Prevention and treatment system of novel coronavirus infection in medical and health institutions: experience in West China Hospital of Sichuan University

Qiao Zhou ,[1] He Yu,[1] Zong-An Liang,[1] Rong Yao,[2] Feng-Ming Luo,[1] Dan Liu,[1] Ting Wang,[1] Zhong Ni,[1] Ce-Jun Zhong,[3] Xiao-Dong Jin[4]

ABSTRACT

The novel coronavirus infection broke out in Wuhan, China, in December 2019, and progressed to a global pandemic. We describe the measures taken by West China Hospital of Sichuan University to address the diagnosis, prevention and treatment of the infection.

INTRODUCTION

At the end of December 2019, pneumonia of an unknown cause was reported in Wuhan, China. Later research found that it was infectious and could spread rapidly through human to human transmission.[1–3] The cause of the epidemic was named 2019-nCoV by the World Health Organization (WHO) on 12 January 2020, and on 11 February 2020 it was officially identified as severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2) by the International Committee on Taxonomy of Viruses. On the same day, the WHO named the disease caused by the virus, coronavirus disease-19 (COVID-19).

On 30 January 2020, the WHO officially classified the epidemic as an international public health emergency. Based on its four characteristics of emergency, urgency, high uncertainty and wide social impact, this declaration from the WHO requires medical and health institutions at all levels not only to complete normal medical work, but also to undertake prevention and medical treatment of the epidemic public health emergencies.[4]

[1]Department of Respiratory and Critical Care Medicine, West China Hospital of Sichuan University, Chengdu, Sichuan, China
[2]Emergency Department, West China Hospital of Sichuan University, Chengdu, Sichuan, China
[3]Infectious Disease Department, West China Hospital of Sichuan University, Chengdu, Sichuan, China
[4]Department of Intensive Care Unit, West China Hospital of Sichuan University, Chengdu, Sichuan, China

Correspondence to Dr Zong-An Liang, West China Hospital of Sichuan University, Chengdu, Sichuan, China; liangza@scu.edu.cn

West China Hospital of Sichuan University is located in Chengdu, Sichuan province, China. It is the largest hospital in southwest China, equipped with 4300 beds, and is the medical referral centre in Sichuan province. It was also the targeted medical institution for the novel coronavirus infection. West China Hospital of Sichuan University formulated a system for epidemic prevention and medical treatment in fighting the novel coronavirus infection, which is described here.

GENERAL ARRANGEMENT FOR EPIDEMIC PREVENTION

Fever clinics

Two 24 hour fever clinics were set-up to assess possible COVID-19 patients. Before the fever clinics opened, the hospital organised training for all, explaining the screening process of patients with fever or an epidemiological history, the key points related to detection of the virus, admission standards and process, and personal protective measures. The hospital designated a specific route from the entrances of the outpatient and emergency departments to the fever clinic, and from the fever clinic to the laboratory.

From 8:00 to 22:00 each fever clinic was staffed with two doctors from the respiratory, infectious diseases and general practice department. From 22:00 to 8:00, each fever clinic was staffed with one doctor from the emergency department. Doctors in the fever clinic were responsible for ordering and interpreting tests from suspected COVID-19 cases and determined the need for hospitalisation. Patients with a fever or other respiratory symptoms or an epidemiological history underwent the following investigations: blood routine, blood biochemistry, blood gas analysis, influenza A and B testing, respiratory viral panel for 13 viruses and chest imaging. In order to avoid cross infection, the laboratory separated body fluid specimens from suspected patients from those of other patients, and there was a dedicated CT room for examination of suspected infectious patients.

If screening was positive (including high inflammation index, lower absolute lymphocyte value, hypoxaemia and chest imaging lesions), the patient was admitted to hospital immediately for isolation and nucleic acid testing. Two nucleic acid tests were performed: one immediately on entry to hospital and a second not less than 24 hours later.

In China, all returning workers were required to be screened for COVID-19 to avoid group spread of the infectious disease. If the returning workers were asymptomatic, they were screened for COVID-19 in the general clinic and waited for the results of the nucleic acid test in a tent outside the emergency department of the hospital or in the fever clinic. Generally it took 6 hours for the screening results, including routine results and the nucleic acid test, and workers were required to keep a distance of not less than 1 m from others and to wear a surgical mask while waiting. If the screening tests for COVID-19 infection were negative, they were discharged without a second nucleic acid test, but if the testing was positive, the workers were hospitalised and a second nucleic acid test was performed.

Nucleic acid testing is the gold standard for the diagnosis of COVID-19; deep sputum is preferred but if there was no sputum, three specimens from a nasal swab, throat swab and stool were taken. In our hospital, we used the respiratory multi virus nucleic acid (six viruses) testing kit, which includes novel coronavirus, developed by our hospital.

Isolation

About 10 days after the outbreak, the hospital emptied 402 beds in three inpatient buildings for isolation purposes. Three floors of one building were designated as confirmed COVID-19 wards, two floors of another building as suspected wards and one floor of the third building was used for buffer wards. All suspected cases waiting for nucleic acid results were isolated in single rooms in the suspected COVID-19 wards. If at least one of the two nucleic acid results was positive, the patient was transferred to the confirmed wards (even if they were asymptomatic), in either a single or double room. Otherwise they were transferred to the buffer wards. Close contacts of the confirmed

patients were immediately required to isolate in single rooms in the suspected wards, and received nucleic acid testing twice (not less than 24 hours apart). All suspected cases, especially those with pulmonary imaging lesions and clinical symptoms, with two consecutive negative nucleic acid test results were placed in the buffer wards. Shen[5] found that the false negative rate of nucleic acid testing was significantly reduced if the test was performed twice (not less than 24 hours apart), but performing three tests was better if possible.

Triage in the entrances of the outpatient and emergency departments

There were three public entrances for patients to our hospital: emergency department, outpatient department and fever clinic. In order to detect suspicious cases outside the fever clinic, triage stations were set-up at the entrances of the outpatient and emergency departments. The triage nurse, wearing a surgical mask, gloves, goggles, a face shield and medical protective clothing, took body temperatures using an infrared thermometer, and performed a clinical symptom and epidemiological history of all patients and personnel on a 24 hour basis. Suspicious patients were required to wear a medical surgical mask and perform hand hygiene. The triage nurse contacted the nurse from the fever clinic, and the fever clinic nurse immediately escorted those suspected patients from the triage station to the fever clinic for further screening (ie, laboratory and chest imaging examinations).

Emergency medical services

A nurse at the emergency nurse station monitored calls from patients on China's emergency phone number (120) on a 24 hour basis. The nurse asked the caller about body temperature, clinical symptoms and epidemiological history. For patients suspected of having COVID-19, a standard ambulance was sent with an emergency physician, nurse, paramedic and negative pressure stretchers to transfer them from home to hospital. For patients who were already known to be COVID-19 positive and needed to be transferred to our hospital because of deterioration of their condition, standard ambulances were replaced by negative pressure ambulances. After arrival at the hospital, patients were placed in the isolation room in the emergency department to be stabilised, and to undergo further screening. Once their emergency condition had stabilised, patients with suspected COVID-19 were hospitalised to wait for the results of testing. Patients with positive results were transferred to the confirmed wards. If the test came back while the patient was in the emergency department and it was negative, they are transferred to the buffer wards.

Online consultation and psychological intervention hotline

In the face of an epidemic, the public is generally anxious. In order to prevent novel coronavirus infection from spreading, reduce psychological pressure and guide patients to seek medical advice, on 26 January the hospital opened a 'novel coronavirus pneumonia online consultation and psychological intervention hotline'. According to our statistics, 202 doctors provided consultations to 7120 patients online and 137 doctors provided telephone consultations for 915 patients by 18 February. If patients reported symptoms of COVID-19 during the consultation process, they were recommended to go to the nearest fever clinic for further screening.

Nosocomial infection prevention

The infection control department provided bespoke training for the whole hospital. The training included diagnosis and treatment of novel coronavirus infection, how to collect epidemiological history and body fluid specimens, the epidemic reporting process and protection skills; the training was made into videos for all working staff. For high risk areas, such as the infectious diseases, respiratory and emergency departments, we launched on-site training and observation, and evaluation of staff wearing protective equipment and hand disinfection. In addition to strictly implementing the protection of medical personnel to avoid cross infection, additional disinfection of the environment and facilities were necessary. As of writing, we are unaware of any cross infection between medical staff and patients in the hospital.

TREATMENT

According to the guidance of the National Health Council, patients received treatments based on their condition (mild, moderate, severe or critical), carrying out 'one person, one case' precision treatment, and adjusting the treatment plan according to changes in the patient's condition. For those with mild and moderate conditions, the combination of traditional Chinese and Western medicine was used, mainly for antiviral and symptomatic treatment. Specifically, antiviral therapy mainly included ribavirin, lopinavir/ritonavir, interferon, arbidol and hydroxychloroquine. Treatment with traditional Chinese medicine is complex because it is a mixture of dozens of herbs and needs guidance from doctors with experience in traditional Chinese medicine. Antibiotics were commonly used, especially quinolones, if there was bacterial infection. Symptomatic treatment mainly included oxygen therapy, antipyretics, cough medicine and expectorants, but for severe and critical patients, rehydration, thymosin, immunoglobulin, plasma transfusion, hormone and respiratory support were added.

The condition of severe and critical patients, who often had comorbid conditions, could change rapidly, often leading to multiple organ failure over a short period of time. Therefore, we developed a multidisciplinary team (MDT) including members from: the intensive care unit; respiratory, infectious diseases, nephrology, cardiology and neurology departments; laboratory medicine; radiology department; pharmacy department; department of traditional Chinese medicine; mental health centre; departments of nutrition and rehabilitation; and respiratory therapists. The respiratory department, intensive care unit and respiratory therapists were mainly responsible for the management of patients' respiratory and circulatory support. The infectious diseases department mainly consulted on the treatment of viral and secondary bacterial infections. Food or enteral feeding was provided to improve nutrition, and the department of rehabilitation began early exercises while the patient was on the ward. The pharmacy coordinated deployment of required drugs. The MDT discussed and analysed the daily clinical situation and disease trend of severe and critical patients every day, and patients received treatment based on an individualised plan made by the MDT.

Discharge and follow-up of recovered patients

Our discharge standards required that body temperature was normal for more than 3 days, respiratory symptoms had disappeared completely, chest imaging had recovered completely, laboratory indicators were normal and the nucleic acid test for COVID-19 was negative on two consecutive days. The length of hospital stay for patients with mild disease was about 12 days, and for critical patients, 18 days. When patients who recovered

met the standards for discharge, we were in contact with community medical teams to share their medical records and we continued to track the discharged patients by telephone call or online. By tracking them we found that there was a higher risk of infection with other pathogens after discharge, and research[6] suggested this may be related to low immune function during the recovery period. Therefore, we suggested that discharged patients should remain isolated at home for 14 days, wearing a mask, keeping their hands clean, avoiding going out, eating separately and living in a single room with good ventilation. They were required to monitor and record their health condition, including taking their body temperature every day and noting any clinical symptoms. We found that in a small number of patients, repeat nucleic acid tests were positive after discharge. Therefore, we recommended nucleic acid testings 2 and 4 weeks after discharge even if there were no clinical symptoms. If nucleic acid testing was found to be positive, they would be treated again in the targeted hospital; otherwise isolation at home would be removed.

REMOTE CONSULTATION

Patients with novel coronavirus infection were distributed across 21 different hospitals in Sichuan province, and our hospital provided guidance on diagnosis and treatment for severe and critical patients in these units. Because of the constraints of natural geographical conditions in Sichuan province (many mountainous areas, inconvenient transportation) and the constraints of medical services in some mountainous areas (lack of medical professionals, and diagnostic and treatment capability), wireless remote consultation played an important role. On 26 January, our hospital took the lead in launching wireless remote multidisciplinary consultation to treat severe and critically ill patients in other hospitals. As of writing, wireless remote consultation has covered five provincial, 24 municipal and 179 county hospitals, including all hospitals that have received patients. As of 25 February, 347 cases of wireless remote multidisciplinary consultation were performed.

Technical support of scientific research

SARS-CoV-2 is a new emerging pathogen, and problems such as storage, pathogenesis and vaccine still need to be explored and resolved. Thus scientific research is needed to fill the knowledge gap and resolve the clinical problems.[7] The West China Hospital has launched emergent scientific research projects at the national and provincial levels, and used technical research to tackle clinical problems, such as early detection and treatment of novel coronavirus infection. We established a large data research platform of disease epidemiology, and a precision diagnosis research and development platform within 1 month. We issued urgent recommendations based on expert consensus of novel coronavirus infection, such as epidemic prevention and respiratory support therapy, to all medical health institutions in China. A novel coronavirus recombinant protein vaccine developed by our State Key Laboratory of Biotherapy is being tested in animal experiments.

CONCLUSION

For novel coronavirus infection, we emphasised 'early detection, early diagnosis and early isolation', so that highly suspicious patients were hospitalised and confirmed patients received timely treatment on a case by case basis. As of writing, the death rate from the novel coronavirus infection was 0.5% in Sichuan province compared with a death rate of 3–15% reported in other areas.[8–10] Strict isolation procedures to avoid cross infection, early examination and diagnosis, admission to hospital as soon as possible once diagnosed, and individualised patient treatment, with the help of multidisciplinary consultation, seem to have contributed to this outcome. We suggest that more medical institutions learn and share knowledge of the novel coronavirus infection, and provide help to medical institutions with fewer resources to achieve joint prevention of the global epidemic. It is hoped that these experiences will be helpful for future public health emergencies.

Acknowledgements The authors thank the staff of West China Hospital of Sichuan University, including the doctors, nurses, respiratory therapists, laboratory researchers, medical students, as well as cleaners and electronic equipment personnel. After the outbreak, they gave up their vacation voluntarily to fight on the front line. Some medical staff were sent to the public health clinical centre in Chengdu and the targeted hospital in Wuhan to treat patients infected with COVID-19.

Contributors QZ and HY contributed equally to this work and are co-first authors. Z-AL is the corresponding author. Other authors had experience of resisting COVID-19 infection. ZQ and YH contributed equally to this work and should be considered co-first authors Z-AL is the correspondence author of this review. Other authors have self-experience in resisting novel coronavirus infection.

Funding This work was supported by the Novel Coronavirus Emergency Projects of Sichuan Science and Technology Office (grant No 2020YFS0005, grant No 2020YFS0009).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Handling editor Edward Carlton

QZ and HY contributed equally.

QZ and HY are joint first authors.

To cite Zhou Q, Yu H, Liang Z-A, *et al*. *Emerg Med J* 2020;**37**:639–641.

Received 17 March 2020
Revised 25 June 2020
Accepted 4 July 2020
Published Online First 25 August 2020

Emerg Med J 2020;**37**:639–641.
doi:10.1136/emermed-2020-209622

ORCID iD
Qiao Zhou http://orcid.org/0000-0003-0018-6901

REFERENCES

1 Chan JF-W, Yuan S, Kok K-H, *et al*. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet* 2020;395:514–23.
2 Wu JT, Leung K, Leung GM. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. *Lancet* 2020;395:689–97.
3 Wang D, Hu B, Hu C, *et al*. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 2020;323:e201585:1061.
4 Patel A, Jernigan DB, *et al*, 2019-nCoV CDC Response Team. Initial public health response and interim clinical guidance for the 2019 novel coronavirus outbreak - United States, December 31, 2019-February 4, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:140–6.
5 Shen N, Zhu Y, Wang X, *et al*. Characteristics and diagnosis rate of 5630 subjects receiving SARS-CoV-2 nucleic acid tests from Wuhan, China. *JCI Insight* 2020;5:e137662.
6 Lin L, Lu L, Cao W, *et al*. Hypothesis for potential pathogenesis of SARS-CoV-2 infection-a review of immune changes in patients with viral pneumonia. *Emerg Microbes Infect* 2020;9:727–32.
7 Shanmugaraj B, Malla A, Phoolcharoen W. Emergence of novel coronavirus 2019-nCoV: need for rapid vaccine and biologics development. *Pathogens* 2020;9:E148.
8 Wang C, Horby PW, Hayden FG, *et al*. A novel coronavirus outbreak of global health concern [published correction appears in Lancet]. *Lancet* 2020;395:470–3.
9 Read JM, Bridgen Jessica RE, Cummings DAT. Novel coronavirus 2019-nCoV: early estimation of epidemiological parameters and epidemic. *medRxiv [Preprint]* 2020:1–8.
10 Huang C, Wang Y, Li X, *et al*. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020;395:497–506.