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An innovative two-wing model for balancing the demands of inpatients with COVID-19 and general medical service in a designated hospital for COVID-19 in Shenzhen, China

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SUMMARY Since COVID-19 was first reported in 2019, the pandemic has posed a great threat to human health. Due to its multiple transmission pathways and virus mutation, this epidemic may be protracted further, and it has already placed a heavy burden on healthcare systems. A strategy needs to be devised to address both needs for COVID-19 treatment and demands for general medical service. A two-wing model of hospital operation, which provides a safe treatment environment for patients, an On duty/On Standby work approach for medical staff, and a reliable surveillance system for hospital operation, is an effective management template to help achieve a balance between multiple demands for medical service in this new era of a long-term war against COVID-19.

Keywords SARS-CoV-2, model of hospital operation, healthcare personnel

1. Introduction

Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory coronavirus 2 (SARS-CoV-2), which has thus far infected over 430 million people globally (*1*). Droplets, aerosols, physical contact, and the digestive tract are all possible transmission pathways (*2,3*). Due to its multiple transmission pathways and virus mutation, this epidemic could be further protracted, and it has already placed a heavy burden on healthcare systems (*4*). A strategy needs to be devised to address both needs for COVID-19 treatment and demands for general medical service. As the designated hospital for COVID-19 in Shenzhen, a city with over 12 million residents, this facility has developed an innovative two-wing model of operation (Figure 1). This mode involves a safe treatment environment for patients, an On Duty/On standby work approach for medical staff, and a reliable surveillance system. To the extent known, this is the first hospital to adopt such a model to balance and address demands for general medical care and COVID-19 treatment in China.

2. Two wings of the hospital

In the early stages of the COVID-19 pandemic in January 2020, there were over 18 admissions per day on average to this hospital. Given the potential for nosocomial infection among patients, most other patients were transferred to other hospitals. Afterwards, an isolation wing located next to the original wing was officially opened in June 2020, with negative pressure wards for patients. Patients with COVID-19 were admitted to the isolation wing, whereas patients with other conditions were admitted to the original wing. In line with this two-wing approach, 1,739 patients with COVID-19 were admitted to the isolation wing as of February 28, 2022, while medical personnel in the original wing cared for an average of 1,836 outpatients and 832 inpatients per day. Evaluation of the quality of hospital administration is a complex task that involves numerous variables, the most essential and sensitive of which are patient satisfaction and treatment outcomes (*5*). Patient satisfaction with this hospital's care was an average of 92% and the rate of successful treatment was an average of 86% while the two-wing model has been operation. There were no nosocomial infections in either wing and no deaths among inpatients with COVID-19.

(A)

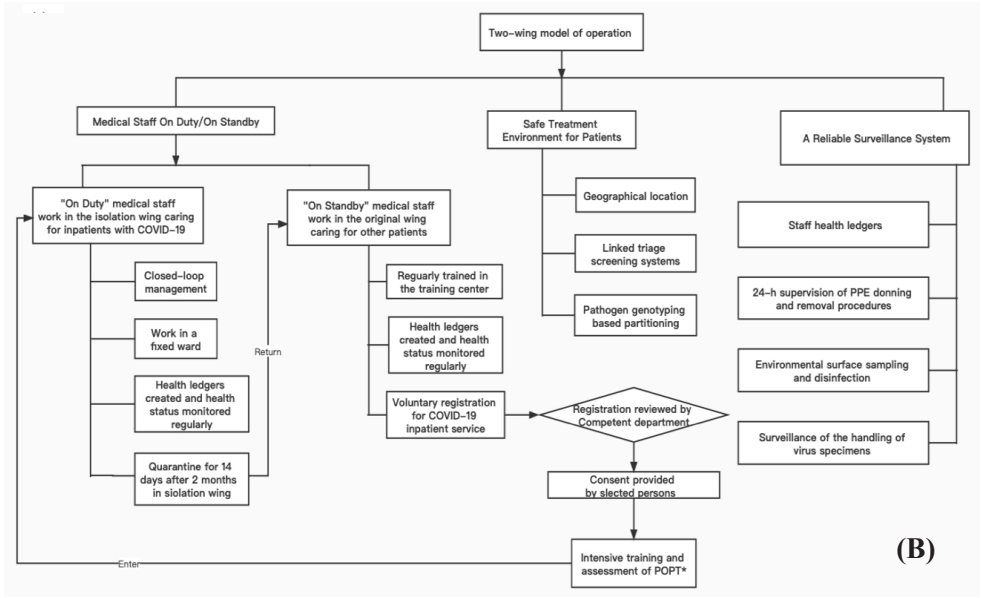

Figure 1. (A), Layout of the two wings. (B), Two-wing model of operation. * POPT: Personal Occupational Protection Technology.

3. Three characteristics of the two-wing model of operation

3.1. Safe treatment environment for patients

3.1.1. Geographical location

The two wings are adjacent, and there is a small hillside between them that acts as a natural barrier (Figure 1). The isolation wing is located downwind of the original wing, and air flows from the original wing to the isolation wing, which satisfies the layout requirements for an site to treat airborne diseases (*6*). Moreover, negative pressure in the isolation wards allows for the disinfection of contaminated air in patient wards before discharge. Both features ensure the biosecurity of air in the surrounding area.

3.1.2. A triage screening system

During the COVID-19 pandemic, patients with relevant symptoms of COVID-19 must undergo screening to rule out COVID-19 before completing subsequent medical treatment. Fever clinics 1 and 2 were established in the isolation wing and original wing, respectively. Patients with relevant symptoms are screened in fever clinic 2, whereas those with an epidemiological history or suspected cases are screened in fever clinic 1, where a dedicated ward was set up for patients suspected of having COVID-19 to wait for their screening results in a single room. A previous study by the current authors (*7*) indicated that the rate at which inpatients with COVID-19 were detected by fever clinic 1 was significantly higher than that the rate at which inpatients were detected by fever clinic 2, indicating that the linked triage screening system (Figure 2) can lower the risk of cross-infection among out-patients.

3.1.3. Pathogen genotyping-based separation of COVID patients and staff

Given the differing level of pathogenicity among SARS-CoV-2 variants (*8,9*), patients were assigned to separate wards based on viral genotypes to avoid cross-infection

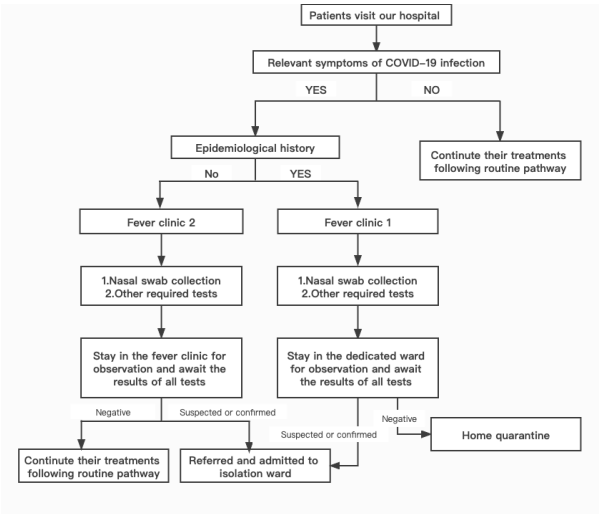

Figure 2. The operation of a triage screening system.

among inpatients. A closed-loop pattern for the handling of virus specimens was also implemented. An electronic monitoring system is used to constantly monitor the status of specimens, including the state of detection, the individual who delivered the specimen, and inspectors. Medical personnel and inspectors are restricted from working in multiple wards and laboratories dealing with different genotypes. Their accommodations are also separated.

3.2. Medical personnel who are "On Duty/On Standby"

Along with vaccination campaigns and other measures, China has made tremendous success in controlling the epidemic. Healthcare personnel are extremely valuable and crucial in addressing the COVID-19 crisis since they are the key to quality healthcare (*10,11*). The two-wing model involves an "On Duty/On Standby" approach to work by personnel based on the severity of the epidemic, which allow medical facilities make the best use of human resources and maintain their mental health.

While "On Standby": In the original wing, there are 37 units dedicated to the treatment of conditions other than COVID-19. Staff who work in the original wing are considered to be "On Standby." While on standby, they provide care to patients with conditions other than COVID-19 and they also receive skill training. A point worth noting is that a training center for infectious disease scenarios, the first of its kind in China, was built; this immersive teaching approach enhances the skills of medical personnel without requiring them to enter infectious disease wards. With the support of this training center, medical personnel are always "On Standby" to care for patients with COVID-19.

While "On Duty": Staff who work in the isolation wing are "On Duty". Staff come "On Duty" when an outbreak of COVID-19 occurs or "On Duty" workers rotate in and out. Medical staff can voluntarily sign up to work in the isolation wing and are selected by a competent department depending on their health status, experience, skill in treating infectious diseases, etc. Selected individuals will rotate into isolation wards, with each shift lasting two months. Closed-loop management of isolation wing personnel has been implemented, including designated accommodations while working and quarantine in a designated hotel for 14 days after they finish work in the isolation wards. Regular rotation can substantially safeguard the mental health of medical staff and reduce the adverse impact that isolation might have.

3.3. A reliable surveillance system

3.3.1. A system to surveil the health status of personnel

Health ledgers were created for medical staff, general staff, patient escorts, and other visitors to the hospital to monitor their health status and identify high-risk individuals or individuals suspected of being infected at the earliest stage possible. The ledger contains health information, including temperature, relevant COVID-19 symptoms, COVID-19 vaccination status, and the antibody titer. In addition, medical staff are tested for COVID-19 on a regular basis, with the frequency varying depending on their working conditions. For staff working in the isolation wing, testing is conducted once every one or two days, while for those in the original wing, it is conducted once every week or varied depending on the status of the epidemic.

3.3.2. 24-hour supervision of personal protective equipment donning and removal

Personal protective equipment (PPE) is essential for avoiding occupational exposure, and especially when working in a contagious environment (*12*). However, one study reported that occupational exposure was sometimes caused by improper wearing and removal of PPE resulting in contamination of the hands or mucous membrane (*13*). In the designated hospital for COVID-19, a monitoring system was implemented and an intercom was used to supervise PPE wear 24 hours a day in isolation wards and to identify high-risk procedures and individuals when donning and removing PPE based on collected data (*14*). These results helped to revise and prioritize training plans, resulting in a more efficient training system.

3.3.3. Environmental surface sampling and disinfection

SARS-CoV-2 has been proven to spread via many routes (*2,3*). The current authors previously found that there was no correlation between environmental factors and symptoms in patients with COVID-19 (*15*). Disinfection of contaminated surfaces is as critical as disinfection of

other transmission pathways. High-risk contaminated surfaces, including door handles, patient beds, and the ward floor, were regularly sampled in both the isolation and original wings to detect the virus. The frequency of sampling in the two wings varied depended on the risk level in different areas and ranged from twice a week to once a month. The disinfection of environmental surfaces varied depending on the area.

4. Conclusion

The adoption of a two-wing model in a designated hospital for COVID-19 has provided an effective management template for a normalization response to pandemic control, and especially in terms of preventing nosocomial transmission and effective utilization of medical resources. This approach can help to achieve a balance between COVID-19 management and general demands for medical service in this new era of a long-term war against COVID-19.

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