

Management Strategies of Ultrasound Department in Response to the Epidemic Crisis

Jie Chen, MD ^a, Bo Zhang, MD ^{a,*}, Mo Yang, MB ^a, Yan Tian, MD ^a, Dandan Guo, MS ^a, Boya Wang, MD ^a, Weidan Lu, MS ^a, Jiaojiao Ma, MS ^a, Cui Zhao, MB ^a, Shuliang Zang, MB ^a, Jianya Wang, MB ^a

^a Department of Ultrasound, China–Japan Friendship Hospital, Beijing, China

Received April 01, 2020; revision received April 014, 2020; accepted April 15, 2020.

Objective: The coronavirus disease (COVID-19) epidemic occurred suddenly, and had a severe impact on the whole society, especially the health care system. The purpose of this article is to share the experience of infection control management in the ultrasound department of China–Japan Friendship Hospital in response to the epidemic.

Methods: In accordance with relevant academic guidance and consensus guidelines, the ultrasound department followed principles of prevention and control which were promulgated by the hospital, combined management measures with the characteristics of ultrasound diagnosis and treatment, to control infection during the epidemic period. These measures included reducing the number of patients and doctors, using targeted protection standards in different work areas, and strengthening the training of staff in the department.

Results: During the epidemic in February to March 2020, the ultrasound department completed a total of 10,719 cases in the outpatient area (a decrease of 68.3% compared with the same period last year) and 1,583 cases from emergency (including 53 cases from the fever clinic). While the clinical needs were met, there was zero infection with COVID-19 of all health care staff in the ultrasound department during the epidemic.

Conclusions: We hope the valuable experience of infection control management in our ultrasound department in response to the epidemic can help global ultrasound doctors be prepared for the pandemic. The teams of ultrasound departments should also work closely with local infection control colleagues to implement measures that are appropriate for their own clinical settings to overcome the pandemic.

Key words: COVID-19; Ultrasound management; Infection control

Advanced Ultrasound in Diagnosis and Therapy 2020;02:090-098

DOI: 10.37015/AUDT.2020.200032

In December 2019, a novel coronavirus emerged in Wuhan, China, called COVID-19, and then spread rapidly across China and the world [1,2]. The main clinical manifestations of COVID-19 are fever, dry cough and fatigue. Severe patients have dyspnea and/or hypoxemia. The main route of transmission is respiratory droplets and close contact, while aerosol transmission may exist in relatively closed environment [3]. On January 20, 2020, the first case of novel coronavirus-infected pneumonia was confirmed in Beijing. On January 24, Beijing initiated a first-level response to this

major public health emergency. Considering the strong ability of transmission of COVID-19 [4], hospitals quickly established measures to prevent nosocomial infections, such as transmission between doctors and patients, or among health care staff.

Ultrasound departments at hospitals in China, are usually densely populated and interact with patients from various departments, including infected patients, suspicious patients, fever patients and common patients. During the examination, the doctor and patient need to be in close contact. Therefore, it was important to

* Corresponding Author: Department of Ultrasound, China–Japan Friendship Hospital, No. 2, Yinghua Road, Beijing, 100029, China
e-mail: zora19702006@163.com

2576-2508/© AUDT 2020 • <http://www.AUDT.org>

This is an open-access article distributed under the terms of the [Creative Commons Attribution 4.0 International license](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium provided that the original work is properly attributed.

accomplish daily medical affairs in ways that reduced the risk of infection and to develop unique and practical workflows and protection against the epidemic. The Beijing Ultrasound Medical Quality Control and Improvement Center provided direction in its “Guidance on Prevention and Control of Novel Coronavirus Infection in Department of Ultrasound” [5]. However, currently there have been few reports on practical experience in ultrasound departments.

China-Japan Friendship Hospital is a large-scale comprehensive tertiary A-level hospital directly affiliated with China's Ministry of Health. It accepts common outpatients, emergency patients, and patients from the fever clinic. During the COVID-19 epidemic, it also undertook the responsibility of screening and treatment for suspected patients, identifying confirmed cases and referring them to COVID-19 treatment hospitals in Beijing, in addition to conducting diagnosis and treatment for other common cases. For this emergency public health event, China-Japan Friendship Hospital quickly established prevention and treatment working leading groups, including a comprehensive coordination group, medical treatment group, hospital infection/control group, and support-safeguard group. Staff of the ultrasound department of the hospital quickly set up a management team to deal with the epidemic. The main responsibilities of the team included: strengthening contact and communication with the management department of the hospital; establishing a strict prevention and control system; getting a full knowledge of the number of ultrasound staff and patients, and formulating corresponding protection measures; reserving and transferring medical protective resources; setting up a daily report system; clarifying the details of work contents of the ultrasound department; and adjusting and responding to loopholes when they were discovered.

As an imaging department, an ultrasound department's working fields include routine examinations for outpatients, emergency patients, and fever patients, as well as bedside examinations and ultrasound guided intervention. While the epidemic continued for more than two months, the ultrasound department of China-Japan Friendship Hospital successfully completed each ultrasonography and ultrasound-guided treatment with no infection of the health care staff. This article summarizes management strategies that the ultrasound department used against the epidemic, with the aim that it might help ultrasound doctors working around the world to prepare.

Personnel Density Control

Actively controlling the number of patients and doctors

The outpatient area of the ultrasound department received common outpatients and patients from wards

by appointment. In the early stage of the epidemic, January 25 coincided with the Chinese Spring Festival, and the ultrasound outpatient area was closed. After the holiday, through the ordinary appointment of the hospital, the ultrasound department received 227 patients in the outpatient area on February 3. Considering increasing cross infection risk when the waiting patients gathered, the management group of the ultrasound department decided to control the number of patients and reduce the personnel density through the following methods: staff of ultrasound department contacted the patients who had made an appointment of ultrasonography, and after comprehensively assessing the urgency of the examination, some appointments were cancelled; medical procedures that posed a high-risk for infection, such as ultrasound intervention and ultrasound-enhanced contrast were suspended; in addition, staff of ultrasound department communicated with the clinicians and recommended reducing unnecessary ultrasound examinations. At the same time, appropriate adjustments were made according to the change of the epidemic situation.

After these adjustments, the density of personnel in the outpatient area was effectively controlled. From Feb 5 to Feb 29, 112 patients were received per day in the outpatient area, compared with an average of 498 patients per day in February 2019. As the domestic situation of the epidemic continued to improve, the department adjusted its responses following the gradual returning to work of the hospital. While meeting the clinical needs, the number of patients was still scientifically controlled. Table 1 show the workloads of the outpatient area of the ultrasound department in the past 24 months. The workloads in February 2020 and March 2020 decreased significantly after the adjustment by the ultrasound department and the hospital during the epidemic.

In the early stage of the epidemic when the situation was unclear, while reducing the number of patients, the number of doctors in the outpatient area was greatly reduced in the ultrasound department. At first, the positions on duty of the outpatient area were reduced from 28 per day to 10 per day, at a decrease of 64.2%, while the emergency ultrasound was still on duty 24 hours. At the same time, indispensable positions such as prenatal screening, bedside ultrasound, ultrasound guided intervention for emergent or critical illness were left to meet the clinical needs. The scheduling was changed from originally once a month to once every week. Considering that COVID-19 was a greater threat to the elderly, the attendance of doctors over the age of 50 was suspended until the overall situation of epidemic in Beijing improved. After that, according to the requirements of the hospital, the gradual recovery of medical diagnosis and treatment was started.

Table 1 Workloads of ultrasound outpatient area in the past 24 months

Latest 12 months	Workloads (number of patients)	Latest 13-24 months	Workloads (number of patients)
April 2019	21347	April 2018	17886
May 2019	18386	May 2018	19596
June 2019	18254	June 2018	17644
July 2019	20062	July 2018	18431
August 2019	18570	August 2018	18431
September 2019	18822	September 2018	17777
October 2019	17985	October 2018	15682
November 2019	19412	November 2018	19296
December 2019	21192	December 2018	18695
January 2020	14347	January 2019	18343
February 2020 *	2507	February 2019	13963
March 2020 *	8212	March 2019	19946

* Indicates the workloads in February 2020 and March 2020 when the number of patients was controlled during the epidemic

Comparison of the workloads of the ultrasound outpatient area from April 2019 to March 2020 and the same period one year ago. In January 2020 and February 2019 which included the Spring Festival, usually the workloads were supposed to decrease, but they were still more than those of February 2020 and March 2020.

Realizing the shunting of patients

In order to strictly control the number of patients waiting in the ultrasound department, management measures of shunting patients by separating them in primary and secondary waiting areas were implemented in the outpatient area. The corridor outside the gate of the ultrasound department was the primary waiting area, and the area inside the gate was secondary. The patients entering the secondary waiting area were managed in batches according to the appointment time of the day. In principle, only patients themselves were allowed to enter the secondary waiting area, although one person was allowed to accompany a patient with a mobility disorder and the special situations were handled by nurses at their discretion. When entering the secondary waiting area, all patients and care-providers were required to wear masks and use wash-free hand sanitizer for disinfection. To make sure that there was one patient in one examination room, patients in the secondary waiting area could enter the examination room only when they were called by the doctor. Patients had to keep a distance of more than one meter while waiting.

The management of the ultrasound outpatient area was difficult. The source of outpatient patients was various, and included a hidden danger of nosocomial infection. In order to reduce the risk of infection, after the screening by other departments, when the patients were accepted by the ultrasound department for

ultrasonography, their temperature were screened and necessary medical history investigation was conducted again. The outpatient area had only one entrance and exit, where a specially assigned staff measured forehead temperature to ensure that the body temperature of all the people entering this area was normal ($<37.3^{\circ}$). If the body temperature was $\geq 37.3^{\circ}\text{C}$ or symptoms were suspicious, the outpatient management team should immediately report to the infection control group of the department and the infection control office of the hospital. Patients with fever were required to visit the fever clinic for screening and therapy before ultrasound examination. The examination flow of patients in the outpatient area of the ultrasound department is shown in Figure 2. Patients scheduled for contrast-enhanced ultrasound or ultrasound-guided intervention completed a preliminary screening questionnaire in advance (Appendix 1) to make sure that the risk of infection was excluded before relative diagnosis and treatment.

During the epidemic in February to March 2020, the ultrasound department completed a total of 10,719 cases in the outpatient area (a decrease of 68.3% compared with the same period last year), and 1,583 cases from emergency (including 53 cases from the fever clinic). Although the hospital received 10 patients with a confirmed diagnosis of COVID-19, the health care staff in the ultrasound department experienced zero infection of COVID-19.

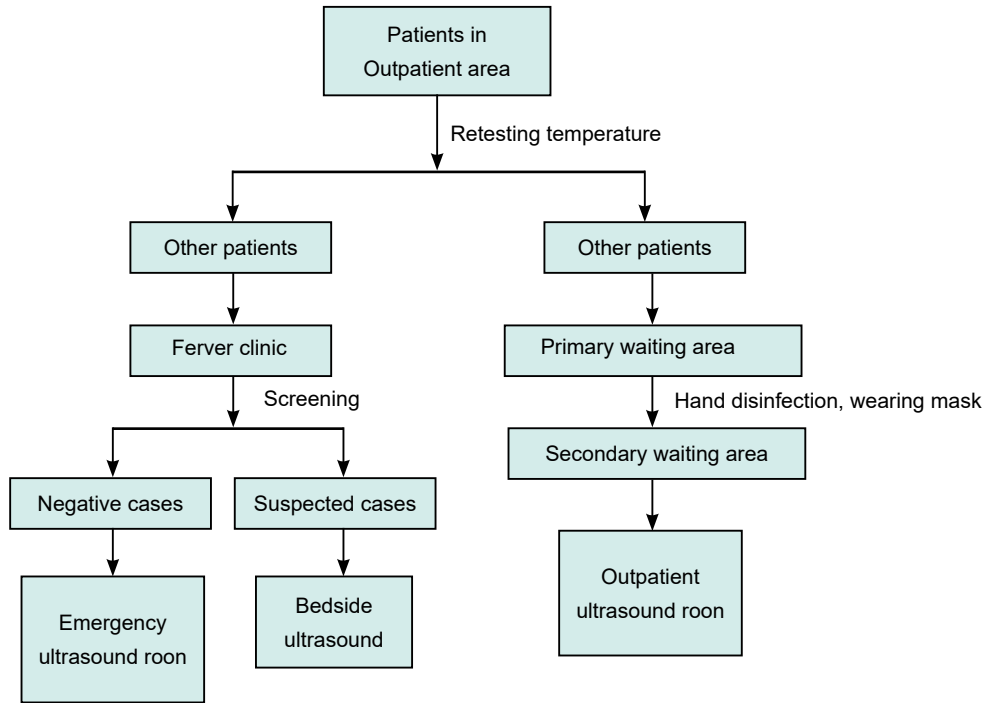


Figure 1 Examination flow of patients in outpatient area of ultrasound department

Establishing Protective Measures in Different Working Areas against the Potential Infection

In accordance with "Guidelines for the Use of Common Medical Protective Products in the Prevention and Control of Novel Coronavirus-infected Pneumonia (Trial)" and "China-Japan Friendship Hospital Management Regulations on Medical Protective Products

During the Epidemic of Novel Coronavirus-infected Pneumonia" [5,6], staff in the department of ultrasound were protected by the principles of standardized accuracy, ensuring safety, and eliminating waste.

According to different exposure risk of novel coronavirus in different working areas, targeted protective standards for each position were formulated in the ultrasound department (Table 2).

Table 2 Protective standards and requirements in different working areas facing different patients

Protection standard	Patients (working area)	Specific requirements
First-level protection	Common outpatients and inpatients (outpatient ultrasound area) Common inpatients (bedside ultrasound)	Wearing working caps, disposable medical surgical masks and working clothes (white coats); when doctors contacting with blood of common patients, such as body fluids, secretions, or excreta, they should wear disposable latex gloves; during bedside ultrasound examination the protective face screen/protective glasses (anti-fog) could be added
Second-level protection	Patients from emergency, fever clinic (emergency ultrasound) Patients from high infection risk department (bedside ultrasound)	Wearing disposable working cap, protective mask/goggles (anti fog type), medical protective mask (N95 mask), protective clothing or disposable impermeable isolation clothing, disposable latex gloves
Third-level protection	Suspected/confirmed patients (bedside ultrasound-guided intervention)	Wearing disposable working cap, medical protective mask (N95 mask) plus disposable surgical mask or full-scale respirator/positive pressure head cover, protective clothing (plus disposable impermeable isolation clothing), disposable latex gloves, medical waterproof boots or disposable waterproof shoe covers

First-level protection was provided for the health care staff in outpatient area of ultrasound department who accepted patients from common outpatients and wards, and health care staff applying bedside ultrasound

for patients from common wards. The protective measures included wearing working caps, disposable health care surgical masks and working clothes (white coats); doctors should wear disposable latex gloves

when in contact with blood, body fluids, secretions, or excreta of common patients; during bedside ultrasound examination, a protective face screen/protective glasses (anti-fog) could be added.

Emergency ultrasound doctors were expected to carry out second-level protection when receiving patients from emergency and the fever clinic. They should also use second-level protection during bedside ultrasound for patients from departments with high infection risk. These protective measures included wearing disposable working cap, protective mask/goggles (anti-fog type), medical protective mask (N95 mask), protective clothing or disposable impermeable isolation clothing, and disposable latex gloves.

Doctors dealing with suspected/confirmed patients who needed bedside ultrasound-guided intervention were expected to carry out third-level protection, including wearing disposable working cap, medical protective mask (N95 mask) plus disposable surgical mask or full-scale respirator/positive pressure head cover, protective clothing (plus disposable impermeable isolation clothing), disposable latex gloves, and medical waterproof boots or disposable waterproof shoe covers.

At the same time, the protective measures of bedside ultrasound doctors were also adjusted for different departments and patients if necessary. For the bedside ultrasound of patients in high infection risk departments (e.g., emergency, the fever clinic, emergency observation room, respiratory department, infectious disease department, intensive care unit), ultrasound doctors were required to communicate with the patients' clinical doctors in advance to decide whether to strengthen protective measures, and the level of protection should be the same as the clinical doctors. Ultrasound examination and ultrasound-guided intervention treatment of suspected/confirmed patients were performed at the local bedside of the isolation ward to avoid bringing novel coronavirus to the environment of ultrasound department. To prevent cross infection, in nonurgent conditions, bedside ultrasound doctors first visited departments of low infection risk and then visited departments of high infection risk. On February 4, one doctor in the ultrasound department performed a bedside ultrasound for a patient infected with H1N1 in Intensive Care Unit, and strictly implemented the protective measures according to the above scheme. After novel coronavirus was detected in the bronchoalveolar lavage fluid of the patient, the ultrasound doctor was placed under strict medical observation until potential COVID-19 infection was excluded. This case strongly proved the effectiveness of the protective measures of bedside ultrasound.

Emergency examination was also part of the

daily work in the ultrasound department. Emergency ultrasound was very important for clinical diagnosis and for examinations that could not be selected or delayed. Therefore, ultrasound doctors needed to be strictly protected to fundamentally eliminate nosocomial infection. The emergency ultrasound room of our hospital specially, which received patients from emergency and the fever clinic, was equipped with two color doppler ultrasound instruments and staffed by one doctor by day and night shift turn. According to the emergency area management plan of the hospital, patients coming to the emergency ultrasound room were consulted for the symptoms, such as fever and epidemiological history, and the fever patients had to be screened for COVID-19 by the fever clinic which provided a screening letter (Appendix 2) if novel coronavirus-infected pneumonia was excluded. In principle, the emergency ultrasound room only allowed the patient himself/herself to enter, and only one person was allowed to assist if necessary, so as to reduce unnecessary contact. All patients and their assistant entering the emergency ultrasound room had to wear masks. Emergency ultrasound doctors strictly implemented hand hygiene (the seven steps washing technique) in addition with second-level protection.

Environmental partition

The ultrasound department was divided into three areas: clean area, buffer area, and polluted area [7]. The office, teaching room, warehouse and bathroom were clean areas. The service desk, corridor and work clothes replacement area were buffer areas. The waiting hall and examination room were polluted areas. Different management measures of prevention and control were implemented for each district. The cleaning area was mainly used for health care staff to rest, eat, and change personal clothes. It was strictly prohibited for patients, family members and other irrelevant personnel to enter this area. Working clothes, masks, hats, gloves, and shoe covers used in the clinic were not allowed to be brought into the cleaning area. The buffer area was mainly used by health care staff to prepare for wearing and hand hygiene before work. At the same time, it served to avoid bringing the virus directly into the clean area when returning directly from the polluted area.

Strengthening environment disinfection and instrument disinfection

Disinfection of the environment in the ultrasound department

(1) Air purification: A window should be opened for ventilation twice a day for 30 minutes. At the end of each day after work, ultraviolet irradiation should be kept for 30-60 minutes or 500mg/L chlorine disinfectant should

be applied for reaction no less than 30 minutes. After the examination for fever patients, immediate disinfection with ultraviolet or chlorine disinfectant should be completed (Fig. 2).

(2) Floor, floor mat and hand washing basin: 1000mg/L chlorine disinfectant should be used by wiping. After 30 minutes of reaction, clean water should be used to wipe and remove residues. This process should be done once every 6 hours, at least twice a day.

(3) Object surface with highly frequent contact ((e.g., desktop, door handle, telephone, wall switch): 75%

alcohol was used to wipe and disinfect once every 6 hours, at least 3 times a day. After 3 minutes of reaction, a dry cloth should be used for wiping.

(4) Medical items: Disposable bed sheets and pillowcases should be used. The bed sheets and pillowcases should be replaced at least once half a day, and should be replaced immediately after being damaged or polluted. Medical waste was disposed according to the routine request. The garbage can should be sterilized with 500mg/L chlorine disinfectant twice a day (Fig. 2).



Figure 2 Working environment and protective measures of the ultrasound department. (A) the seats of waiting hall reminded patients to sit at intervals and keep the distance at 1 meter; (B) nurse of ultrasound department was disinfecting the examination room with chlorine disinfectant; (C) bedside ultrasound examination for patients of neonatal ward with first-level protection (wearing work cap, disposable medical surgical mask, disposable gloves, work clothes); (D) ultrasound doctor performed bedside ultrasound examination for ICU patients with second-level protection (wearing disposable work hat, protective glasses, medical protective mask plus surgery mask, disposable impermeable isolation clothing, disposable latex gloves).

Instrument disinfection

(1) Ultrasonic probe: Before and after the examination, the probe contacting the body surface could be disinfected by wiping with 75% alcohol, quaternary ammonium salt disinfectant or hydrogen peroxide, and the probe used in the cavity and interventional ultrasound could be disinfected by soaking with glutaraldehyde or 7.5% hydrogen peroxide (Fig. 2).

(2) Host shell, display, control panel of ultrasound instrument, cable, etc.: 75% Alcohol should be used by wiping for disinfection or ultraviolet irradiation should be used for disinfection of the whole machine ≥ 30 minutes, once a day.

(3) Bedside machine: After each bedside inspection, staff should disinfect the whole machine with 75% alcohol, or disinfect the whole machine with ultraviolet irradiation for more than 30 minutes.

Strengthening the Training of Protection against COVID-19

The training classes included in-hospital training and remote online training up to 6 times. Through repeated training on the protective measures in different areas and on work precautions, staff should have a full understanding of the relevant protective measures to

implement during practical work.

The staff should be monitored body temperature twice a day, and they could start working only when the body temperature was normal. If a fever or other related symptom occurred, they should go to see the doctor in time and report to the department director. Staff must not work with suspected diseases.

In cases where health care staff is exposed (or suspected exposed) by novel coronavirus, the emergent plan of the department should be immediately started. The exposed staff should be replaced by the standby personnel and should be isolated immediately. The rooms and instruments that were not disinfected in time should be suspended. Disinfection measures of suspected pollutants and contaminated areas included ventilation, alcohol scrubbing, alcohol spray and ultraviolet lamp irradiation. The original consulting rooms and instruments could be restored to use only after completely disinfection.

Discussion

Although the pandemic has not ended yet, China has made great achievements in fighting against it. Most of the newly added cases are imported from abroad now. Since the outbreak of the epidemic, China–Japan

Friendship Hospital has actively responded. Under the unified guidance of the hospital, the ultrasound department implemented scientific and reasonable prevention and control measures in combination with its own technical characteristics. Under the severe pressure of the epidemic, good medical order was ensured and clinical needs were met in the ultrasound department while nosocomial infection was prevented effectively.

Looking back to the 2003 SARS epidemic, 5327 people were infected and 349 people died in the Chinese Mainland. A total of 1,002 medical staff were infected, and 19 of them died [8], which was a painful lesson for the health care system. An important way of transmission for SARS was nosocomial infections [9]. According to experiences and lessons on infection control of SARS, measures such as isolating patients and close contacts and strictly wearing masks, gloves, and gowns can help to contain the epidemic [10,11].

We found that wearing mask and hand hygiene played a vital role during ultrasound examination. The WHO considers wearing medical mask as a precautionary measure to limit the spread of respiratory diseases including COVID-19 [12]. In previous studies on influenza, medical surgical masks and N95 respirators have been considered effective in reducing the risk of infection [13,14]. In medical environments with limited resources, overcrowded medical facilities, lack of clear partition, and lack of alcohol-based hand sanitizers are challenges for the implementation of hand hygiene [15]. Wearing masks was required, environmental partition was made and hand sanitizer was provided to ensure hand hygiene of health care staff and patients.

In addition, given the characteristics of the specialty, two points in the management experience might be worth highlighting: one is partition of patients with different risk levels for infection, and the other is the control of patient density. In terms of patient partitioning, ultrasound examinations for patients from emergency, the fever clinic, and patients with fever from other departments all underwent ultrasound examination in the emergency ultrasound room, in order to separate them from the common patients of outpatient area. According to reports on the epidemic, 98% of patients with COVID-19 have symptoms of fever [16], so it was reasonable to exam the fever patients in a designated ultrasound room. Ultrasound examinations of suspected/confirmed cases were performed in isolation wards. In terms of personnel density control, measures such as limiting the number of patients, releasing patients into the department in different time period, and reducing unnecessary escorts were adopted in the ultrasound department. These measures could effectively deal with the threat caused by asymptomatic infection.

Asymptomatic infections are also contagious [17], and the proportion of them is not rare, ranging from about 18-30.8% according to some prediction models [18,19]. Therefore, control the population density to reduce the probability of potential asymptomatic infections infecting others among the waiting patients is very necessary.

At present, COVID-19 is still in pandemic globally [20], and the situation of China has shifted from domestic transmission to overseas imported. Under the background of returning to work and production of the whole society in China, the number of people in the hospital is increasing, which indicates that we still need to adhere to strict prevention and control management. The experience summarized by the ultrasound department of our hospital in response to the epidemic could be valuable as a reference for ultrasound doctors worldwide.

Acknowledgments

This study was supported by Discipline Construction of Peking Union Medical College Project in 2019 (special construction project) (Tsinghua 211). Project Number: 201920102305.

We wish to appreciate Ms. Jennifer F. Wilson from Thomas Jefferson University for revising and editing our manuscript.

Conflict of Interest

The authors have no conflict of interest to declare.

References

- [1] She J, Jiang J, Ye L, Hu L, Bai C, Song Y. 2019 novel coronavirus of pneumonia in Wuhan, China: emerging attack and management strategies. *Clin Transl Med* 2020; 9: 19. DOI: 10.1186/s40169-020-00271-z.
- [2] Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020; 395: 1054-1062.
- [3] Office of National Health Office, Office of the National Administration of traditional Chinese medicine. Novel Coronavirus-infected Pneumonia diagnosis and treatment plan (Trial Seventh Edition). (GWB YH [2020] No. 184).
- [4] Tang B, Bragazzi NL, Li Q, Tang S, Xiao Y, Wu J. An updated estimation of the risk of transmission of the novel coronavirus (2019-nCov). *Infect Dis Model* 2020; 5: 248-255.
- [5] Beijing Ultrasonic Medical Quality Control and Improvement Center. Novel coronavirus infection control and guidance center in ultrasound department (First Edition).
- [6] China-Japan Friendship Hospital Management Regulations on Medical Protective Products During the Epidemic of Novel Coronavirus-infected Pneumonia.
- [7] National Health Commission. Guidelines for the Use of Common Medical Protective Products in the Prevention and Control of Novel Coronavirus-infected Pneumonia (Trial). (GWB YH [2020] No. 75)
- [8] World Health Organization. Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003 (Based on

- data as of the 31 December 2003). Available from: https://www.who.int/csr/sars/country/table2004_04_21/en/
- [9] de Wit E, van Doremalen N, Falzarano D, Munster VJ. SARS and MERS: recent insights into emerging coronaviruses. *Nat Rev Microbiol* 2016; 14: 523-34.
- [10] Pang X, Zhu Z, Xu F, Guo J, Gong X, Liu D, et al. Evaluation of control measures implemented in the severe acute respiratory syndrome outbreak in Beijing, 2003. *JAMA* 2003; 290: 3215-21.
- [11] Svoboda T, Henry B, Shulman L, Kennedy E, Rea E, Ng W, et al. Public health measures to control the spread of the severe acute respiratory syndrome during the outbreak in Toronto. *N Engl J Med* 2004; 350: 2352-61.
- [12] World Health Organization. Advice on the use of masks in the community, during home care and in healthcare settings in the context of the novel coronavirus (COVID-19) outbreak. Available from: [https://www.who.int/publications-detail/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-\(2019-ncov\)-outbreak-60k](https://www.who.int/publications-detail/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-(2019-ncov)-outbreak-60k).
- [13] Smith JD, MacDougall CC, Johnstone J, Copes RA, Schwartz B, Garber GE. Effectiveness of N95 respirators versus surgical masks in protecting health care workers from acute respiratory infection: a systematic review and meta-analysis. *CMAJ* 2016; 188: 567-574.
- [14] Loeb M, Daffoe N, Mahony J, John M, Sarabia A, Glavin V, et al. Surgical mask vs N95 respirator for preventing influenza among health care workers: a randomized trial. *JAMA* 2009; 302: 1865-71.
- [15] Loftus MJ, Guitart C, Tartari E, Stewardson AJ, Amer F, Bellissimo-Rodrigues F, et al. Hand hygiene in low- and middle-income countries. *Int J Infect Dis* 2019; 86: 25-30.
- [16] Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020; 395: 497-506.
- [17] Bai Y, Yao L, Wei T, Tian F, Jin DY, Chen L, et al. Presumed Asymptomatic Carrier Transmission of COVID-19. *JAMA* 2020: e202565.
- [18] Nishiura H, Kobayashi T, Suzuki A, Jung SM, Hayashi K, Kinoshita R, et al. Estimation of the asymptomatic ratio of novel coronavirus infections (COVID-19). *Int J Infect Dis* 2020: S1201-9712(20)30139-9. DOI: 10.1016/j.ijid.2020.03.020.
- [19] Mizumoto K, Kagaya K, Zarebski A, Chowell G. Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. *Euro Surveill* 2020; 25: 2000180. DOI: 10.2807/1560-7917.ES.2020.25.10.2000180.
- [20] World Health Organization. Latest updates - Live press conference (Geneva). (accessed April 12, 2020). Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>.

Appendix 1

Admission Screening Questionnaire for Patients Responding to Novel Coronavirus-infected Pneumonia

Department of Ultrasound, China-Japan Friendship Hospital

(Health care staff should take necessary protective measures before asking.)

In accordance with relevant regulations on infection control of the hospital.

Question 1. Are you a visitor from Wuhan or Hubei?

No Yes

Question 2. Have you been to Wuhan or Hubei recently?

No Yes (Exact date _____)

Question 3. Have you met with relevant personnel from Wuhan or Hubei recently?

No Yes (Exact date _____)

Question 4. Are there any confirmed patients among the people you have recently contacted? Is there an aggregation of disease?

No Yes (Exact date _____)

Question 5. In the past two weeks, is there any tourism history, residential history, or contact history of patients in the local (foreign) areas where cases continue to spread?

No Yes: tourism history residential history contact history

(If yes, exact date _____)

Question 6. Does your family, company, or your child's nursery or school have cluster disease (more than three people)?

No Yes Unclear

Question 7. Do you have the following symptoms/signs recently? (multiple choices available)

fever chills fatigue dry cough stuffy nose runny nose diarrhea sore throat headache
 asthma shortness of breath nausea vomiting chest pain dyspnea muscle ache joint ache
 conjunctival congestion none above

If you have the above-mentioned relevant symptoms/signs, please give a specific description (including time, inducement, severity, medication history, etc., and further investigate the risk of infection according to the specific situation.) _____

Patient's instructions: COVID-19 has the characteristics of long incubation period, strong infection ability, and strong concealment. Although we have adopted corresponding prevention and control measures, if you find any confirmed or suspected cases after ultrasound contrast/ puncture / intervention with the same period of time, you will need follow-up monitoring according to infection control regulations.

Please be fully aware of the above screening contents and precautions, and promise to answer truthfully for yourself (convenient for later contact), and accept the risk of potential infection in the process of receiving ultrasound contrast examination / puncture / intervention.

Signature of patients: _____ telephone number: _____

ID card no. of patients: _____ residence in recent 2 weeks: _____

Signature of screening staff: _____ Date: _____

Appendix 2

Fever Clinic Screening Form of China-Japan Friendship Hospital

Name _____ Gender _____ Age _____ Temperature _____

Leukocyte _____ X-ray _____

FluA _____ FluB _____

Inconsistent with suspected COVID -19, due to:

Signature of Physician _____

Date: _____