



Prevention and control strategies of novel coronavirus pneumonia in medical institutions in Jiangsu Province

Jianan Xu^{1#}, Ning Wang^{2#}, Dandan Yang¹

¹Jiangsu Provincial Center for Disease Control and Prevention, Nanjing, China; ²Nanjing Municipal Center for Disease Control and Prevention, Nanjing, China

Contributions: (I) Conception and design: J Xu; (II) Administrative support: D Yang; (III) Provision of study materials or patients: D Yang; (IV) Collection and assembly of data: N Wang; (V) Data analysis and interpretation: J Xu; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors

[#]These authors contributed equally to this work.

Correspondence to: Dandan Yang, Jiangsu Provincial Center for Disease Control and Prevention, Nanjing 210009, China.

Email: yangdan1997@163.com.

Abstract: Coronavirus disease 2019 (COVID-19) is an infectious disease caused by the novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19, which in severe cases can lead to pneumonia, is mainly transmitted through respiratory tract droplets. This potentially life-threatening disease is responsible for the most severe global pandemic that humans have encountered in a century. Medical workers have played a crucial role in preventing and controlling the spread of the novel coronavirus; however, information about the disease is still lacking, and medical workers continue to risk their health and lives at work. In response to this, Jiangsu Provincial Center for Disease Control and Prevention has formulated technical specifications for the prevention and control of the novel coronavirus in medical institutions, with the aims of promoting effective prevention and control of the spread of the disease in hospitals, and reducing the risk posed to medical staff to protect their health and lives. These specifications target medical posts and the characteristics of the process of medical activity, and instruct medical institutions to implement measures to prevent and control COVID-19-associated pneumonia outbreaks as well as the secondary spread of the disease.

Keywords: Coronavirus disease 2019 (COVID-19); medical protection; nosocomial infections

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Introduction

Coronavirus disease 2019 (COVID-19), the infectious disease caused by the novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is responsible for the most severe global pandemic that humans have encountered for a century. The disease, which is mainly transmitted through droplets from the respiratory tract, is associated with respiratory symptoms, and in severe cases, can lead to pneumonia and even death. The protection of human health and lives in the face of the COVID-19 pandemic poses a massive challenge for countries around the

world. Medical staff have played a huge role in preventing and controlling the pandemic to date, from diagnosing and treating cases to conducting epidemiological investigations. However, the novel coronavirus poses a serious threat to the health of medical staff and presents the risk of nosocomial infections that would eventually result in secondary spread of the disease. In order to prevent and control the spread of the novel coronavirus in medical institutions, reduce the risk of nosocomial infections, and effectively protect medical staff and patients, Jiangsu Provincial Center for Disease Control and Prevention has formulated new guidance for the prevention and control of COVID-19-associated pneumonia

outbreaks in medical institutions, based on the characteristics of medical posts and processes of medical activity.

Occupational exposure of medical staff to the novel coronavirus

According to the current clinical data, COVID-19 is mainly transmitted via respiratory droplets and direct contact, and the aerosols and the digestive tract have yet to be confirmed as routes of transmission (1). The “Novel Coronavirus Pneumonia Diagnosis and Treatment Program (Trial Version 7)” also clearly stated that because the novel coronavirus can be separated in feces and urine, the disease may be transmitted when individuals are exposed to high concentrations of aerosol in a relatively closed environment for a long time. Therefore, attention should be paid to the aerosols or contact transmission caused by feces and urine pollution of the environment (2). When treating patients, medical staff may come into contact with blood, body fluids, or other contaminants. Sharp objects used in treatment, such as needles and blades, can puncture the skin. “Aerosols” accidentally generated when using medical devices, if not properly protected, can be easily inhaled and the respiratory tract is infected to cause related infectious diseases. COVID-19 is highly infectious, including during the incubation period, which makes its prevention and control extremely challenging. For medical staff, there are three grades of risk for occupational exposure: (I) low risk of exposure: indirect contact with patients, such as Pharmacy preparation, intravenous configuration, logistics support, information maintenance, or drug management; (II) medium risk of exposure: direct contact with non-COVID-19 patients or indirect exposure examination of patients with suspected COVID-19 (such as blood drug concentration tests or genetic testing); (III) high risk of exposure: any exposure to aerosol or body fluid during the treatment of specimens from diagnosed or suspected COVID-19 patients. The main areas of medical institutions as risk of exposure to the novel coronavirus include fever clinics, emergency departments, general wards, isolation wards, laboratories, and operating rooms.

Prevention and control measures

Basic requirements

Organization and management

The medical institutions should strictly implement the main

responsibility for epidemic prevention and control, and establish an organization system for COVID-19 emergency prevention and control led by the main person in charge of the medical institution. Also, medical institutions should establish a leading group for epidemic prevention and control to ensure that specialized departments and personnel are responsible for epidemic prevention and control.

Plan formulation

According to the pathogenic characteristics of the novel coronavirus, medical institutions should set up an early warning mechanism, formulate an emergency plan and the work processes of medical activities, which should be based on the source of infection, transmission route, susceptible group and diagnosis and treatment conditions.

Material support

Medical institutions should ensure that the funds and materials necessary for the prevention and control of COVID-19 are available; this includes acquiring materials for the response to outbreaks, including protective equipment, disinfectant, medical equipment, and drugs.

Training

The content of training for medical staff should be tailored to their specific roles. Medical staff in fever clinics, medical clinics, pediatric outpatient departments, intensive care units (ICU), respiratory wards, and other high-risk departments, as well as those who provide emergency services, such as imaging, should receive focused training. The training should be aimed at improving knowledge of COVID-19 prevention and control, as well as promoting methods and skills for the early detection, reporting, quarantine, diagnosis, treatment, and management of patients with the disease.

Personnel protection

Medical institutions should standardize disinfection, isolation, and protection measures. To ensure medical personnel have adequate protection, medical institutions should reserve qualified and sufficient protective materials, such as disinfection products and personal protective equipment including surgical masks, medical protective masks, gowns, and goggles. On the basis of strictly implementing the standard prevention, medical institution should strengthen the contact transmission, droplet transmission and airborne infection prevention and control.

Key measures for infection prevention and control include selecting and wearing masks correctly and practicing hand hygiene. Health management should be strengthened. Medical institutions should reasonably allocate human resources to avoid medical staff being overworked and provide nutritious meals to enhance their immunity. According to the nature of the post and the results of risk assessment, active health monitoring should be carried out, including by checking body temperature and respiratory symptoms. Various measures also should be taken to ensure that medical personnel provide medical services to patients in a healthy way.

Epidemic management

Infection monitoring

Medical institutions should give an early warning and prediction, strengthen supervision and guidance on infection prevention and control, and identify hidden dangers and make timely improvements. When a case of COVID-19 is suspected or confirmed, it should be promptly reported according to the relevant requirements, and the information should be reported within 2 hours. Also, the disposal work about this case should be completed well.

Outbreak management

The rules and regulations of infection prevention and control should be strictly implemented to minimize the risk of COVID-19 outbreaks. Suspected novel coronavirus infections or outbreaks should be reported promptly according to the relevant regulations. The medical institution should implement an emergency plan according to the relevant standards and procedures, and cooperate with the investigation and disposal work.

Cleaning and disinfection

According to WS/T 367 (3), the ventilation in areas used for the diagnosis and treatment of patients should be improved. If the conditions permit, medical institutions could carry out air disinfection or have equipment for the disinfection of circulating air. WS/T 367 should be strictly implemented. The treatment environment should be thoroughly cleaned and disinfected, as should medically instruments and patients' belongings. Objects that come into contact with the respiratory secretions, excreta, and vomit of patients should undergo strict terminal disinfection. Greater efforts should be made to monitor the efficacy of disinfection. For example, the novel coronavirus nucleic acid test of environmental samples and objects' surface samples can be

carried out to evaluate the disinfection effect.

Patient management

Patient treatment

To reduce the risk of nosocomial infection, medical institutions should ensure that patients are effectively managed and that overcrowding is minimized. For cases with suspected or confirmed COVID-19 infection, measures for isolation or to control transmission should be taken in accordance with the law, and medical observation and other necessary precautions should be taken for the patient's close contacts. If a patient cannot be treated by a particular medical institution, they should be promptly referred to a medical institution capable of diagnosis and treatment.

Patient education

Medical institutions should actively educate patients and their companions regarding protective measures against the novel coronavirus, and guide them on effective hand hygiene, coughing etiquette, medical self-observation, and home isolation.

Medical waste management

Medical waste generated from confirmed or suspected COVID-19 patients should be handled as infectious medical waste and be disposed of in strict accordance with the relevant provisions of the Regulations on Medical Waste Management and the Measures on Medical Waste Management of Medical and Health Institutions.

Prevention and control in key places

Fever clinic

The building layout and workflow of the fever clinic should meet WS/T 311 and other relevant requirements (4). The observation room or emergency room should have adequate ventilation; if mechanical ventilation is used, the airflow should be directed from the clean side to the polluted side. Adequate protective equipment for medical personnel should be provided, and the entrance and exit of the fever clinic should be equipped with hand sanitation facilities, such as quick-drying hand sanitizer. Medical staff should take standard prevention measures when diagnosing or treating patients. Surgical masks and protective medical masks should be worn correctly. Hands should be washed or disinfected before putting on and after removing masks. In strict accordance with the relevant regulations, medical personnel should wear protective equipment inside the fever clinic and

observation ward, and take off it off before leaving. Medical staff should have an understanding of the epidemiological and clinical characteristics of COVID-19, screen patients according to the rules for diagnosis and treatment, and take measures to immediately isolate and promptly report patients suspected or confirmed with the disease. After the patient has been transferred from the fever clinic, the terminal treatment should be carried out according to WS/T 367. Patients and their companions should be supplied with masks and instructed to wear them properly.

Emergency treatment

The pre-examination triage system should be implemented. Patients with fever should be guided to the fever clinic, and an emergency plan for the transfer and treatment of severe patients should be devised and strictly implemented. An appropriate isolation area should be set up to facilitate on-site isolation and treatment of suspected or confirmed COVID-19 patients. Medical personnel should strictly carry out preventive measures and manage their personal protection and the environment for diagnosis and treatment. When emergency endotracheal intubation and other infectious occupational exposure measures are needed, preventive measures should be taken in accordance with the requirements of the confirmed patients. The treatment area should be well ventilated and regularly cleaned and disinfected. Effective measures, such as the creation of waiting areas, should be taken to prevent crowds from gathering.

General wards (rooms)

Emergency isolation wards should be set up for the isolation and treatment of patients suspected or confirmed with COVID-19. Relevant working systems and procedures should be established, adequate disinfection should be carried out, and protective equipment should be provided. If a patient on a ward (room) is suspected or confirmed to have COVID-19, the relevant emergency plans and work procedures should be initiated, and timely and effective isolation, treatment, and referral should be implemented according to the standard requirements. Suspected or confirmed COVID-19 patients should be treated and nursed by specially-assigned staff, and access to unrelated medical personnel should be restricted. In principle, no visitors should be allowed on the ward. If possible, the patient can be placed in negative pressure ward. Non-designated hospitals that do not have the capacity to treat COVID-19 patients should ensure such patients are transferred to designated

hospitals that are capable of isolation and treatment. For patients waiting for referral, effective isolation and treatment measures should be taken. After the patient has been transferred, the contact environment should be terminally disinfected according to WS/T 367.

Isolation wards (rooms)

The layout of the building and work flow should comply with WS/T 311 and other relevant requirements, and should be equipped with appropriate quantities of medical personnel protective equipment in accordance with the requirements. Medical institutions with negative pressure wards (rooms) should implement standardized management according to the relevant requirements. For suspected or confirmed COVID-19 patients, quarantine measures should be taken promptly, and they should be placed separately; suspected patients should be isolated in a single room, and those with etiologically confirmed COVID-19 can be placed together. On the basis of standard prevention, measures such as contact isolation, droplet isolation, and air isolation should be taken. Specific measures include: entering and leaving the isolation ward, strictly implementing WS/T 311, properly implementing hand hygiene, and removing protective equipment. The procedure of putting on and removing protective equipment for medical personnel should be drawn up; a flowchart should be made and the mirror should be configured. To prevent contamination, personnel skilled in technology for the prevention and control of infection should supervise medical personnel when putting on and removing protective equipment. Stethoscopes, thermometers, sphygmomanometers, and other medical devices, along with nursing items, should be specially designated for use in the diagnosis and treatment of suspected or confirmed COVID-19 patients. If resources are limited and medical equipment cannot be specially designated, standard cleaning and disinfection should be carried out after each use. Critically ill patients should be admitted to ICUs or towards equipped with conditions for monitoring and rescue, and must not be exposed to other patients. In principle, there should be a strict visitation system and no escort. If the patient is in a critical condition or there are other special circumstances that make a visit necessary, visitors must take personal protection measures in strict accordance with the provisions. Air purification should be carried out in accordance with WS/T 368 (5).

Laboratory

Virus isolation and culture, animal experiments and

other activities should be carried out in a biosafety level 3 laboratory. These activities shall be examined and approved by the provincial health administration department and then submitted to the National Health Commission (NHC) for approval. If uncultured infectious materials cannot be reliably inactivated, they should be subjected to viral antigen tests, serological tests, nucleic acid tests (detection after inactivation for 30 minutes at 56 °C is recommended), biochemical analysis, and other operations. The biosafety type II or enhanced type II should be conducted in a biosafety cabinet.

Operating rooms

The operating rooms should meet the requirements of GB 50333 (6) and WS/T 368. The appropriate purification methods should be selected, and the quality of air purification and disinfection in the departments at high risk of infection should be regularly monitored. Before the operation, the biosafety risks of the operation should be assessed, and corresponding protective measures should be adopted according to the findings of the assessment. If necessary, a nasopharyngeal swab sample can be collected from the patient and a novel coronavirus nucleic acid test can be performed.

Protection of medical personnel

Basic requirements

Medical institutions should: strengthen the implementation of standard preventive measures; ensure adequate ventilation management of diagnosis areas, wards (rooms), and laboratories; strictly implement the requirements of GBZ/T 213 (7), WS 233 (8), WS/T 311, WS/T 313 (9), and WS/T 442 (10); and ensure medical personnel have the necessary personal safety protection. If personal protective equipment is contaminated by the patient's blood, body fluids, or secretions, it should be promptly replaced. Protective equipment should be used properly. Hand hygiene should be practiced before putting gloves on and immediately after the removal of gloves or isolation clothes (with running water). Sharp instrument injury prevention measures should be strictly followed. Medical devices and appliances used by each patient should be cleaned and disinfected according to WS/T 367 requirements.

Outpatient service, emergency treatment and imaging staff

During routine diagnosis and treatment, medical personnel

who provide outpatient, emergency treatment, and imaging services should wear disposable working caps, surgical masks, and overalls (white coats). When contacting or escorting suspected or confirmed COVID-19 patients, and performing environmental cleaning and disinfection, protective measures should be selected according to different situations. If there is no risk of exposure to body fluids, blood, secretions, or excreta, a medical protective mask, a disposable work cap, an isolation gown, gloves, and shoe covers should be worn. If there is any risk of exposure to body fluids, blood, secretions, or excreta, a medical protective mask, a disposable work cap, an isolation gown, goggles, gloves, and shoe covers should be worn.

Fever clinic staff

Fever clinic staff should wear surgical masks, disposable work caps, isolation gowns, gloves, and shoe covers for routine diagnosis and treatment. When contacting or escorting suspected or confirmed COVID-19 patients, and performing environmental cleaning and disinfection, protective measures should be selected according to different situations. If there is no risk of exposure to body fluids, blood, secretions, or excreta, a medical protective mask, a disposable work cap, an isolation gown, gloves and shoe covers should be worn. If there is any risk of exposure to body fluids, blood, secretions, or excreta, a medical protective mask, a disposable work cap, an isolation gown, goggles, gloves, and shoe covers should be worn.

Isolation ward staff

If there is no risk of exposure to fluid, blood, secretion, or excreta, isolation ward staff should wear a disposable working cap, anti-fog goggles, a medical respirator (N95), (disposable) protective clothing or work clothes (white coat), disposable latex gloves (double), and disposable shoe covers. If there is any risk of exposure to fluid, blood, secretion, or excreta, a medical protective mask and goggles or a powered air filter respirator should be worn, along with anti-permeability protective clothing, a disposable work cap, double gloves, and disposable shoe covers.

Protection for laboratory personnel

Level 3 biosafety protection should be adopted: Medical protective or N95 masks, single or double latex gloves (different colors may be allowed if resources permit), face screens, goggles, protective clothing, single or double medical protective caps should be worn, and hand hygiene should be practiced. A double-layered mask can be worn

if necessary (medical protective mask as the outer layer and an N95 mask as the inner layer). Special protection: If the patient has a severe cough and there is no respiratory barrier, on the basis of three-level protection, the patient can be given a double-layered protective suit, a double-layered mask (medical protective mask as the outer layer, and an N95 mask as the inner layer), a comprehensive respirator, three layers of latex gloves, and a double-layered medical protective cap.

Patient protection management

Suspected or confirmed COVID-19 patients should be isolated promptly, and guided into the isolation zone according to the designated standard route. Patients should change their clothes before entering the ward. After centralized disinfection, personal belongings and changed clothes should be stored in a designated place for unified storage by the medical institution. Patients should be instructed to wear masks correctly, and to follow coughing etiquette and hand hygiene correctly. The management of patients' visitors or accompanying personnel should be taken seriously. For the quarantined patients, in principle, their activities are restricted in the isolation ward and transfer ward to reduce their movement. If it is necessary to leave the isolation ward or the isolation area, appropriate measures, such as wearing a medical protective mask, should be taken to prevent the patient from contaminating other patients or the environment. When suspected or confirmed COVID-19 patients are discharged from the hospital or transferred to another hospital, they should be given a clean change of clothes before leaving, and terminal disinfection of their contact environment should be conducted according to WS/T 367. In cases of death of a suspected or confirmed COVID-19 patient, the corpse shall be disposed of in a timely manner. Treatment method: all open channels, such as the mouth, nose, ear, and anus should be filled with 3,000 mg/L chlorine disinfectant or a 0.5% peracetic acid cotton ball or gauze. The body should be wrapped in a single double-layer cloth, placed in a double-layer body bag, and sent directly in a special vehicle to the designated place for cremation. Personal belongings used by patients during hospitalization can be taken home by them or their family members after disinfection.

Discussion

When COVID-19 first emerged, very little was known

about the characteristics of its person-to-person transmission. Relevant institutions and medical staff had insufficient awareness for preventing and controlling the disease, which frequently resulted in nosocomial infections. Some patients became infected during hospitalization. Occupational exposure has led to many medical staff becoming infected. Li *et al.* (11) reported on 425 people infected with COVID-19. They found that between January 1 and 11, 2020, the proportion of infected medical staff among the diagnosed patients reached 3%; from January 12 to 22, this proportion increased to 7%. The infection of medical personnel was particularly serious in Wuhan. As of February 11, 2020, there were 1,716 confirmed cases of COVID-19 medical personnel who may have been non-occupationally exposed to infection, accounting for 3.8% of the cases confirmed nationally. These cases included 6 deaths, accounting for 0.4% of all deaths in the country. Hubei province reported 1,502 confirmed cases of COVID-19 among medical personnel, representing 87.5% of such cases nationally; Wuhan alone reported 1,102 cases (73.4% of Hubei's total) (12,13). Wuhan University Central South Hospital reported that among the 138 confirmed cases of COVID-19, 57 (41.3%) were hospital infections and 40 (29.0%) were medical staff. Of the infected medical staff, medical staff from general wards accounted for 77.5% (31/40), with the rest coming from the emergency department (17.5%, 7/40) and ICU (5.0%, 2/40) (14). These cases were not the result of super spreading, which suggests that many medical staff and non-COVID-19 patients became infected in the hospital. With the research of COVID-19 and the correct judgment of the epidemic situation, the relevant national departments and various medical institutions have formulated and continuously updated in-hospital measures and work processes for the prevention and control of COVID-19 infection. However, there are still many challenges and difficulties in the fight against COVID-19. In response to the problems in controlling the spread of the disease in hospitals, we proposed a response strategy and formulated DB32/T 3761.1-2020 "Technical Specifications for COVID-19 Prevention and Control Part 1: Medical Institutions". It will be of great significance and value in guiding the response of the medical service during the ongoing pandemic.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/jphe-20-67>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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