

Prevention and Control Strategies of Nosocomial Infection and Effectiveness Evaluation in a Tertiary Teaching Hospital during the Epidemic of COVID-19

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Abstract

Objective: To evaluate the role of prevention and control strategies for nosocomial infection in a tertiary teaching hospital during the sudden outbreak of Corona Virus Disease 2019 (COVID-19). **Methods:** The hospital initiated an emergency plan involving multi-departmental defense and control. It adopted a series of nosocomial infection prevention and control measures, including strengthening pre-examination and triage, optimizing the consultation process, improving the hospital's architectural composition, implementing graded risk management, enhancing personal protection, and implementing staff training and supervision. Descriptive research was used to evaluate the short-term effects of these in-hospital prevention and control strategies. The analysis compared changes in related evaluation indicators between January 24, 2020 and February 12, 2020 (Chinese Lunar New Year's Eve 2020 to lunar January 19) and the corresponding lunar period of the previous year. **Results:** Compared to the same period last year, the outpatient fever rate increased by 1.85-fold ($P < 0.001$), while the hand hygiene compliance rate in-



creased by 32.20% this year ($P < 0.001$). From January 24 to February 12, 2020, 103 cases were isolated for observation, 15 of which were suspected of COVID-19, with one confirmed diagnosis; importantly, none were among the medical staff. A total of 16 problems were identified, with a problem resolution rate of 81.25%. **Conclusion:** The nosocomial infection prevention and control strategies implemented during this specific period improved the detection and control abilities for the COVID-19 source of infection and enhanced the compliance with measures. This likely contributed significantly to avoiding the occurrence of nosocomial infection.

Keywords

Corona Virus Disease 2019, Nosocomial Infection, Prevention and Control Strategy, Effectiveness Evaluation

1. Introduction

At the end of 2019, the Corona Virus Disease 2019 (COVID-19), emerged as a novel infectious disease characterized by sudden onset, high transmissibility, various transmission routes, mutability, and significant challenges in prevention and severity of illness. It has significantly impacted human life, safety, and social and economic development. In response, the World Health Organization (WHO) declared it an “international public health emergency” [1] [2] [3] [4]. Subsequently, on January 20, 2020, China classified COVID-19 under Class B infectious diseases but managed it according to the more stringent Class A infectious diseases guidelines [5]. The virus generally sees the population as susceptible, leading to numerous COVID-19-related nosocomial infections reported in ordinary departments amongst medical staff [6]-[11]. Furthermore, infection control measures in medical institutions have encountered several challenges [10] [11], making the prevention and control of nosocomial infections notably difficult.

Although our hospital is not designated for the admission of COVID-19 patients, suspected cases could be admitted. Therefore, achieving the “four early” policy—early detection, early isolation, early diagnosis, and early treatment—is necessary to promptly prevent nosocomial cross-transmission and ensure the safety of healthcare and medical personnel. In response to the epidemic situation and to prepare for the potential influx of a large number of cases in a short period, our hospital has launched an emergency plan. This plan includes a series of measures aimed at promptly identifying COVID-19 cases, avoiding missed diagnoses and misdiagnoses, and preventing nosocomial infections, especially among medical staff.

2. Methods

2.1. Setting

The First Affiliated Hospital of Zhejiang Traditional Chinese Medical Universi-

ty, a tertiary teaching hospital situated in Hangzhou, Zhejiang Province, boasts 2060 beds, serves 2.7 million outpatients annually, and discharges 60,000 patients every year. It records approximately 30,000 fever-related outpatient visits annually.

2.2. Establishment of Special Working Groups

The following groups were established: Leadership, Diagnosis and Treatment, Infection Prevention and Control, Material Security, Logistics Support, Public Opinion and Information, Student Management, and Supervision. Emergency response was implemented throughout the hospital. The Spring Festival vacation was canceled, and multi-departmental cooperation for prevention and control was implemented.

2.3. Strengthening Pre-Examination and Triage Procedures

A temperature monitoring station is established at the hospital entrance to assess the temperatures of all entering patients, companions, and staff. Individuals exhibiting a temperature of $\geq 37.3^{\circ}\text{C}$ must visit the fever clinic for further consultation. At the entrances of both outpatient and inpatient buildings, patients are questioned about their epidemiological history and any presence of respiratory symptoms. Regardless of fever presence, individuals displaying respiratory symptoms or with a COVID-19 epidemiological background are directed to the fever clinic.

2.4. Reconstruction of the Isolation and Observation Ward

Two medical wards, comprising 65 beds each, were transformed into an isolation and observation ward in just three days. This newly configured space included separate passages for staff, patients, cleaning item delivery, and sewage. The ward was divided into three key zones: cleaning areas, potentially contaminated areas, and contaminated areas. The cleaning zones housed changing rooms, doctors' offices, and restrooms. Meanwhile, the potentially contaminated zones featured chemical storage rooms, nurses' offices, and rooms for preparing various articles. The contaminated zones were made up of observation and isolation rooms, alongside rooms designated for the disposal of contaminated materials. Furthermore, one of the additional medical wards, also consisting of 65 beds, was repurposed; half of it became a staff medical observation ward, and the other half served as an employee dormitory.

2.5. Restrictions on General Outpatient and Inpatient Services

From January 24 to February 29, the Stomatology Department, Otolaryngology Department, Ophthalmology Department, and Pulmonary Function Room were closed. Expert Clinics, Special Needs Clinics, and Specialist Clinics were suspended, while General Clinics remained open. Additionally, elective surgery was suspended during this period.

2.6. Strengthening of Nosocomial Infection Prevention and Control

2.6.1. Formulation of Systems and Programs

Six main systems and programs were developed, continuously updated, and optimized in accordance with the latest national and provincial documents to make them scientific, reasonable, and effective. These include: 1) Graded protection scheme and different posts protection standards (See Supplementary appendix **Table 1**); 2) The process for putting on and taking off personal protective equipment (Refer to Supplementary appendix **Figure 1**); 3) Instructions for the use of personal protective equipment in short supply; 4) Standard operating procedures (SOP) for cleaning and disinfecting environments affected by COVID-19; 5) Procedures for the disposal of medical waste stemming from COVID-19; 6) Key points of prevention and control of COVID-19.

2.6.2. Risk Classification Management

1) Key departments, including fever clinics (for both pediatrics and adults), respiratory clinics, isolation and observation wards, medical imaging departments, and polymerase chain reaction (PCR) laboratories, were identified as critical control points in the management of COVID-19. These departments underwent strict partition management, further categorized into clean areas, potentially contaminated areas, and contaminated areas. The activities and protective measures within these three zones were rigorously defined to ensure compliance with infection control standards.

2) Risk Department: A protective scheme was established for the stomatology department, endoscopic center, ophthalmology, pulmonary function room, otolaryngology department, hemodialysis room, obstetrics and gynecology department, emergency department, and emergency operation.

3) General outpatient clinic: The outpatient consultation process was formulated and optimized. The protection requirements for personnel in different positions were categorized and can be found in Supplementary Appendix **Table A1**.

4) General Ward: The department's infection control group comprises a department director, head nurse, infection control doctor, and infection control nurse. This group is tasked with the training, assessment, supervision, and improvement initiatives within the undergraduate department.

5) Logistics Support Department: The Joint Logistics Support Department, along with the Medical Security Department, Information Department, and Security Department, conducted training and assessments on nosocomial infection prevention and control. This training was targeted at personnel who might come into contact with patients or enter high-risk departments. Participants included cleaning staff, engineering service staff, transportation staff, equipment engineers, information engineers, and security staff.

2.6.3. Personal Protection Management

The National and Provincial Health Committee requirements for the protection against COVID-19 were strictly implemented. A protection plan, tailored to the

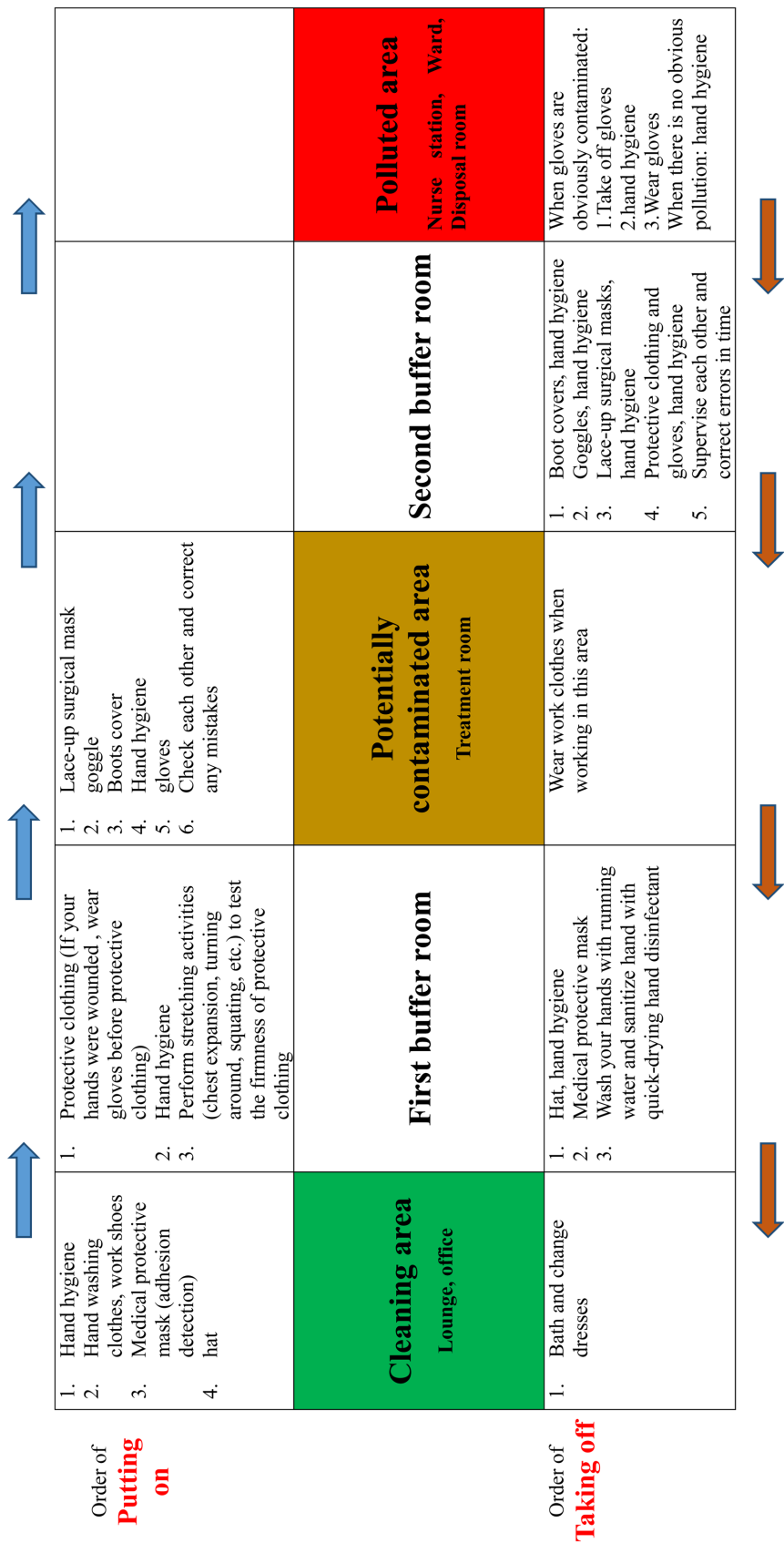


Figure 1. Flow chart of putting on and taking off protective equipment.

specific needs of our hospital, was developed. The procurement department ensured that all acquired or donated protective materials were inspected by infection control professionals. This was to confirm compliance with national standards or other relevant benchmarks. Due to the scarcity of certain supplies (such as protective clothing, gowns, medical protective masks, eye masks, and face masks), centralized limited distribution was enforced. This approach aimed at promoting scientific use and preventing overuse of these vital resources. Additionally, an alternative plan was established to ensure emergency preparedness in case the primary strategy proved insufficient.

2.6.4. Intensive Full Staff Training

Various online and offline methods were used to enhance staff training. A learning plan was accessible via the DingDing App on mobile phones. Staff from isolation and observation wards, fever clinics, medical imaging departments, laboratory departments, and logistics support departments underwent face-to-face training. The proficiency in donning and doffing personal protective equipment was evaluated by infection control professionals for each individual.

2.6.5. Strengthening Supervision

Three infection control professionals were appointed to oversee the clinic for at least half a day to implement nosocomial infection prevention and control measures. The fever clinic and isolation and observation ward adopted a 24-hour “two members, two supervision” system. An infection supervisor was stationed in each clinical and logistics service department to report daily results, which were then summarized and analyzed for further improvements. Although issues were resolved on the same day, the implementation of rectified measures was not instantaneous.

2.7. Effect Analysis

2.7.1. Control of the Source of Infection

The management efficiency of febrile patients with the outpatient rate of the fever clinic was evaluated. The outpatient rate of the fever clinic during Chinese Lunar New Year’s Eve 2020 to the lunar January 19 (January 24-February 12, 2020) was compared to that during the lunar time last year (lunar February 4-February 23, 2019). The outpatient rate of fever clinic = (the number of fever outpatients/the total number of outpatients and emergency outpatients during the same period) \times 100%. The isolation observation rate, the proportion of suspected patients in isolation, and the proportion of confirmed patients in isolation were used to evaluate the control of the source of infection. The data were collected from January 24 to February 12, 2020. Isolation observation rate = (The number of patients in isolation/(the number of fever outpatients + newly admitted patients in the same period)) \times 100%. The proportion of suspected patients in isolation = (total number of suspected patients/isolated patients) \times 100%. The proportion of confirmed patients in isolation = (confirmed patients/suspected patients) \times 100%. The definition of suspected and confirmed cases is mentioned

in “The Diagnosis and Treatment Plan of New Coronavirus Pneumonia (Trial Version 6)” [5]. The data were obtained from the medical record system.

2.7.2. Staff Exposure Assessment and Medical Observation

Under the graded protection scheme, the infection diagnosis and treatment team, alongside the infection prevention and control expert group, assessed the effectiveness of personal protective measures for staff who were in close contact with suspected and confirmed cases. They then determined the need for medical observation [12]. The duration of medical observation was set at 14 days.

2.7.3. Compliance Analysis of Nosocomial Infection Prevention and Control Measures

Hand hygiene compliance was utilized as a metric to assess the implementation rate of prevention and control measures within the hospital. This measure, alongside hand disinfectant consumption, was evaluated from the eve of the Chinese Lunar New Year 2020 to lunar January 19 (January 24-February 12, 2020), and compared to the corresponding period in the previous year (February 4-February 23, 2019). An infection-control nurse monitored hand hygiene compliance across several departments, including the emergency department, fever clinic, infectious disease department, ICU, hematology, oncology, neurology, and gastrointestinal surgery departments. The observation methods adhered to the WHO Observation Tool [13]. The consumption data for hand disinfectants, classified as hazardous chemicals requiring usage records in each department, was obtained through consultation of these records.

2.7.4. Problem Solving

To improve the problems detected between January 20 and February 12, 2020, four lists, problem, rectification, responsibility, and problem-solving, were established, which required coordination among multiple departments. Problem resolution rate = (number of solved problems/number of problems) × 100%.

2.8. Data Analysis

SPSS 22.0 software (IBM, Armonk, NY, USA) was used to perform statistical analysis. A chi-square test was used to compare the rates. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Source of Infection Control

3.1.1. Outpatient Rate of Fever Clinic

Compared to the lunar period of the previous year, the outpatient rate of the fever clinic increased by 1.85-fold in the current year (4.64% vs. 1.63%, $P < 0.001$) (See **Table 1**).

3.1.2. Isolation Observation

103 cases were observed in isolation, of which 15 were suspected of COVID-19,

and 1 was diagnosed with COVID-19. The isolation observation rate stood at 4.89%. The proportions of suspected and confirmed patients in isolation were 14.56% and 0.97%, respectively (See **Table 2**).

3.2. Medical Observations of Staff

Three individuals were in close contact with two suspected patients under medical observation. These patients tested negative for the novel coronavirus nucleic acid twice over an interval of more than 24 hours. Additionally, two staff members were in close contact with a confirmed patient under medical observation. Nevertheless, no infections were reported at the end of the medical observation period.

3.3. Hand Hygiene Implementation Rate

Compared to the same period last year, the compliance rate of hand hygiene increased by 32.20% (65.28% vs. 86.30%, $P < 0.001$), and the consumption of hand disinfectant increased by 1.57-fold at the inpatient department (13.19 mL/bed

Table 1. Changes in outpatient, emergency, and admission numbers compared to the same lunar time last year.

Variable	January 24-February 12, 2020	February 4-February 23, 2019
Number of outpatients	17,458	77,616
Total number of outpatient and emergency patients	21,566	87,231
Number of admissions	1106	3910
Number of bed days actually occupied	12,892	27,948
Number of fever outpatients	1000	1418
Outpatient rate of fever clinic (%)	4.64*	1.63

Note: * $P < 0.001$.

Table 2. Suspicious COVID-19 isolation observation situation.

Variable	January 24-February 12, 2020
Number of people in isolation	103
Fever clinic transfer	96
General ward transfer	7
Number of COVID-19 suspected patients	15
Number of COVID-19 confirmed patients	1
Isolation observation rate (%)	4.89
Proportion of suspected patients in isolation (%)	14.56
Proportion of confirmed patients in isolation (%)	6.67

day vs. 5.13 mL/bed day), and increased by 4.42-fold at the clinic (1.68 mL/patient vs. 0.31 mL/patient) (See **Table 3**).

3.4. Problem Solving

Sixteen problems were listed as of February 12, 2020. Of these, 13 were resolved, and three were under continuous improvement (See **Table 4**). The problem resolution rate was 81.25%.

4. Discussion

In response to the COVID-19 epidemic, the hospital implemented a series of measures aimed at enhancing the detection of infection sources and ensuring adherence to prevention and control protocols, thereby reducing the risk of nosocomial infections. The period from January 24 to 30, 2020, coincided with the Chinese Spring Festival holiday. Due to the COVID-19 outbreak, the holiday was extended to include the Lantern Festival on February 8, 2020. During this time, there was a notable decrease in outpatient, emergency, and hospital admissions compared to the same period in the previous year. However, there was a significant increase in the rate of fever cases observed in the clinic, suggesting that the strengthened pre-examination and triage measures markedly improved case detection and decreased the likelihood of missed diagnoses. This paper discusses the effective isolation of one COVID-19 case from among 103 individuals undergoing isolation and observation, which helped minimize close contact between patients.

We exercised caution regarding the exposure of medical staff to protect each staff member who came into close contact with suspected or confirmed COVID-19 patients. Every staff member received effective protection and underwent an exposure risk assessment, given any possibility, however slight, of protection failure. We recommended medical observation for those in contact with suspected patients until such patients were ruled out. Ultimately, none of the five cases under medical observation contracted the infection.

Table 3. Hand hygiene compliance rate compared to the same period last year.

Variable	January 24- February 12, 2020	February 4- February 23, 2019
Hand hygiene compliance		
Number of hand hygiene opportunities	365	337
Number of hand hygiene actually performed	315	220
Hand hygiene compliance rate (%)	86.30*	65.28
Consumption of Hand disinfectant		
Hospitalization (mL/bed day)	13.19	5.13
Outpatient and emergency (mL/patient)	1.68	0.31

Note: * $P < 0.001$.

Table 4. Four lists for solving problems.

Number	Problem list	Rectification list	Responsibility list	Problem-solving list
1	How to find fever patients for the first time?	Set up temperature monitoring points at each entrance of the hospital.	Outpatient office, Nursing department, Security department	Solved
2	How to avoid forgetting to ask about epidemiological history?	Add an epidemiological history to the outpatient and inpatient electronic system. If you do not complete it, you cannot proceed to the next step.	Medical department, Outpatient office	Solved
3	How to monitor the symptoms and temperature of family members and caregivers of inpatients?	Guide proactive health notifications and take temperature measurements twice in the morning and evening.	Nursing department	Solved
4	Isolation/observation room is not enough; how to isolate patients in the first place?	Reconstruction of two general medical wards into isolated observation wards.	Medical department, Nursing department, Department of infection control	Solved
5	What to do for patients with symptoms from the epidemic area for more than 14 days of medical observation period?	A special consultation room is set up in the emergency area. And a specialist is required to come over for treatment.	Medical department, Emergency department	Solved
6	How to deal with fever patients in whom the possibility of infectious diseases has been eliminated?	A special consultation room is set up in the emergency area. A specialist is required for the treatment.	Medical department, Emergency department	Solved
7	How can medical staff strengthen their protection?	Develop a graded protective plan, set up a nosocomial infection protection supervision posts to supervise the implementation of protective measures.	Department of Infection control, Medical department, Nursing department	Solved
8	How to arrange a route for a suspected patient?	Find the route of least crowd contact. Set up a dedicated elevator, and establish a procedure of examinations outside the clinic and hospitalizations for fever outpatients; procedures of the transfer and inspection for patients in isolation and observation; procedure of fever patients to fever clinic. More than a dozen medical procedures in total.	Medical department, Department of infection control, Nursing department, Logistics support department, Outpatient office	Solved
9	How to strengthen daily disinfection?	The environmental cleaning and disinfection SOP during the COVID-19 was formulated. All original clean level areas were updated to disinfection level.	Department of infection control, Logistics support department	Keep improving
10	How to perform terminal disinfection in patients with COVID-19?	First use Endipen (compound quaternary ammonium salt spray) to disinfect the surface of environment and then perform conventional terminal disinfection.	Department of Infection control, Logistics Support department, Nursing department	Solved

Continued

11	How to treat medical waste in patients with COVID-19?	Double-layer medical garbage bag, 3/4 full, sealed with gooseneck knot, and put another medical garbage bag before taking out the contaminated area.	Department of infection control, Logistics support department	Solved
12	How to deal with medical fabrics used by patients with COVID-19?	Seal into soluble storage bag and transport to an outsourced washing company for processing.	Department of infection control, Logistics support department,	Solved
13	What about emergency surgery?	Develop an emergency surgical treatment procedure, screen for novel coronavirus nucleic acid before surgery, and perform surgery in negative pressure surgery for patients with unknown infection of COVID-19. Surgery for patients with a limited period of time should be performed after twice negative novel crown nucleic acid test (more than 24 h between two times).	Medical department, Department of infection control	Solved
14	How can employees resume work safely?	The returnees from the affected area should not go to work before 14 days of isolation at home.	Human resources department, Preventive health division	Solved
15	How to strengthen training?	Full-staff training through various online and offline ways.	Department of infection control, Medical department, Nursing department, Logistics Support department.	Keep improving
16	How to ensure that measures are put in place?	Establish nosocomial infection supervision posts and implement two-level management of hospitals and departments.	Department of infection control, Medical department, Nursing department, Logistics support department.	Keep improving

Hand hygiene serves as a key indicator of compliance with prevention and control measures. The data on hand hygiene were not specifically collected for this study, as they represent a routine aspect of hospital infection control. It is widely recognized as one of the most effective infection control practices. Additionally, the rate of hand disinfectant usage provides evidence of improved compliance with hand hygiene practices. During the epidemic, the placement of hand disinfectants in the clinic increased compared to the same period in the previous year. Consequently, the residual amounts in dispensers also increased, indicating that the consumption of hand disinfectants in outpatient and emergency departments was higher than the actual consumption reported.

Based on current findings, it is deducible that engineering prevention (physical isolation) served as the foundational method for controlling respiratory droplet-borne diseases. Administrative prevention, encompassing the establishment of systems, risk management, training, supervision and inspection, and multi-department joint prevention and control, acted as a safeguard against the spread of diseases. Personal protection, including the correct use of protective

equipment, represented the last line of defense in occupational protection, where precision was critical and errors were unacceptable.

There are no perpetual hard winters and no late springs. The collective efforts of the hospital staff have enabled us to navigate through this challenging period successfully. We have made significant advancements in combating the COVID-19 pandemic, underlining the importance of continuing to analyze and share our experiences. This will enhance prevention and control strategies for similar or emerging infectious diseases in the future. The series of prevention and control measures implemented have proven to be effective, serving as a valuable guide for future emergency responses to epidemics. Additionally, these measures will improve our ability and efficiency in managing public health emergencies. They also offer a reference point for global health security, thereby strengthening the stability and resilience of the global health security system [14].

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Du, Y.B. (2022) Research on COVID-19 Epidemic Prevention and Control Strategies Based on Infectious Disease Models and Statistical Analysis Methods. Doctoral Thesis, Hunan Normal University, Changsha. <https://doi.org/10.27137/d.cnki.ghusu.2021.000283>
- [2] Zhu, N., Zhang, D., Wang, W., *et al.* (2020) A Novel Coronavirus from Patients with Pneumonia in China, 2019. *The New England Journal of Medicine*, **382**, 727-733. <https://doi.org/10.1056/NEJMoa2001017>
- [3] World Health Organization. WHO Coronavirus (COVID-19) Dashboard. <https://covid19.who.int/data>
- [4] National Health Commission of the People's Republic of China (2022) Diagnosis and Treatment Plan for Novel Coronavirus Pneumonia (Trial Ninth Edition). <http://www.nhc.gov.cn/yzygi/s7653p/202203/b74ade1ba4494583805a3d2e40093d88/files/ef09aa4070244620b010951b088b8a27.pdf>
- [5] The General Office of the National Health Commission and the Office of the State Administration of Traditional Chinese Medicine (2020) The Diagnosis and treatment plan for Novel Coronavirus Pneumonia Infection (Trial Version 6). <http://www.nhc.gov.cn/xcs/zhengcwj/202002/8334a8326dd94d329df351d7da8aefc2.shtml>
- [6] Wang, D., Hu, B., Hu, C., *et al.* (2020) Clinical Characteristics of 138 Hospitalized Patients with 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA*, **323**, 1061-1069. <https://doi.org/10.1001/jama.2020.1585>

- [7] Li, Q., Guan, X., Wu, P., *et al.* (2020) Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. *The New England Journal of Medicine*, **382**, 1199-1207. <https://doi.org/10.1056/NEJMoa2001316>
- [8] The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team (2020) Vital Surveillances: The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID-19) in China. *Chinese Journal of Epidemiology*, **41**, 145-151.
- [9] Chan, J.F.-W., Yuan, S.F., Kok, K.-H., *et al.* (2020) A Familial Cluster of Pneumonia Associated with the 2019 Novel Coronavirus Indicating Person-To-Person Transmission: A Study of a Family Cluster. *Lancet*, **395**, 514-523. [https://doi.org/10.1016/S0140-6736\(20\)30154-9](https://doi.org/10.1016/S0140-6736(20)30154-9)
- [10] Comprehensive Team of the Joint Prevention and Control Mechanism of the State Council in Response to the New Coronavirus Pneumonia Epidemic (2021) Report on the Ineffective Prevention and Control of the New Coronavirus Pneumonia Epidemic in Gaocheng People's Hospital and Xinle Traditional Chinese Medicine Hospital, Shijiazhuang City, Hebei Province. <http://www.nhc.gov.cn/yzygj/s7659/202101/2af7f451bcc54b7284636e63f3ffd947.shtml>
- [11] Comprehensive Team of the Joint Prevention and Control Mechanism of the State Council in Response to the New Coronavirus Pneumonia Epidemic (2020) Report on the Situation of the New Coronavirus Pneumonia Cluster Epidemic in Heilongjiang Province. <http://www.nhc.gov.cn/xcs/zhengcwj/202005/9115d2334dfb4b2badcd9a5482f4a9b8.shtml>
- [12] Central People's Government of the People's Republic of China (2020) New Coronavirus Pneumonia Prevention and Control Plan (Fourth Edition). http://www.gov.cn/zhengce/zhengceku/2020-02/07/content_5475813.htm
- [13] World Health Organization (2009) Hand Hygiene: Why, How & When? https://www.afro.who.int/sites/default/files/pdf/Health%20topics/Hand_Hygiene_Why_How_and_When_Brochure.pdf
- [14] Jiang, R.C. (2023) Research on the Basic Experience of China's New Crown Epidemic Prevention and Control. Master's Thesis, Lanzhou University of Finance and Economics, Lanzhou. <https://doi.org/10.27732/d.cnki.gnzsx.2023.000248>

Supplementary Appendix

Table A1. Graded protection and protection standards of different posts.

Post	Protection classification	Recommendations for the configuration of protective materials
Emergency	Pre-examination and triage in Outpatient and emergency	Primary protection 1 Disposable work caps, medical surgical masks and work clothes, quick-drying hand disinfectants, disinfecting wipes; Use a protective face shield if necessary.
	Emergency consulting room, Rescue area, EICU	Primary protection 1 Disposable work caps, medical surgical masks and work clothes, quick-drying hand disinfectants, disinfecting wipes; Wear gloves, protective clothing and face shield if necessary.
	Emergency special consulting room	Primary protection 1 Disposable work caps, medical surgical masks and work clothes, quick-drying hand disinfectants, disinfecting wipes; Wear gloves, protective clothing and face shield if necessary.
Outpatient	General Clinic	Standard protection 0 Medical surgical masks, work clothes, quick-drying hand disinfectants, disinfecting wipes.
	General fever Clinic (Including pediatrics)	Primary protection 1 and above Disposable work caps, medical protective masks, protective glasses, work clothes, isolation gowns, quick-drying hand disinfectants, disinfecting wipes; Wear gloves, protective clothing and disposable shoe covers if necessary.
	Respiratory Clinic, Infectious Disease Clinic	Primary protection 1 Disposable work caps, medical protective masks, work clothes, protective glasses, isolation gowns, quick-drying hand disinfectants, disinfecting wipes; Wear gloves if necessary.
	Oral clinic, ENT clinic	Primary protection 1 Disposable work caps, medical protective masks, protective glasses or face shield, isolation gowns, gloves, quick-drying hand disinfectants, disinfecting wipes; Wear a surgical mask when operating without aerosol.
	Close-up operation in ophthalmology clinic	Primary protection 1 Disposable work caps, medical surgical masks, work clothes, protective glasses, quick-drying hand disinfectants, disinfecting wipes; Wear gloves if necessary.
	Endoscopy Center	Primary protection 1 Disposable work caps, medical surgical masks, work clothes, gloves, quick-drying hand disinfectants, disinfecting wipes; Wear medical protective masks, protective glasses or face shields if necessary.
	Pulmonary function room	Primary protection 1 Disposable work caps, medical protective masks, protective glasses or face shield, isolation gowns, quick-drying hand disinfectants, disinfecting wipes; Wear a surgical mask when operating without aerosol.
Inpatient ward	Isolation ward	Secondary protection 1 and above Disposable work caps, medical protective masks, work clothes, protective glasses, wearing isolation gowns or protective clothing, gloves, disposable shoe covers, quick-drying hand disinfectants, disinfecting wipes; Wear protective clothing, face shield or positive pressure hood if necessary.

Continued

	General ward	Standard prevention 0	Medical surgical masks and work clothes, quick-drying hand disinfectants, disinfecting wipes.
	ICU	Standard prevention 0	Medical surgical masks and work clothes, quick-drying hand disinfectants, disinfecting wipes.
Window units	Pharmacy, Comprehensive Service Counter, Cashier, Volunteer Activities, Admission Preparation Center, Physical Examination Reservation Center	Standard prevention 0	Disposable work cap, medical surgical mask, work clothes, protective face shield, quick-drying hand disinfectants.
Clinical Laboratory	PCR Lab	Tertiary protection 3	Disposable work caps, medical protective masks, work clothes, goggles or full-face respirators or positive pressure hoods, protective clothing, gloves (2 pairs), disposable shoe covers, impermeable barriers, quick-drying hand disinfectants, disinfecting wipes.
	Other laboratories, blood collection windows	Standard prevention 0	Disposable work cap, medical surgical mask, work clothes, gloves, quick-drying hand disinfectants, disinfecting wipes; Wear protective face shield if necessary.
Medical imaging Department	Examination of infected, suspected patients	Secondary protection 2	Disposable work caps, medical surgical masks, work clothes, protective glasses or face shields, isolation gowns, gloves, disposable shoe covers, quick-drying hand disinfectants, disinfecting wipes.
	Examination of Fever outpatients	Primary protection 1	Medical surgical masks, work clothes, isolation gowns, quick-drying hand disinfectants, disinfecting wipes.
	General examination	Standard prevention 0	Medical surgical masks, work clothes, quick-drying hand disinfectants.

Note: 0 Standard prevention: Applicable to medical staff in all treatment places; 1 Primary protection: It is suitable for medical personnel who may contact suspected NCP patients, such as pre-examination and triage clinics, fever clinics, respiratory clinics, and infectious diseases departments; 2 Secondary protection: It is applicable to medical personnel engaged in diagnosis and treatment activities in close contact with suspected or confirmed NCP patients; 3 Tertiary protection: It is applicable to situation when aerosol-generating operations are performed for suspected or confirmed patients during which the patient's respiratory tract secretions, blood, body fluid may spray or splash, such as sputum suction, airway sampling, tracheal intubation and tracheotomy, etc.