD patients in Sichuan Province. About 13.6% (348 patients) of the patients in the province are being treated in the PD center of Sichuan Provincial People's Hospital which is one of the largest centers in Southwest China. The urgent issue was

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how to ensure these patients received the necessary treatment, while reducing the risk of COVID-19 infection. We reviewed and studied relevant literature. Based on that and our experience, on 25 January 2020, we set up a project and contingency plan to protect the safety of PD patients.

Amassed response team

We set up a response team consisting of PD doctors, PD nurses, experts of nosocomial infection control, and hospital administrators. Team members discussed the possible problems that would be encountered, created a corresponding action plan and continuous improvement plan, and formulated long-term strategies for the pandemic period. We evaluated the outbreak risks of COVID-19 in the PD center, therapeutic efficacy, and comprehensive service capacity of all medical staff. It was decided that personal protective measures are placed on primary level (wearing surgical mask) both for medical staff and for PD patients during the health-care activities. Strict protection is the top priority for reducing medical staff infection. We also kept the minimum required number of workers on duty for outpatient services and registered staff daily health information.

PD fluid supply

Peritoneal dialysate is the lifeline of PD patients. Ensuring the supply of dialysate is the basis of treatment. Our patients usually visit the hospital once a month and get dialysate and drugs at the same time. After receiving the prescription, the pharmaceutical distribution company will deliver the peritoneal dialysate to the patient's home on time. We usually recommend that patients store at least 2 weeks of PD fluid at home in case of emergency. For patients in remote areas, the stored supply of peritoneal fluid should be at least 1 month. The project provides sufficient time for us to prepare and ensure the supply of PD fluid during the COVID-19 pandemic.

During the outbreak, our management strategy for the guarantee of the PD dialysate supply is to recommend that:

1. Patients increase their store of PD supplies to a level sufficient for 3 months usage.
2. Patients check up their stock of peritoneal fluid at home and then send their orders to PD center and pharmacy if they are in need.
3. Patients cooperate with the pharmacy and to check inventory. The pharmacy's stockpile of dialysate should be planned to guarantee that outpatients can receive dialysate at any time.
4. Patients contact the PD delivery company to ensure weekly delivery.
5. Patients establish mutual-aid teams for those who cannot receive distribution in remote areas. Patients can get through the crisis by borrowing dialysate from each other.

Table 1. Epidemiological screening for COVID-19 for outpatient.

Context
Epidemiological history
History of travel/residence in Hubei or other areas with continuous transmission of local cases within 14 days
History of direct contact with patients have fever or respiratory symptoms from Hubei or other areas with continuous transmission of local cases within 14 days
History/epidemiologic association with COVID-19 infection in family members/relatives/neighbors
Symptom report
Fever
Fatigue
Cough
Dyspnea

COVID-19: coronavirus disease 2019.

Process of outpatient

Given the drop in outpatient numbers, we reduced the PD outpatients' services to two times per week from three times per week and optimized the process for outpatients.

Outpatient preregistration and epidemiological screening

The outpatient appointment registration system was implemented with web access only. Patients must fill in the COVID-19 epidemiological survey before making an appointment (Table 1). The patients must go to a fever clinic to screen for COVID-19 if the epidemiological survey is positive.

Adjust outpatient service procedure

Given the protection level needed, we formulated a policy for outpatients in the COVID-19 pandemic period. Patients and caregivers are required to follow the guidance of PD nurses and wear masks in the whole process. Patients would receive epidemiological screening again in the PD center. The special procedure flowchart is shown in Figure 1.

Reservation for examination and transfer set exchanging

We suspended all nonemergency peritoneal equilibration testing because it would increase the retention time of patients in hospital. To reduce the chance of nosocomial infection in the PD center, an advance reservation was required for patients who needed blood biochemical examinations and exchange transfer sets.

Disposal of PD garbage

Research shows that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is not only found in the

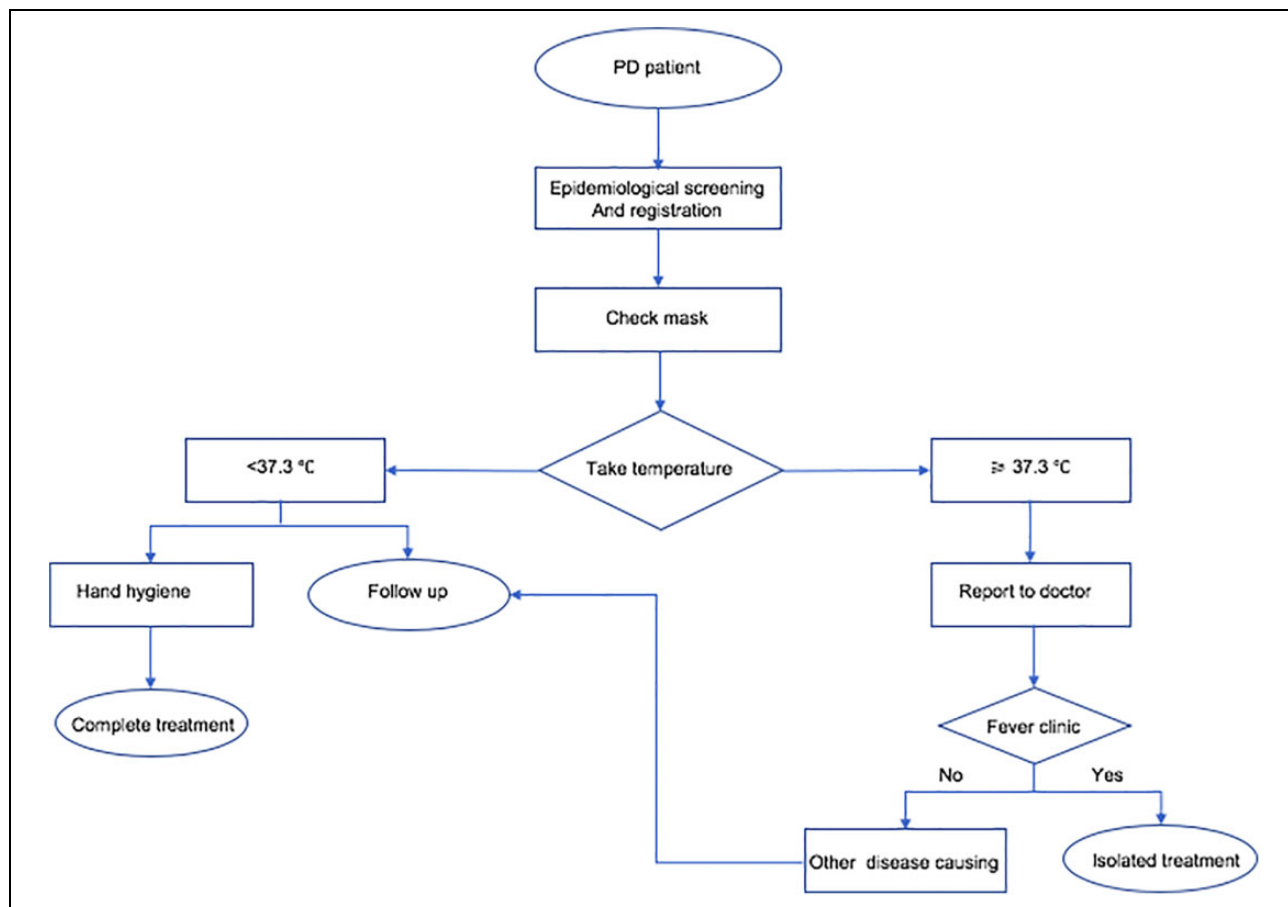


Figure 1. Outpatient service process in outbreak.

nasopharynx and sputum. The viral load has also been detected in blood, feces, urine, and pleural fluid. The virus has been isolated in urine and stool recently.⁸⁻¹⁰ Based on the evidence that the new coronavirus can be transmitted by contact, it is necessary to prevent the spread caused by sewage pollution. Therefore, we recommend paying more attention to the disposal of waste bags and dialysate, although no virus has been found in ascites or drained dialysate currently. However, there are no clearly defined methods for the disposal of medical waste from PD.^{11,12} We suggest that patients pour the drained dialysate carefully into the toilet, avoiding splashing, and then disinfect any dialysate splashes and the toilet with 500 mg/L of chlorine containing preparations. We also encourage patients to separate and recycle waste bags as medical waste during the pandemic to prevent virus transmission.

Policy of using face mask

PD patients are trained in the six-step handwashing technique and mask wearing in our education program. Wearing disposable surgical masks is required at the time of dialysis exchanges and exit site care. COVID-19 is an infectious respiratory disease. Wearing masks and hand hygiene are the most important methods of

preventing virus transmission.¹³ The Chinese Center for Disease Control and Prevention recommends people wear a mask when they go out.¹⁴ However, the shortage of masks has become a prominent problem during the pandemic. We suggest PD patients wear masks whenever they go out to hospitals, to public places, or in public transportation. Masks need not be worn at home, in places with good ventilation and low personnel density. Hand hygiene is required before putting on the mask at the time of PD exchange. Under the circumstances, masks could be reused. However, the mask should be replaced promptly in case of dirt, deformation, damage, and a peculiar smell.

COVID-19 testing

Currently, SARS-CoV-2 nucleic acid real-time polymerase chain reaction (RT-PCR) testing, SARS-CoV-2 Immunoglobulin G - Immunoglobulin M (IgG-IgM) combined antibody detection, and computed tomography (CT) imaging are the primary tools for clinical diagnosis of the infection.¹⁵⁻¹⁸ Given the complicated operation and hours required for RT-PCR, IgG-IgM detection and chest CT scans are priority options. We screen COVID-19 for patients who need hospitalization to recognize

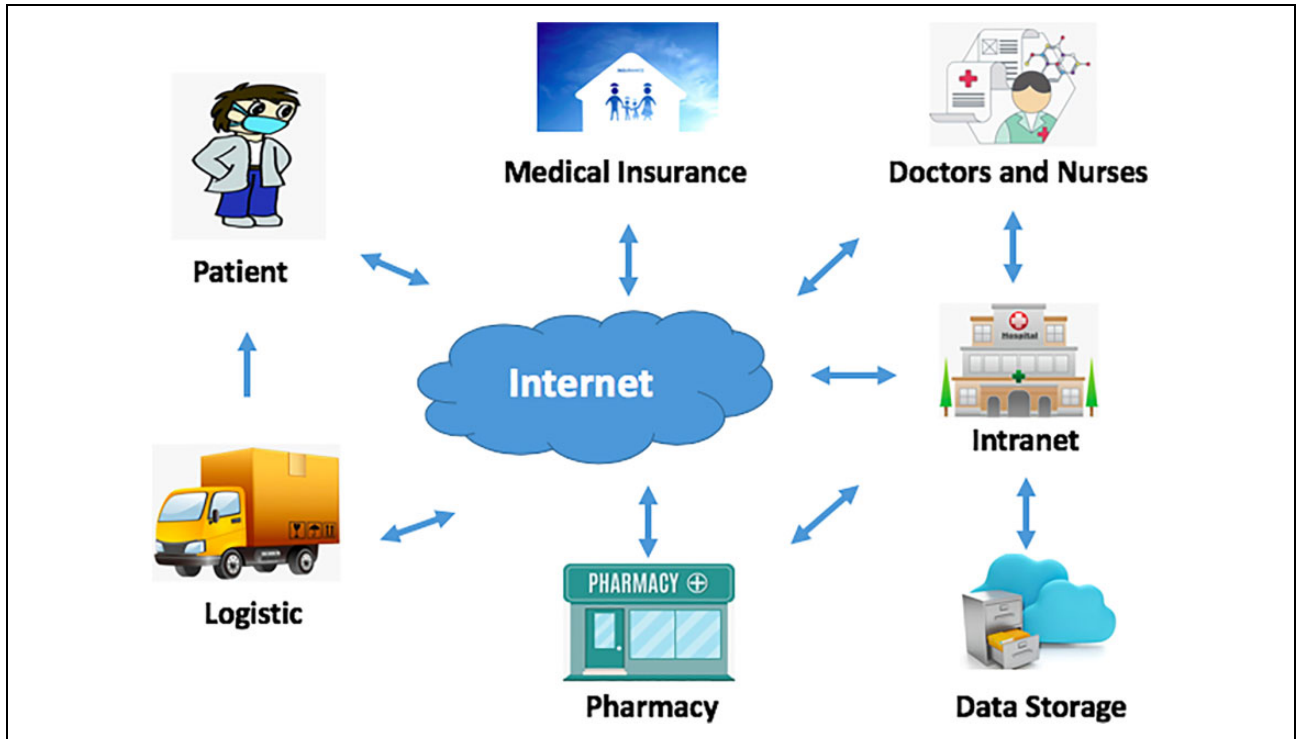


Figure 2. Architecture and process of PD management platform. PD: peritoneal dialysis.

asymptomatic carriers and avoid virus spread in hospital. In addition to serologic testing and a chest CT scan, RT-PCR of nasal swabs and throat swabs are performed for patients who had contact history of COVID-19 patients/travel history of Wuhan, now showing fever or respiratory symptoms. We do not screen PD patients who therapy at home without any epidemic history or symptoms. So far, we have completed nucleic acid detection for 10 patients, and antibody and CT examination for 28 patients.

Telehealth application

Telemedicine systems are ideal for mitigating overcrowding of hospitals and preventing additional unnecessary human exposures during the COVID-19 crisis.¹⁹ Some studies reported the benefits of eHealth interventions in supporting patients on PD.^{20,21} Considering the risks of traffic control, outpatient restrictions, and nosocomial infection during the outbreak, we encourage patients to stay at home rather than go to the hospital. We launched a follow-up and training plan through telehealth to improve the medical safety of patients during the pandemic period.

Emergency telephone

We arranged for nurses in the PD center to be on telephone duty 24 h a day, 7 days a week. Patients can make phone calls

at any time in case of emergency. Once the emergency is reported, PD nurses will respond immediately to guide the patient to do first aid by themselves or arrange the admission.

Using social media software

The PD center has always advocated patients using social media software such as WeChat and QQ to receive notifications related to dialysis. We provided outpatients with information and layman-friendly science knowledge, and we conducted patient surveys through social media software during the disease outbreak. PD nurses continue to provide online support in work hours. The application of social media establishes a convenient way of communication between medical staff and PD patients, and between patients and patients as well. This effective social communication is also a beneficial remedy for the psychological health of the patients.

Online medical services:

Our hospital obtained its online medical services license in 2019. The PD management platform has been established above hospital Internet service platform. We launched the PD outpatient online medical service after the government started its emergency response. The special flowchart is shown in Figure 2. The PD management platform is linked to the hospital WeChat official account which is opened to

the public. Data are stored in Cloud storage. The hospital Internet service platform connects the hospital internal systems including hospital information system, laboratory information system, and external apps (such as medical insurance) through data interface or application programming interface. Different customer client apps, such as patient app and doctor app, are deployed based on different end users. The PD management platform's functional modules cover diagnosis, treatment service, payment/refund function, electronic prescription, prescription quality control, drug distribution, and business statistics. Patients provide the main symptoms and upload dialysis-related data to the PD management platform through WeChat Official Accounts. After receiving "patient service requirement" on app client, doctors issue prescriptions online based on the information received in the service requirement, previous documents, digital images, and blood biochemical examination results. Patients make online payments in the medical insurance app. The hospital pharmacy will arrange for logistics companies to distribute dialysate and drugs to patients' homes after clinical pharmacists review prescriptions. We also conduct virtual visiting for PD patients through an interactive audio and video telecommunications system. By applying Internet technology, PD patients completely achieved home isolation treatment, effectively reducing the risk of infection during the pandemic.

Telephone visit

A PD nurse follows up with telephone visiting for elderly patients or patients who are lacking the ability to use social media software and Internet hospital applications. In telephone visiting, we enquired about changes in blood pressure, bodyweight, ultrafiltration volume, urine output, edema, exit site, and procedure of dialysis. Recommendations are given to patients according to the changes. When confronted with complicated problems, doctors will follow-up to find a solution and provide feedback to patients.

Remote monitoring in APD

We managed 19 APD users, about 5.4% in all patients before the outbreak. By accessing the data in the cloud, a PD nurse could monitor dialysis data and biometric information of patients, then consult PD doctors to adjust the dialysis prescription. In general, few impacts on APD patient management were observed during the outbreak.

Patient education

We usually implemented a 5-day program of patient training according to the recommendation of ISPD before the pandemic.²² The course is taught one-on-one and nurse-to-patient. Incident PD patients training is performed in two ways during the epidemic:

1. Face-to-face training: It was the first choice of patient training. However, this one-on-one course cannot be provided during the outbreak. We try to minimize face-to-face time to reduce the possibility of nosocomial infection.
2. Remote training: The training slides and operation video are uploaded in the pad beside hospital bed. Patients can learn it by themselves following the designed education schedule. PD procedure is practiced using teaching aids. PD nurses can provide help and instruction through a pad camera.

Special education programs were carried out through the social media software to increase the patients' understanding of COVID-19 and the relevant prevention and control measures. The content included COVID-19 information, daily precautions, and the use of personal protective equipment. Considering the COVID-19 cases were mostly infected through airborne and close contact in daily living, hand hygiene was strongly encouraged and reinforced in the programs. This education also provided psychosocial support for patients during the pandemic.

Program for urgent-start PD

A report from hemodialysis (HD) center with the COVID-19 outbreak has indicated HD patients are a highly susceptible population and HD centers are high-risk areas in the pandemic.⁴ To avoid such risk, the PD response team established the following policies for start urgent PD:

1. HD patient who was confirmed COVID-19 without isolation treatment should transfer to APD immediately.
2. Incident dialysis patient should prefer PD rather than other renal replacement therapy. Specially designated staff members are responsible for catheter implantation and APD treatment.

Survey of PD implementation

We conducted a questionnaire survey in the PD center in March 2020 (Table 2). We completed 337 surveys, which is 96.8% of the total number of patients. Most of the patients reported dialysis treatment was less affected by the pandemic. There were 11 (3.3%) patients who reduced dialysis due to a shortage of PD solution or the effects of the pandemic. Two deaths were caused by an advanced malignant tumor and a sudden death. However, 69 (24.4%) patients stopped erythropoietin injections due to the suspension of outpatient service in some community hospitals. Our investigation revealed that, in addition to dialysis, the issue of erythropoietin injection during the pandemic should be considered. It is feasible to train patients to inject erythropoietin by themselves.

Table 2. Survey results from PD patients.^a

Survey question	Patients (n = 337)
Reduce PD exchanges	11 (3.3%)
Hospitalization	8 (2.4%)
Death	2 (0.6%)
Body weight change	44 (15.3%)
Gain weight > 2 kg	12 (3.6%)
Loss weight < 2 kg	8 (2.4%)
Blood pressure fluctuate	54 (16.0%)
Disinfect the toilet and drained fluid	251 (74.6%)
Hand hygiene correctly	258 (76.7%)
Wear masks correctly	316 (93.8%)
Stop EPO in needed	69 (24.4%)
Lack of antiseptic solution	82 (28.5%)

PD: peritoneal dialysis.

^aData are presented as n (%).

No patients or staff members reported COVID-19 in our PD center, although there were 561 cases of COVID-19 infection reported in Sichuan Province as of 16 April 2020, according to the data from the Sichuan Provincial Center for Disease Control and Prevention.

Routine catheter implantation was performed in eight patients. An urgent-start PD was implemented in one HD patient with diagnosed active pulmonary tuberculosis. No obvious impact on PD uptake rate was observed in the survey. It seemed we had successfully stemmed the spread of the virus and ensured safety of PD patients after the outbreak of COVID-19.

Although PD as a kind of home therapy has the advantage of avoiding infection during a pandemic,²³ PD center should pay more attention to patient management and provide dialysis support in a COVID-19 crisis. The use of telehealth has potential to improve patient care under these difficult circumstances. We hope our experience will help PD centers when they face the risks of COVID-19 infection. With our effort, PD patients will to be weathering the crisis.

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Author contributions

JC and LW contributed to study design, data analysis and manuscript writing. CJ, LJY, HG, QZ, PLL, WSL contributed to patients management, data acquisition. LW, HLD, DQH, AND GSL contributed to literature review, supervision or mentorship. All authors have read and approved the final manuscript.

Declaration of conflicting interests

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Ethical approval

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Informed consent

Not applicable as this is a review article.

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References

- Pan L, Wang L and Huang X. How to face the novel coronavirus infection during the 2019–2020 epidemic: the experience of Sichuan Provincial People's Hospital. *Intensive Care Med* 2020; 46(4): 573–575.
- Liao X, Wang B and Kang Y. Novel coronavirus infection during the 2019–2020 epidemic: preparing intensive care units—the experience in Sichuan Province, China. *Intensive Care Med* 2020; 46(2): 357–360.
- Naicker S, Yang C-W, Hwang S-J, et al. The novel coronavirus 2019 epidemic and kidneys. *Kidney Int* 2020; 97(5): 824–828.
- Ma Y, Diao B, Lv X, et al. Novel coronavirus disease in hemodialysis (HD) patients: report from one HD center in Wuhan, China, <https://www.medrxiv.org/content/10.1101/2020.02.24.20027201v2> (2020, accessed 2 March 2020).
- Chinese Society of Nephrology. Recommendations for prevention and control of new coronavirus infection in blood purification center (room) (First trial version). *Chinese Journal of Nephrology* 2020; 36(2): 82–84. DOI: 10.3760/cma.j.issn.1001-7097.2020.02.002.
- Basile C, Combe C, Pizzarelli F, et al. Recommendations for the prevention, mitigation and containment of the emerging SARS-CoV-2 (COVID-19) pandemic in haemodialysis centres. *Nephrol Dial Transplant* 2020; 35: 737–741.
- ISPD Guideline Committee. Strategies regarding COVID-19 in PD patients. International Society of Peritoneal Dialysis, http://ispd.org/wp-content/uploads/ISPD-PD-management-in-COVID-19_ENG.pdf (2020, accessed 28 March 2020).
- Guan W, Ni Z, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med* 2020; 382: 1708–1720.
- Lescure FX, Bouadma L, Nguyen D, et al. Clinical and virological data of the first cases of COVID-19 in Europe: a case series. *Lancet Infect Dis* 2020; 20(6): 697–706.
- Chen X, Zhao B, Qu Y, et al. Detectable serum severe acute respiratory syndrome coronavirus 2 viral load (RNAemia) is

- closely correlated with drastically elevated interleukin 6 (IL-6) level in critically ill patients with coronavirus disease 2019. *Clin Infect Dis*. Epub ahead of print 17 April 2020. DOI: 10.1093/cid/ciaa449.
11. Bailie GR, Kowalsky SF, Eisele G, et al. Disposal of CAPD waste in the community. *Perit Dial Int* 1991; 11(1): 72–75.
 12. Vas SI. Environmental protection and peritoneal dialysis garbage. *Perit Dial Int* 1991; 11(1): 12–13.
 13. Desai AN and Aronoff DM. Masks and coronavirus disease 2019 (COVID-19). *JAMA* 2020; 323(20): 2103.
 14. National Health Commission and China Health Education Center. *Novel coronavirus pneumonia health education manual*. 2nd ed. <http://www.nihe.org.cn/news.php?id=62541> (2020, accessed 9 March 2020).
 15. Jin YH, Cai L, Cheng ZS, et al. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). *Mil Med Res* 2020; 7(1): 4.
 16. Li Z, Yi Y, Luo X, et al. Development and clinical application of a rapid IgM-IgG combined antibody test for SARS-CoV-2 infection diagnosis. *J Med Virol*. Epub ahead of print 27 February 2020. DOI: 10.1002/jmv.25727.
 17. Pan Y, Zhang D, Yang P, et al. Viral load of SARS-CoV-2 in clinical samples. *Lancet Infect Dis*. 2020; 20(4): 411–412.
 18. Liu R, Han H, Liu F, et al. Positive rate of RT-PCR detection of SARS-CoV-2 infection in 4880 cases from one hospital in Wuhan, China, from Jan to Feb 2020. *Clinica Chimica Acta* 2020; 505: 172–175.
 19. Rockwell KL and Gilroy AS. Incorporating telemedicine as part of COVID-19 outbreak response systems. *Am J Manag Care* 2020; 26(4): 147–148.
 20. Cartwright EJ, Goh ZZS, Foo M, et al. eHealth interventions to support patients in delivering and managing peritoneal dialysis at home: a systematic review. *Perit Dial Int*. Epub ahead of print 17 April 2020. DOI: 10.1177/0896860820918135.
 21. Nayak KS, Ronco C, Karopadi AN, et al. Telemedicine and remote monitoring: supporting the patient on peritoneal dialysis. *Perit Dial Int* 2016; 36(4): 362–366.
 22. Figueiredo AE, Bernardini J, Bowes E, et al. A syllabus for teaching peritoneal dialysis to patients and caregivers. *Perit Dial Int* 2016; 36(6): 592–605.
 23. Cho JH, Do JY, Kim SH, et al. Impact of dialysis modality on the incidence of 2009 pandemic H1N1 influenza in end-stage renal disease patients. *Perit Dial Int* 2011; 31(3): 347–350.