

# Management of Maintenance Hemodialysis Patients under the Coronavirus Disease Pandemic

Fei Xiong<sup>1,2</sup>, Can Tu<sup>1,2</sup>

<sup>1</sup>Department of Nephrology, Wuhan No. 1 Hospital, <sup>2</sup>Hemodialysis Quality Control Center, Wuhan, Hubei Province, China

## Abstract

Coronavirus disease (COVID-19) has spread worldwide and has resulted in high mortality, increased pressure on medical systems, and severe global economic losses. Hemodialysis patients may be highly susceptible to infections due to old age, immunocompromised status, preexisting comorbidities, and frequent hospital visits. Moreover, the closed and crowded environment of dialysis rooms increases the risk of cross-infections. The Wuhan Hemodialysis Quality Control Center has accumulated valuable experience in the prevention and control of the COVID-19 epidemic and has normalized management of the epidemic since early 2020. In this review, we garnered experiences and knowledge from China and worldwide to summarize an approach to COVID-19 prevention, control, and management in hemodialysis patients under normalized epidemic conditions.

**Key words:** Coronavirus disease, hemodialysis patients, management, prevention

## INTRODUCTION

Coronavirus disease (COVID-19) is an infectious disease caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). The National Health Commission of the People's Republic of China classified COVID-19 as a Class B infectious disease via Announcement No. 1 (2020) and provided recommendations for its prevention and control as a Class A infectious disease. The pandemic caused by SARS-CoV-2 is more widespread, has resulted in more infections, resulted in higher mortality, placed greater demands on the health-care system, and caused more extreme

global economic losses than the two previous outbreaks caused by SARS-CoV and MERS-CoV.<sup>[1-4]</sup>

Compared to the general population, patients undergoing maintenance hemodialysis (MHD) are more susceptible to SARS-CoV-2 infection. During the epidemic period from January 1, 2020, to March 10, 2020, the Wuhan Hemodialysis Quality Control Center (WHQCC) reported a COVID-19 infection rate of 2.15% (154/7154) among patients on dialysis across 65 dialysis centers in Wuhan. This rate was significantly higher than that of the general population (0.5%) during the same period.<sup>[5]</sup> Similarly, the SARS-CoV-2 antibody positivity rate of dialysis patients (3.5%–27.2%) was higher than that of the average population (<10%).<sup>[6]</sup> Moreover, the mortality rate due to SARS-CoV-2 increased the mortality rates of MHD patients from 1.2% to approximately 16.2%–31%,<sup>[7-11]</sup> which is 21.1 times higher than the expected 1.2% mortality of historical controls.<sup>[12]</sup> This may be because patients on dialysis are generally older, have lower immunity, and need to visit

**Address for Correspondence:** Prof. Fei Xiong,  
Department of Nephrology, Wuhan No. 1 Hospital (Wuhan Traditional Chinese and Western Medicine Hospital), No. 215 Zhongshan Avenue, Wuhan 430022, Hubei Province, China.  
E-mail: xiongf23@sina.com

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hospitals frequently. Furthermore, they are more susceptible to COVID-19 because they often have multiple comorbidities such as cardiovascular disease, cerebrovascular disease, and diabetes and undergo dialysis in relatively closed and densely populated environments.<sup>[13-15]</sup> Therefore, it is important to develop effective methods to manage MHD patients during the COVID-19 pandemic to ensure that they can receive daily dialysis and medical treatment while preventing COVID-19 infection.

During the early stages of the epidemic, the WHQCC led the development of the Hemodialysis Clinical Emergency Response Plan during the Wuhan Public Health Event (COVID-19) to curb the impact of COVID-19 on dialysis patients.<sup>[16]</sup> This document served as an essential guide for the prevention and control of the epidemic. Moreover, the appropriate use of Chinese medicine (CM) has played an important role in the management of the epidemic. Currently, major strategic achievements in the governance of COVID-19 have been observed in China.<sup>[17]</sup> However, comprehensive guidelines for the prevention and treatment of COVID-19 in patients on MHD have not been summarized. Therefore, we collated the experiences of the WHQCC and data from the published literature on COVID-19 prevention among patients on MHD, and discussed CM interventions and supportive care required for SARS-CoV-2-infected MHD patients.

The standard protocol for COVID-19 management has been followed for over a year at all medical centers, and all institutions have gained experience managing patients on MHD. Based on the nationwide experiences, the WHQCC created a standardized COVID-19 prevention and management plan for MHD patients in all dialysis centers across China. The latest version of the Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Version 7)<sup>[18]</sup> issued by the National Health Commission and State Administration of Traditional Chinese Medicine was used as the basis for all prevention and treatment protocols for COVID-19 in this consensus. The standard prevention and control measures for COVID-19 at MHD centers were summarized according to the Technical Guidelines for Prevention and Control of COVID-19 in Medical Institutions (First Edition)<sup>[19]</sup> (National Health Office Medical Letter [2020] No. 65), Circular on Implementing Regular Epidemic Prevention and Control and Further Strengthening Infection Control in Medical Institutions,<sup>[20]</sup> Hygienic Standards for Disinfection in Hospitals (GB 15982-2012),<sup>[21,22]</sup> Objects Surfaces Disinfectant (GB 27952-2020),<sup>[23]</sup> Regulation for Disinfection Technique in Healthcare Settings (WS/T 367-2012),<sup>[24]</sup> and Regulation for Cleaning and Disinfection Management of Environmental Surface in Healthcare (WS/T 512-2012).<sup>[25]</sup> Compared with other guidelines, our article

not only summarizes the management of MHD patients and medical staff in the normalization of the COVID-19 epidemic but also summarizes the management of the health-care environment, medical waste, and the use of Chinese medicine.

## Effect of Chinese medicine on the COVID-19 epidemic

CM has played an important role during the COVID-19 pandemic.<sup>[26,27]</sup> During the early stages of the epidemic, when no specific treatments were available, CM was administered to 92% of patients with COVID-19 across China. The utilization and total efficacy rates of CM for confirmed COVID-19 cases in Hubei Province exceeded 90%.<sup>[28]</sup> Six CM recipes, including Jinhua Qinggan granules, Lianhua Qingwen capsules, lung cleansing and detoxifying decoction, Xuanfeibaidu, Huashibaidu, and Xuebijing, have been shown to be remarkably effective for treating patients with COVID-19. Jinhua Qinggan granules and Lianhua Qingwen capsules are recommended during medical observation; lung cleansing and detoxifying decoction is recommended for the treatment of both severe and nonsevere COVID-19 cases; Xuanfeibaidu granules are recommended for treating moderate cases, whereas Huashibaidu and Xuebijing have been used to effectively manage severe cases.<sup>[26]</sup> Ke Hu *et al.* also reported that mortality was significantly lower in patients treated with Lianhua Qingwen granules + oseltamivir than that of control subjects. Moreover, the median time to recovery from fever, cough, and fatigue in the treatment group was significantly lower than that in the control group.<sup>[29]</sup> During the epidemic, Hu and Zhang proposed that the combination of CM and Western medicine was complementary and could potentially be the best protocol for the prevention and treatment of infectious and other diseases.<sup>[30]</sup> Clinical studies also confirmed that the combination of Chinese and Western medicine in the treatment of COVID-19 significantly alleviated the clinical symptoms of patients, shortened the disease course, improved the clinical cure rate, and achieved better outcomes than treatment with Western medicine alone.<sup>[31,32]</sup> Furthermore, various molecular biological and network pharmacological studies have revealed the mechanisms of action of the active ingredients in CM recipes that target angiotensin converting enzyme 2 (ACE2), 3CL hydrolase, and interleukin-6, among others. The main protease of SARS-CoV-2 is the 3CL hydrolase, whereas ACE2 is the receptor for SARS-CoV-2.<sup>[33-35]</sup>

The CM principle of “treating the disease before it happens” can be used as a guide to limit the spread of COVID-19. The key focus is “preserving the positive qi and avoiding the toxic qi.”<sup>[36]</sup> In MHD patients who have been ill for a long time, the positive qi is deficient and the external guard is weak, making

them susceptible to illness. Therefore, these patients have a greater need to “support positive qi and expel evil qi.” Most dialysis patients have no urine output and oral medications increase the patient’s water load. Hence, external treatments are more appropriate. Recent research has confirmed that moxibustion can improve immunity and enhance antioxidant capacity.<sup>[37,38]</sup> Owing to the environmental restrictions of the dialysis room, researchers have used smokeless moxibustion to regulate the spleen and stomach.<sup>[39,40]</sup> Two acupuncture points, Zusanli and Sanyinjiao, were selected, and the function of the spleen and stomach of MHD patients improved. Nutritional health was also improved, thereby relieving the symptoms of positive qi deficiency. Sachet therapy uses aromatic herbal medicines that enter the body from the mucous membrane of the mouth, nose, skin, hair, and meridian points. Meridian points are present throughout the body via the circulation of qi and regulate qi while dredging meridians. This makes the qi and blood flow smooth and makes the internal organs peaceful, thereby enhancing the body’s immunity against diseases by promoting overall health.<sup>[41]</sup> Studies have highlighted that the fumigation method using the Chinese herbal medicines *Atractylodes rhizome* and *Wormwood* leaves are more appropriate than ultraviolet (UV) irradiation for indoor disinfection under constant conditions<sup>[42,43]</sup> and safer than smoke fumigation. Therefore, this method can be used for air disinfection during dialysis and can prevent damage to the human body caused by disinfection with UV irradiation. The inclusion of CM in the standard protocols for epidemic prevention and control requires further investigation. A combination of CM and Western medicine can be beneficial in minimizing the risk of infection during MHD. Regrettably, no study has investigated the use of traditional CM in treating COVID-19 in patients with MHD.

## Maintenance hemodialysis patient management under normalized COVID-19 epidemic

### Patient education

Our understanding of COVID-19 improves as knowledge and evidence regarding the disease are updated. Regularly educating dialysis patients and their families about the transmission routes and characteristics of SARS-CoV-2 may improve their compliance with infection prevention and control measures. Early and active health education among patients on MHD has been shown to significantly reduce the risk of COVID-19 infection.<sup>[44]</sup> The importance of patient education has been emphasized by nearly all guidelines or standards, and the following topics have been addressed in the literature.<sup>[45,46]</sup>

### Transmission routes, respiratory hygiene, handwashing, and cough etiquette

Respiratory droplets and close contact are the main routes of COVID-19 transmission.<sup>[18]</sup> Droplet transmission in closed spaces such as dialysis rooms can be prevented by wearing a mask, prohibiting food/beverage consumption, and paying attention to cough etiquette.<sup>[47,48]</sup> Washing and disinfecting hands also reduce contact transmission.<sup>[49]</sup> During hospital visits for dialysis, patients and their caregivers should wear medical masks that comply with regulations, maintain proper cough etiquette, avoid eating and drinking in dialysis rooms, change clothing and footwear on entry and exit from the dialysis unit, and thoroughly wash hands. Hands should be sanitized upon entry and exit from the MHD unit and before and after changing clothes. The mouth and nose should be covered during coughing to avoid spreading droplets. The hands, mouth, and nose were cleaned regularly. These findings were consistent with the interim guidelines published by the Centers for Disease Control and Prevention (CDC), the American Society of Nephrology, and the International Society of Nephrology.<sup>[50,51]</sup>

### Regional epidemiological status

Patients should be informed of the current infection risk levels in domestic and international regions, based on updated epidemiological findings. Patients should be advised to avoid traveling to medium- and high-risk areas, prevent contact with persons returning from these areas, and promptly report any relevant epidemiological history. This may be how China treats COVID-19 differently from other countries.

### Understanding the clinical presentation

Patients should be educated about the common clinical presentations of COVID-19 according to the latest Diagnosis and Treatment Protocol for COVID-19.<sup>[44]</sup> This will empower patients to self-screen for COVID-19 and undertake preventive measures. The clinical characteristics of COVID-19 include fever, new cough, sore throat, tiredness, and shortness of breath. This approach was also recommended by the CDC because patients could screen themselves for COVID-19 and undertake appropriate preventive measures.

### Prescreening and triage

Although the specific procedures for prescreening and triage may differ, most guidelines propose that prescreening and triage should be established and strictly implemented to prevent SARS-CoV-2 transmission from close contact among patients at dialysis centers or within hospitals.<sup>[51-54]</sup> Temperature testing, symptom screening, and epidemiological history surveys should be performed for patients and accompanying persons. Digital registration and scanning should be conducted at the entrance. For dialysis patients, the body temperature

should be measured and recorded before and after dialysis. A standardized procedure should be established for fever treatment and reporting of positive nucleic acid amplification test (NAAT) results at all individual dialysis centers so that the results can be immediately reported and appropriately managed in a timely manner to avoid viral spread.

Patients identified with fever during screening should not only be reported as per the protocol but should be promptly isolated for observation. Studies have shown that timely isolation of suspected and confirmed cases can be extremely helpful in containing the outbreak.<sup>[5,55,56]</sup> The recommendations for prevention of novel coronavirus infection in blood purification center (room) from the Chinese Medical Association Nephrology Branch (Trial Version 1)<sup>[57]</sup> mentions that febrile patients can be treated with continuous renal replacement therapy (CRRT) by health-care workers in isolation wards until COVID-19 infection is ruled out. At dialysis centers that are incapable of performing CRRT, the patient should undergo dialysis alone after the completion of all other patient procedures, and a final disinfection should be conducted after dialysis. If the patient has respiratory symptoms, but the COVID-19 infection has been excluded, the patient should be placed in the corner of the MHD room during the last shift of the day. MHD patients with suspected or confirmed COVID-19 infection should be immediately transferred to a designated hospital for COVID-19, where CRRT or MHD treatment can be performed according to availability and the patient's medical condition [Figure 1].

This protocol has been adopted by several dialysis centers in China and worldwide during the pandemic, resulting in good prevention and control outcomes.<sup>[58,59]</sup> Specifically, Wuhan was in the “midst of a storm” during the early and middle stages of the epidemic, and the prescreening and triage system played a crucial role in controlling the outbreak.<sup>[5,60]</sup>

Patients visiting the hospital for dialysis and accompanying individuals should enter the treatment area at the appointed time to avoid unnecessary crowding in the dialysis room. Accompanying individuals should consistently follow strict infection control measures. A social distance >1 m should be maintained in the waiting area with spaced seating.<sup>[59]</sup> The term “dialysis patients” includes both outpatient and inpatient dialysis patients; dialysis outpatients have more complicated contacts. Dialysis can be performed for patients in fixed groups, depending on space availability and prevalence trends. Staggered dialysis shifts should be planned for out- and inpatients so that they receive MHD at different time slots of the day.<sup>[58]</sup>

### Regular screening

Therefore, regular NAATs should be performed. As dialysis rooms have a high population density, high mobility, high

social contact frequency, and high risk of exposure,<sup>[61]</sup> regular periodic screening of patients on dialysis is deemed necessary. NAAT is one of the most widely used screening tools to assess the clinical symptoms of dialysis patients<sup>[18]</sup> and is recommended to be performed once every 2–4 weeks. The frequency of screening can be adjusted according to the risk level of the epidemic in the region. Screening methods, such as serologic tests and chest imaging, can be appropriately used according to the patient's medical needs to reduce false-negative diagnoses and avoid missed diagnoses.<sup>[60,62,63]</sup>

## Management of the health-care environment and medical waste under normalized COVID-19 epidemic

### Air disinfection

According to the Management Specifications of Air-cleaning Techniques in hospitals (WS/T368-2012),<sup>[64]</sup> the frequency and duration of ventilation and air disinfection should be increased during the epidemic. At least a 30-min UV disinfection should be arranged between the two shifts of patients. Fresh air system devices will perform better in strengthening cleaning and disinfection, and increasing the frequency of air exchange. In contrast, areas that are incapable of being ventilated should be equipped with air purification and disinfection devices that can be used while persons still occupy the room. In the event of suspected or confirmed cases, air conditioning should be turned off immediately, while air purification and disinfection should be performed after the patients leave.

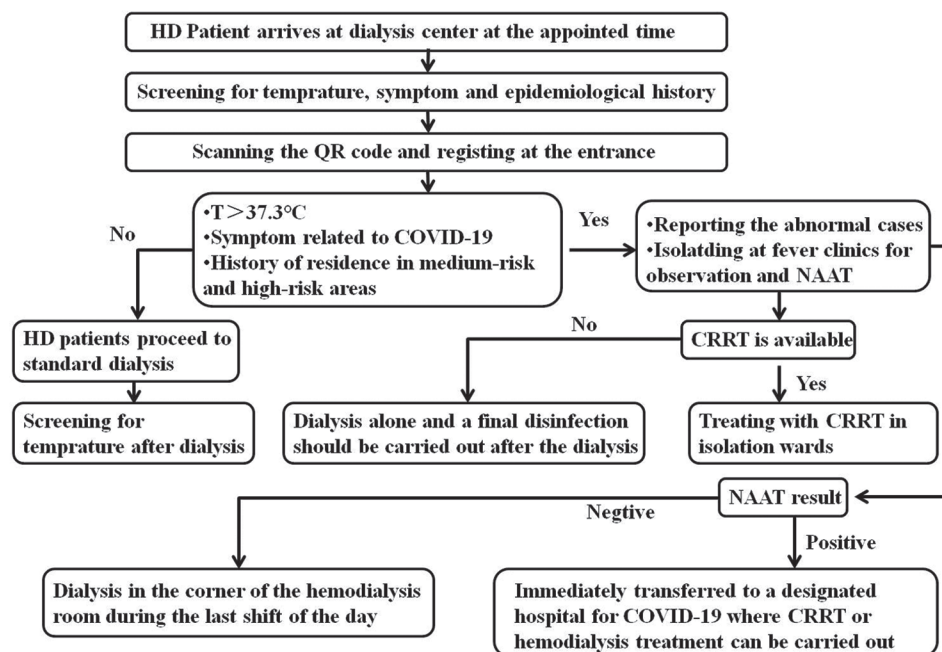
### Surface disinfection of objects

The regulation of Disinfection Techniques in Health-care Settings<sup>[24]</sup> (WS/T367-2012) and the Regulation for Cleaning and Disinfection Management of Environmental Surface in Healthcare<sup>[25]</sup> (WS/T512-2016) should be strictly followed during management, and implementation of the regulations should be supervised. Specific cleaning and disinfection methods are slightly different for different medical articles, but all follow the principle of using single-use equipment. In terms of disinfection and sterilization requirements, medical supplies, such as ventilators, threaded tubes of anesthesia machines, and humidifiers, should be cleaned with a disinfectant, dried, soaked in 500 mg/L chlorine-containing disinfectant containing effective oxygen for 30 min, washed with water, and dried before being sent to the disinfection supply center for further cleaning and disinfection.<sup>[65]</sup>

### Medical waste management

The requirements of the Regulations on the Management of Medical Waste,<sup>[66]</sup> Measures for the Medical Waste Management in Medical and Health Institutions,<sup>[67]</sup>





**Figure 1:** Prescreening and triage process for patients on maintenance hemodialysis. T, temperature; HD, hemodialysis; COVID-19, Coronavirus disease; NAAT, nucleic acid amplification test; CRRT, continuous renal replacement therapy.

Standards and Labeling of Medical Waste Packaging and Containers,<sup>[68]</sup> Catalogue of Medical Waste Classification,<sup>[69]</sup> and other relevant national regulations and documents should be strictly followed. On January 28, 2020, the Ministry of Ecology and Environment of the People's Republic of China printed and issued a Technical Guide for the Emergency Management and Disposal of Medical Waste in Novel Coronavirus Cases (Trial). The guidelines provide a technical route for the emergency disposal of medical waste. The guidelines highlight that local measures should be taken according to local conditions. To ensure the disposal effect, mobile medical waste disposal facilities, hazardous waste incineration facilities, household waste incineration facilities, industrial furnaces, and other facilities can be selected to deal with epidemic-related waste and implement the designated management. Infectious medical waste generated for the prevention of COVID-19 and other medical waste should be separated and managed separately and treated in accordance with the Standards and Labeling of Medical Waste Packaging and Containers Packaging.<sup>[70]</sup>

## Medical staff management under normalized COVID-19 epidemic

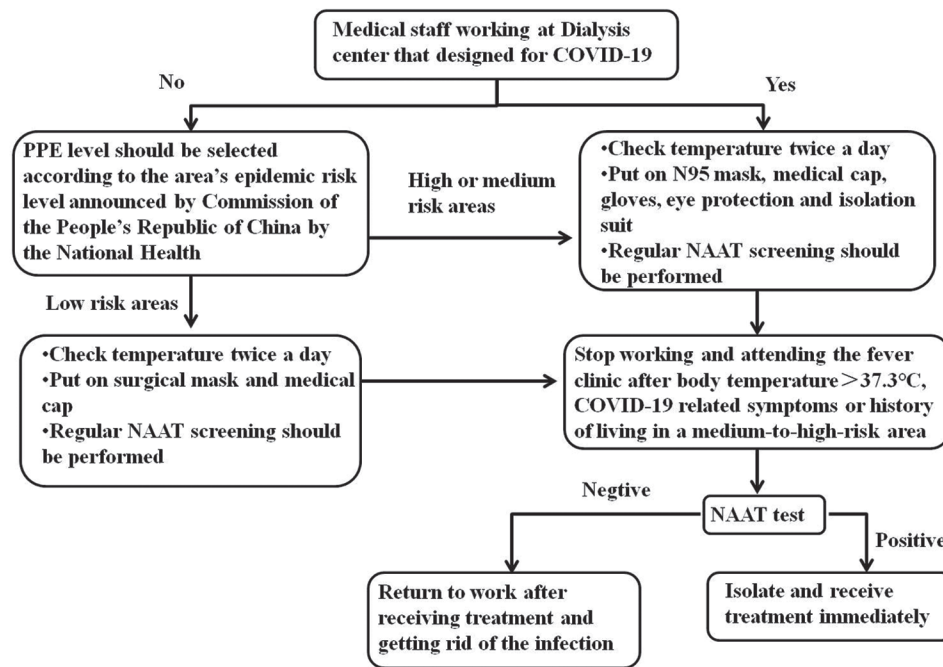
### Teamwork and emergency drills

Teamwork also plays a crucial role in the prevention and control of epidemics.<sup>[46,61]</sup> It is required among health-care workers, such as dialysis physicians, nurses, engineers, and essential workers. Regular training should be provided

regarding the latest clinical knowledge, prevention measures, and guidelines regarding the COVID-19 epidemic. Detailed emergency plans should be developed, and regular emergency drills should be performed.

### Personal protective equipment

Although the specific requirements of personal protective equipment (PPE) differ across the world, the importance of PPE in the prevention of COVID-19 is emphasized.<sup>[51-54]</sup> Medical staff should pay close attention to personal protection and strictly follow the requirements of the Technical Specifications for Hospital Isolation,<sup>[71]</sup> Technical Guidelines for Prevention and Control of COVID-19 Infection in Medical Institutions (First Edition),<sup>[19]</sup> and Specification of Hand Hygiene for Healthcare Workers (WS/T 313-2019).<sup>[72]</sup> The appropriate protection level should be selected according to the epidemic risk level of the area [Figure 2]. Medical staff working at dialysis centers designed for COVID-19 or high-medium-risk areas should wear N95 masks, medical caps, gloves, eye protection (face shields or goggles), and isolation suits. Meanwhile, medical staff working at dialysis centers not designed for COVID-19 could wear surgical masks and medical caps. Gathering for meals should be avoided. Precautionary measures should be adopted to avoid injuries from sharps, and appropriate protective equipment should be selected as a countermeasure to the possible risk of exposure during diagnosis, treatment, and care. In addition, the department should keep in stock PPE of adequate quality and quantity.<sup>[45,46]</sup>



**Figure 2:** Personal protective equipment for medical staff. COVID-19, Coronavirus disease; NAAT, nucleic acid amplification test; PPE, personal protective equipment.

### Health records

Health monitoring of all staff was recommended by various guidelines.<sup>[51,52]</sup> Doctors, nurses, engineers, and cleaners, in the department should perform self-testing.<sup>[61]</sup> Information should be reported electronically twice daily, as recommended. Personnel with any abnormalities in body temperature should be immediately removed from the work environment or medical intervention and isolated. Regular NAAT screening should be performed by medical staff once every 2–4 weeks; this recommended frequency can be adjusted according to the epidemic risk level in the area.

### Applying new technologies to deal with medical problems and difficulties caused by COVID-19

Digital technologies such as big data, artificial intelligence, and cloud computing should be adequately developed and applied to support epidemic surveillance and analysis, virus tracking, prevention, control, treatment, and resource deployment.<sup>[73]</sup> In Shanghai, various information technologies such as “Internet + Healthcare” and “AI technology + 5G network” were used to perform epidemic monitoring, prevention, control and treatment, disinfection and cleaning, resource deployment, and other measures during the COVID-19 epidemic; their use enhanced the efficiency and safety of the listed procedures.<sup>[74]</sup> Therefore, new technologies, such as the DataX tool, can be adopted in regular epidemic prevention and control and be used

to report and export data efficiently and accurately.<sup>[75]</sup> The dual-spectrum intelligent human body temperature measurement and health-care big data management system can rapidly measure body temperature without physical contact and perform facial recognition for persons wearing masks, facilitating the quick registration of personal information for real-time and retrospective tracking of population mobility.<sup>[76]</sup> These technologies also enable the statistical analysis of personal information and modeling and prediction of the development of the epidemic. The analysis results improved the precision and efficiency of epidemic prevention and control strategies.<sup>[61]</sup> An “Internet + pharmacy service” platform maximally utilized the advantages of the internet by operating remotely and without contact. Patients could receive diagnosis and treatment for their conditions and have medicine delivered to their homes without the need to go outdoors; this service saved patient time and minimized the risk of cross-infection.<sup>[77]</sup>

### The role and improvement of Wuhan Hemodialysis Quality Control Center during the COVID-19 epidemic

During the COVID-19 outbreak in Wuhan, WHQCC used network information technology to collect data. An epidemic data-monitoring platform was established, and an MHD map was plotted for macroscopic deployment during emergencies.<sup>[5,60]</sup> These technologies played a crucial role in the management and execution of MHD during the outbreak. The WHQCC continues to highlight its leadership

and coordinating role during epidemics by accelerating the improvement of quality control data platforms that collect and analyze data, thereby expediting the return to normalcy. The dialysis map function should be improved to perform intelligent triage to manage dialysis patients and fulfill their individualized needs, improve efficiency, and reduce the burden on medical workers. Moreover, the Hemodialysis Clinical Emergency Response Plan During Public Health Event (COVID-19) in Wuhan should be improved to provide guidance for emergency measures for MHD in case of unexpected public health events.<sup>[13]</sup>

## CONCLUSION

Special attention should be paid to patients on MHD during epidemics as they are a high-risk population.<sup>[78]</sup> The epidemic risk level worldwide is changing dynamically. Moreover, epidemic prevention and management protocols are normalizing in China. Therefore, our study summarizes prevention and response measures for MHD patients, facilities, and medical staff in the normalized epidemic situation of COVID-19. The WHQCC established a working plan for regular epidemic prevention and control. However, MHD management in the context of persistence of the epidemic should be explored. These actions will help expedite the return to normalcy, consolidate treatment quality, improve the survival of dialysis patients, reduce the COVID-19 infection rate, and safeguard the public's safety and health. Technical approaches to epidemic prevention and control should also be updated with changes in COVID-19 global epidemiological information and research. The epidemic prevention and management measures for MHD patients summarized in this paper are only for the reference of single dialysis centers, and will be subsequently updated, as necessary.

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## Conflicts of interest

Fei Xiong is an Editorial Board Member of the journal. The article was subject to the journal's standard procedures, with peer review handled independently of this member and his research group.

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