Letter to the Editor

Disinfection and Protective Measures for Makeshift Hospitals

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During the COVID-19 epidemic, Wuhan city had the hardest hit in China. The treatment capacity of the local medical system exceeded due to the rapid growth of COVID-19 cases. As a result, a considerable part of diagnosed patients could not be admitted to hospitals for isolation and treatment in time, causing the risk of spreading in the community. To effectively achieve the goals of controlling the source of infection by cutting off the transmission route, increasing the cure rate and reducing the mortality rate, Wuhan has reconstructed several makeshift hospitals based on large public places, which can admit hundreds of people at the same time. Makeshift hospitals are used to isolate and treat cases with mild to moderate symptoms, and provide services of frequent monitoring, rapid triage, basic medical care, essential living security, social engagement, and isolation.

On March 10, 2020, 16 makeshifts hospitals in Wuhan (with 15 in operation) were closed, and more than 12,000 cases with COVID-19 diagnosis were admitted. Makeshift hospitals have played an important role in 'Leave No One Unattended' of COVID-19 cases. The model of makeshift hospitals has been proved to be very effective, and the United States, Britain, Germany, Spain and other countries have also adopted this method. China has taken a series of preventive control and medical treatment measures to control COVID-19 epidemic. The epidemic situation in other countries of the world is still severe, and China's experience in controlling the epidemic is shared with other countries, especially the experiences in constructing the makeshift hospitals, which are urgently needed by other countries in coping up with COVID-19 pandemic.

The design and conversion of makeshift hospitals should be meet some basic requirements. Makeshift hospitals should be made in remote areas, i.e., distant from the densely populated urban areas such as residential areas, kindergartens, schools etc. Buildings such as exhibition center, stadium, big factory warehouse where internal space can be easily partitioned are highly recommended. Ventilation and air conditioning, water supply and drainage, power supply and distribution, telecommunication, and fire-fighting of the existent building should basically meet these requirements for makeshift constructions or at least meet after renovation. Makeshift architectural layout should meet the requirements of 'Three areas and Two passages' (the contaminated area, potentially contaminated area, clean area; medical staff passage and patient passage). Different colors should be applied to differentiate the contaminated area, potentially contaminated area and clean area, and supervision personnel must be arranged at the entrances and exits of the contaminated areas. The passages for medical staff and patients must be completely separated. The toilets for patients and medical staff should be separated.

The maximum number of patients that a makeshift hospital can accommodate in a ward is limited by the number of medical care and hardware capabilities. Too many patients in each ward causes great pressure for medical treatment, and increases other infectious diseases or public emergency risks of health and safety incidents. Capacity of patients should not exceed 42 beds in each ward in the makeshift hospital[1]. The arrangement of the beds should be arranged with an appropriate distance to facilitate medical treatment. The parallel distance between two beds should not be less than 1.2 meters[1].

Makeshift hospitals are large in scale and treat multiple patients at the same time. Therefore, personal protection, environmental cleaning and disinfection are critical measures to prevent cross-infection. When restoring normal functions at the end of the epidemic, terminal disinfection measures should be carried out to ensure the existence of no

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virus.

Effectiveness of personal protective measures play a crucial role in reducing SARS-Cov-2 transmission. These measures include conduction of personal protection training, ensuring adequate personal protective equipment (PPE), standardizing the process of putting on and taking off PPE, establishing a place to put on and take off PPE, and setting up supervision and auxiliary personnel to check the wear of PPE for people entering and leaving the contaminated/potentially contaminated areas. Staff work in makeshift hospitals should wear appropriate PPE. In clean areas, primary protection (disposable surgical cap, surgical mask, work uniform and disposable latex gloves) is needed. When carrying out high risk activities (such as diagnosis and management of confirmed cases, epidemiological investigations, case transfer, corpse treatment, environmental cleaning/disinfection and specimen collection) or entering contaminated areas/ potentially contaminated areas, secondary protection (disposable surgical cap, disposable medical protective uniform, N95 mask/powered air-purifying respirator, goggles and/or face shield, disposable latex gloves, shoe covers) should be used. All COVID-19 patients in makeshift hospitals should wear medical masks.

The hands of medical staff and the support team members often get contact with patients and the environmental surfaces contaminated by patients. There is a risk of cross-infection if the hand hygiene of medical staff and patients is insufficient. Strict hand hygiene measures should be taken in daily work, especially before putting on PPE, before performing aseptic operation on patients, after contact with patients' blood, body fluids and contaminated environmental surfaces, and in the process of removing PPE. The number of hand hygiene facilities should be matched with the workload of the treatment. When there are visible contaminants, the hands should be washed with soap and running water. If soap and clean running water are not available, use alcohol-based hand sanitizers or other hand disinfectants to maintain hand hygiene.

Droplets and intimate contact may be the main routes of transmission of COVID-19. Confirmed cases with COVID-19 can produce virus-borne droplets and aerosols when speaking, coughing, and sneezing[2]. So, there is a possibility of aerosol transmission when exposed to high concentrations of aerosols for a long time in a relatively closed environment. Studies have shown that SARS-Cov-2 can survive for up to 3 h in the aerosol state, 4 h on the copper surface, 24 h on the cardboard surface, and up to 2–3 days on plastic or stainless steel surfaces under laboratory conditions in a relative humidity of 40%–65% and at temperature of 21 °C–23 °C[3]. It is suggested that the medical staff in makeshift hospitals are in high-risk environment. Environmental cleaners and security guards are also exposed to contaminated environments.

At present, there is no direct data on the resistance of SARS-Cov-2. Based on previous knowledge of coronaviruses, commonly used disinfectants could be able to kill SARS-Cov-2, such as chlorine-based disinfectant, chlorine dioxide, hydrogen peroxide, peracetic acid, and compound quaternary ammonium salts. All disinfectants should be used strictly in accordance with the manufacturer's instructions. In the daily disinfection work of the makeshift hospitals, it's recommended to use chlorine-based disinfectant aqueous solution with available chlorine concentration of 1,000 mg/L to disinfect the surface of environmental objects, and a concentration of 5,000 mg/L for items contaminated by blood or body fluids. Quaternary ammonium salt disinfectants (1,000–2,000 mg/L) can be used for disinfection objects that are easily to be corroded. The disinfection and cleaning utensils in the contaminated areas, possible contaminated areas, and clean areas shall be marked in different colors and shall not be mixed.

The surfaces of highly frequent touched objects, and the public goods that get contacted and used by patients should be disinfected timely. Personnel training should include selection, configuration, and usage of disinfectants. The disinfection frequency should be adjusted based on the degree of pollution on the surface of the object and the frequency of patient contact.

SARS-Cov-2 has been detected in stool and urine specimens[4,5], suggesting them as risks of aerosol or contact transmission due to environmental pollution. Sewage and feces should be collected centrally and treated in a harmless manner. Supervision personnel should be arranged to administer disinfection. The waste of patients and the waste generated by diagnosis and treatment activities should be treated as medical wastes.

During sterilization, process monitoring and sterilization quality control should be conducted well. Daily disinfection activities need to be recorded, including disinfectant name, disinfectant concentration, disinfection frequency and disinfection time. The disinfectant products must be legal and effective, and strictly follow the product

instructions.

The makeshift hospitals that have been used need to undergo terminal disinfection to restore their previous functions. Terminal disinfection of potentially contaminated areas and contaminated areas in makeshift hospitals should be focused on. The final disinfection objects mainly include indoor air, environmental objects, floors, walls, used disposable items, medical treatment equipment, bedclothes medical fabrics, etc. Only after final disinfection, the related articles and building materials can be cleared and transported. Terminal disinfection needs to be conducted by professionals under the guidance of the local disease control agency. When the final disinfection is done, a disinfection effect evaluation by the local disease control agency should be done.

The air in the ward might be contaminated by viruses, and if the exhaust vent is close to the residential area and the exhaust air is not filtered or disinfected, then there is a risk of pollution spread. It is recommended to use exhaust air devices with a high-efficiency filter and disinfection spray. The exhaust air measures should be organized and adopted as the volume of the exhaust air in the contaminated area is greater than the air supply volume in the potentially contaminated area. This ensures that the direction of air flows from the clean area to the potentially contaminated area, and then to the contaminated area. Buffer rooms should be set up reasonably between each ward.

Promote people to develop good hygiene habits to prevent infection of COVID-19, which include regularly cleaning hands with an alcohol-based hand rub or with soap and running water; maintaining at least 1-meter distance between yourself and others, following good respiratory hygiene. Protective knowledge propaganda and psychological counseling could be carried out to patients through radio, TV, mobile social software, etc.

Patients are admitted to the makeshift hospitals in a centralized manner, and there are potential dangers of clustering infections from other infectious diseases, such as diarrhea, influenza, tuberculosis or other infectious diseases. To prevent and reduce the occurrence of infectious diseases and public health emergencies in makeshift hospitals, a corresponding work plan should be formulated in advance, and the plan should be effective and feasible.

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