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Terminal disinfection scheme and disinfection effect evaluation in designated hospitals for treatment of novel coronavirus pneumonia (COVID-19)

—Taking Nanjing Public Health Medical Center as an example

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ABSTRACT: Objective To provide scientific guidance on terminal disinfection and disinfection effect evaluation in designated hospitals in China for novel coronavirus pneumonia (COVID-19). **Methods** Applying the case study method and taking Nanjing Public Health Medical Center as the object, this paper described the practice of terminal disinfection and effect evaluation in the designated hospitals of COVID-19 from the aspects of “hospital infection logistics support and disinfection implementation”. According to the implementation plan, terminal disinfection, disinfection effect evaluation, and hygienic tests of centralized air conditioning were carried out in Buildings B and C of Nanjing Public Health Medical Center. **Results** The disinfection effect evaluation results of Buildings B and C of Nanjing Public Health Medical Center showed that, the killing rate of indicated microorganisms and natural bacteria in the air have all reached the standards. The hygienic test results of the central air conditioning showed that, the amounts of dust, bacteria, fungi and β -hemolytic streptococcus have all reached the standards. **Conclusion** This implementation plan can effectively guide the terminal disinfection work of designated hospitals, ensure that the designated hospitals of COVID-19 complete the terminal disinfection work in high quality, and restore the normal diagnosis and treatment order as soon as possible.

KEY WORDS: Novel coronavirus; Terminal disinfection; Disinfection effect evaluation

Since the outbreak of novel coronavirus pneumonia in 2019 (hereinafter referred to as “COVID-19”), the novel coronavirus strain has been constantly changing. Although its virulence has gradually declined, with the continuous improvement of transmission capacity^[1,2], the difficulty of pandemic prevention and control has also increased, and the global new coronavirus pandemic continues to spread. Since the main transmission routes of novel coronavirus are respiratory droplets and aerosols, novel coronavirus may remain on the environmental surfaces, medical devices, and central air conditioning and ventilation systems of designated hospitals^[3]. Also, some research results show that indoor movement patterns caused by heating, ventilation, and air conditioning systems may contribute to the occurrence of transmission events^[4,5]. Therefore, it

is urgent to strengthen the cleaning and disinfection of designated hospitals.

Nanjing Public Health Medical Center, as the designated hospital of Nanjing for the treatment of COVID-19, vacated all non-isolated wards in the hospital after the outbreak of the pandemic, and transformed buildings B and C into COVID-19 isolation wards for the treatment of patients with COVID-19. July 20, 2021 witnessed the COVID-19 outbreak in Lukou International Airport, Nanjing City, Jiangsu Province. In this outbreak, Nanjing Public Health Medical Center received 560 confirmed cases and successfully completed various rescue tasks, but then came the problem of transformation from “pandemic” back to “regular”. However, due to the needs of medical treatment and hospital infection prevention and control, and the com-

plex environment with various items such as medical devices, in order to complete the terminal disinfection of the environmental surfaces, the air conditioning and ventilation system as well as the related disinfection effect evaluation test efficiently and quickly, the implementation of the terminal disinfection work is the key step.

The novel coronavirus can survive for several hours under suitable conditions^[6]. While the centralized air conditioning system environment with low temperature and extreme humidity is a good environment for the virus to exist in the long term, strict implementation of disinfection measures can effectively eliminate the pathogens in the environment^[7]. In addition to the central air conditioning and ventilation system, some research results showed that positive swabs were found in other environmental sampling swabs of patients with COVID-19^[8]. Therefore, after all the patients are cured and discharged, how to complete the terminal disinfection of the hospital environment in high quality and ensure that the hospital recovers the regular admission of patients is an urgent issue to be addressed.

Taking the practice of terminal disinfection in Nanjing Public Health Medical Center as an example, this paper briefly describes the implementation of terminal disinfection and disinfection effect evaluation, the implementation of infection control system measures, and logistics support.

1 Preparation for terminal disinfection

1.1 Organizational structure

(1) Core leadership team is responsible for overall planning; (2) Construction organization is the organization or institution responsible for the specific implementation of disinfection operation, and third-party disinfection service institutions can be selected; (3) Evaluation organization is the organization or institution responsible for the process evaluation and disinfection effect evaluation of terminal disinfection; (4) The hospital infection management department is responsible for the hospital infection prevention and control, the stream-

line design for entering and exiting the contaminated area, the inspection and supervision, the technical guidance for disinfection, and the treatment of medical waste during the disinfection process; (5) Equipment maintenance department is responsible for assisting in on-site investigation, guiding the disassembly, cleaning and disinfection of central air-conditioning system, and guiding the disinfection of medical devices; (6) The logistics support department is responsible for the support of protective materials and disinfection materials.

1.2 Prevention and control of hospital infection

1.2.1 Formulate system and process

According to the actual situation of terminal disinfection, the corresponding hospital infection prevention and control system and process shall be formulated, as well as the wearing process of protective equipment, closed-loop management requirements, environmental material table disinfection process, medical waste transfer process, occupational exposure emergency disposal process, etc. shall be specified in detail to ensure the safety of disinfection personnel.

1.2.2 Organize training and assessment

All personnel shall strictly follow the principle of training before taking the post, and the infection control personnel shall receive targeted training according to their mastery of infection control knowledge. The training content is divided into two parts: the theoretical knowledge of infection control and the operation of wearing and removing protective clothing. All staff shall be trained and assessed before taking up their posts. In case of major mistakes in wearing and removing protective clothing, all personnel shall drop their posts immediately for retraining and assessment. They can only take up their posts after passing the examination, so as to ensure the normal and orderly implementation of terminal disinfection.

1.2.3 Supervision on wearing and removing protective articles

When the formal operation begins, wearing and removing protective clothing requires the supervision, assistance and prompt of the infection

control personnel to ensure the correctness so as to reduce the risk of exposure. During the operation of the disinfection personnel, the infection control personnel shall patrol to check whether the protective articles are damaged, displaced, or the protective clothing is soaked during operation. If so, the emergency disposal process for occupational exposure shall be followed.

1.2.4 Working area and route design

According to the layout of buildings requiring terminal disinfection, a reasonable route to enter and exit the contaminated area shall be established, and an area for unloading personal protective articles shall be set. The route to and from the contaminated area shall be timely adjusted according to the disinfection progress. The clean passage, contaminated passage, clean area and contaminated area shall be strictly distinguished. A clean work area shall be set up to store all kinds of protective equipment and supervise the wearing and removing of protective clothing.

1.2.5 Logistics support

Related logistics support mainly includes: (1) providing pandemic prevention and disinfection materials; (2) ensuring that the closed-loop management of staff is implemented according to the standard procedures and requirements; (3) reasonably arranging the closed-loop management shuttle bus for normal performance in disinfection; (4) ensuring that the daily diet and nutrition of the staff are balanced, and timely adjusting the diet according to their personal dietary habits; (5) paying attention to the psychological state of the staff, and timely relieving their depression, fatigue, irritability or other bad emotions; (6) carrying out health monitoring for all staff and providing timely medical treatment services.

2 Terminal disinfection implementation process and disinfection effect evaluation

It shall be carried out according to the process of on-site investigation, formulation of disinfection technical scheme, training of disinfection personnel, implementation of terminal disinfection and disinfection

effect evaluation.

2.1 On-site investigation

All medical institutions that treat patients infected with COVID-19 shall make detailed statistics of the space volume of the contaminated area and its floor, wall and ceiling areas, as well as the number of all medical devices and equipment that may be contaminated after all the infected patients are cured and discharged. The basic operation of the air conditioning system shall be evaluated, the zoning of the air conditioning system in each area of the hospital shall be acknowledged, and the internal surface area of the air duct (estimated by the number of air conditioning units, air inlet (return) outlets, fan coils, air conditioning filters, exhaust systems, and top floor ventilation shafts) shall be estimated.

2.2 Formulation of terminal disinfection technical scheme

The technical scheme for terminal disinfection shall be formulated according to the investigation. The technical scheme shall include the basic principles of terminal disinfection, the selection of disinfection equipment, disinfectants, disinfection methods, personal protection of disinfection personnel, disinfection precautions, etc., and serve as the guidance document for terminal disinfection of the medical institution.

2.3 Training of disinfection personnel

All personnel involved in terminal disinfection shall be trained on COVID-19 prevention and control knowledge, including basic knowledge of COVID-19, correct ways of putting on and taking off secondary protection, hand hygiene specifications, occupational exposure emergency response procedures, etc. After the training, the personnel can only enter the contaminated area for disinfection after passing the theoretical and practical examination.

2.4 Implementation of terminal disinfection

2.4.1 Implementation plan for pre-disinfection

In order to protect the disinfection operators, a relatively safe operation area shall be prepared, and the contaminated area shall be preliminarily cleaned and sorted out. First, preliminarily disinfect the space where the air conditioner personnel are

located, the objects they will touch (air supply and return ports, etc.) and the surrounding air. Since the water seal of the toilet sewer may dry up when left unused, it is also necessary to disinfect the toilet, basin and floor drain to consolidate the water seal. The specific process is shown in Figure 1.

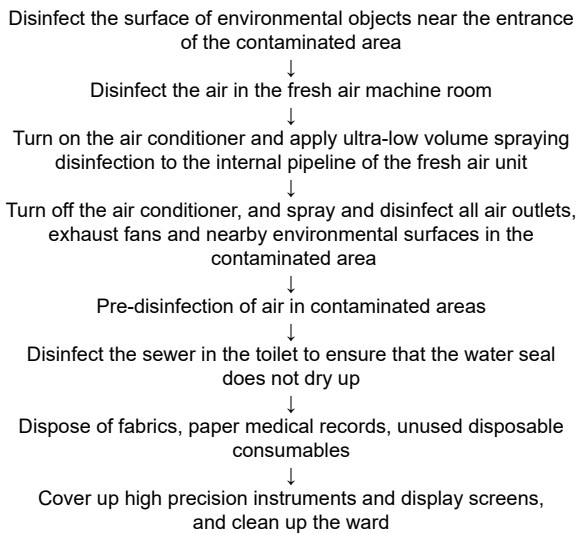


Figure 1 Implementation process of pre-disinfection

2.4.2 Implementation plan for cleaning and disinfection of central air-conditioning ventilation system

Air conditioning disinfection personnel shall wear secondary protection, waterproof disposable isolation clothing is an optional addition.

The central air-conditioning system is relatively complex, so the implementation plan shall be adjusted according to the actual situation of the air-conditioning system in the medical institution. The air conditioning system needs to be cleaned first to remove dirt such as dust, so as to avoid affecting the disinfection effect. The equipment maintenance department of the hospital shall participate throughout the process to guide the removal of fresh air units and fan coils, as well as the cleaning and disinfection of air ducts. When cleaning the air duct, a reasonable assessment shall be made according to the air duct direction: Try to select the midpoint of the maximum working radius of the cleaning machine for opening, use a special machine for cleaning, and then disinfect. It is recommended that all air conditioning filters, exhaust fans and connecting hoses in the ward area of COVID-19 patients be removed and disinfected as medical

waste. The specific disinfection steps are shown in Figure 2.

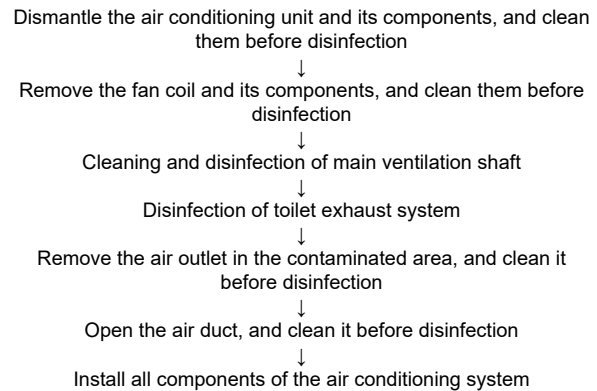


Figure 2 Cleaning and disinfection steps of central air conditioning ventilation system

2.4.3 Implementation plan for disinfection of surface and air and disinfection effect evaluation

The disinfection effect evaluation test shall be conducted in accordance with the *Standard of Field Disinfection Evaluation During COVID-19 Pandemic* (WS/T 774-2021). All steps of surface and air disinfection shall be well connected with the disinfection effect evaluation test. The specific implementation steps are shown in Figure 3.

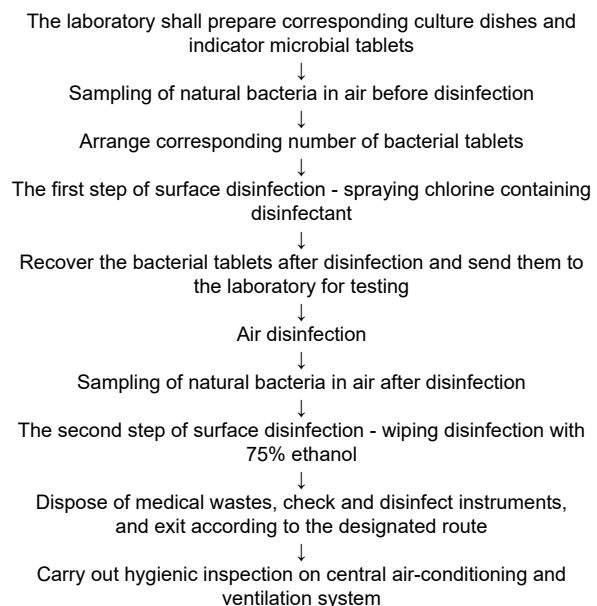


Figure 3 Implementation steps of surface and air disinfection and disinfection effect evaluation

2.5 Disinfection evaluation

The disinfection process record shall be completed in reference to Appendix A.2 of standard (WS/T 774-2021). Record in detail the concentration and dosage of disinfectant in daily work, en-

sure that it is used according to the standard configuration, and then evaluate the disinfection effect.

The evaluation of disinfection effect of surface and air shall be carried out according to the standard (WS/T 774-2021). If the evaluation result is unqualified, terminal disinfection and disinfection effect evaluation shall be conducted again.

Disinfection evaluation of central air-conditioning system shall be carried out pursuant to standard (WS/T 395-2012). Unqualified air conditioning and ventilation systems need to be re-disinfected and re-evaluated.

3 Results

After the terminal disinfection of Nanjing Public Health Medical Center, Nanjing Municipal Center for Disease Control and Prevention evaluated the disinfection effect of buildings B and C and tested the hygiene of the air conditioning system in accordance with *Standard of Field Disinfection Evaluation During COVID-19 Pandemic* (WS/T 774-2021) and *Hygienic Evaluation Specification of Central Air Conditioning Ventilation System in Public Buildings* (WS/T 395-2012). The test includes the killing rate of indicator microorganisms, the killing rate of natural bacteria in the air, the amount of dust in the air, PM10, the total number of bacteria, fungi and β -Streptococcus hemolyticus. There are 371 indicator microbial sites and 300 air natural bacterial settling sites; 97 samples of air conditioning system components, 21 samples of air conditioning supply air and 36 samples of dust accumulation were collected. After detection the samples of dust accumulation (n=36), PM10 (n=21), total bacterial count (n=118), total fungal count (n=118), β -Streptococcus hemolyticus (n=118), the results showed that the terminal disinfection effect evaluation of Nanjing Public Health Medical Center was qualified, and the hygiene indicators of the central air-conditioning and ventilation system were also qualified.

4 Discussion

After the terminal disinfection of Nanjing Pub-

lic Health Medical Center was carried out with this technical scheme, all hygienic indicators were qualified, indicating that the disinfection effect of this technical scheme is sound. This study effectively guides the overall terminal disinfection and disinfection effect evaluation of designated hospitals after discharge, and provides a better implementation plan and ideas. However, only a principled plan is proposed for some specific steps in the process, and each designated medical institution needs further refining according to the specific situation. In addition, due to the continuous updating of the new guidelines related to COVID-19, it is necessary to actively follow up the latest disinfection programs and information.

We firmly believe that, if we always adhere to the principle of “people first and life foremost”, stick to scientific, accurate and dynamic zero clearing, and make every effort to control the spread of the pandemic as soon as possible, we will definitely be able to contain the Omicron variant strain and minimize the impact of the pandemic on normal medical order.

References

- [1] CHENG Y, LIU Z, LONG L, et al. Epidemiology and viral genomic characteristics of COVID-19 clustering epidemics of in Chengdu City[J]. *Chin J Public Health*, 2022, 38(6):752-757.
- [2] LI Y F, FAN W, WANG W H, et al. A school cluster outbreak of COVID-19 caused by SARS-CoV-2 Omicron variant[J]. *Chin J Public Health*, 2022, 38(5): 614-618.
- [3] Horve PF, Dietz LG, Fretz M, et al. Identification of SARS-CoV-2 RNA in healthcare heating, ventilation, and air conditioning units. *Indoor Air*. 2021; 31:1826-1832. doi: 10.1111/ina.12898.
- [4] Park SY, Kim YM, Yi S, et al. Coronavirus Disease Outbreak in Call Center, South Korea. *Emerg Infect Dis*. 2020; 26:1666-1670. doi: 10.3201/eid2608.201274.
- [5] Lu J, Yang Z. COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020. *Emerg Infect Dis*. 2020; 26:2791-2793. doi: 10.3201/eid2611.203774.
- [6] Zhang R, Li Y, Zhang AL, Wang Y, Molina MJ. Identifying airborne transmission as the dominant route for the

- spread of COVID-19. *Proc Natl Acad Sci U S A.* 2020; 117:14857-14863. doi: 10.1073/pnas.2009637117.
- [7] Siddiqui R, Khamis M, Ibrahim T, Khan NA. SARS-CoV-2: Disinfection Strategies to Prevent Transmission of Neuro pathogens via Air Conditioning Systems. *ACS Chem Neurosci.* 2020; 11: 3177-3179. doi: 10.1021/acscchemneuro.0c00595.
- [8] Horve PF, Dietz LG, Bowles G, et al. Longitudinal analysis of built environment and aerosol contamination associated with isolated COVID-19 positive individuals. *Sci Rep.* 2022; 12:7395. doi: 10.1038/s41598-022-11303-8.