

Risk factors and prevention strategies for the occupational exposure of medical staff during the coronavirus disease-19 pandemic (Review)

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Abstract. During the sudden epidemic of this novel coronavirus-induced pneumonia, a number of medical staff were infected and even succumbed to coronavirus disease-19 (COVID-19). Based on the experience of medical professionals from The Hubei 672 Orthopedics Hospital of Integrated Chinese and Western Medicine on this COVID-19 pandemic, the present review summarizes the risk factors associated with the occupational exposure of front-line medical staff. Challenges encountered include insufficient understanding, lack of early protection, environmental factors and routine procedures and the lack of adequate prevention strategies. Overcoming these challenges can potentially enhance awareness of COVID-19 prevention and control among medical staff, in addition to strengthening the personal protection of front-line medical staff, rational area layout, regular disinfection, standardization of daily procedures, reasonable scheduling and early psychological intervention. The present article may serve as a referencing point for the prevention and control of this epidemic.

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1. Introduction

In December 2019, a novel coronavirus-induced pneumonia epidemic began in Wuhan, Hubei, which was officially termed coronavirus disease-2019 (COVID-19) by the World Health Organization thereafter (1). By midnight, March 10, 2020, according to reports from 31 provinces, including autonomous regions and municipalities directly under the central government in China, Xinjiang Production and Construction Corps, there were 16,145 confirmed cases, 4,492 of which were severe, 61,475 cured and discharged cases, 3,158 deaths, 80,778 confirmed and 285 suspected cases (2). Subsequently, a total of 675,886 those who came into close contact with those infected were traced, where 14,607 close contacts were placed under medical observation (2).

During this sudden epidemic, the medical staff are severely affected. During the COVID-19 epidemic, as the high-risk group fighting in the front line, a number of medical staff have been infected. Among the 138 patients diagnosed with COVID-19 continuously admitted to The Zhongnan Hospital of Wuhan University (Wuhan, China) between January 1 and January 28, 2020, the proportion of medical professionals was 40% (1). In addition, among the 1,099 patients with COVID-19 in 552 hospitals across 31 provinces in China, the proportion of medical staff was 2.09% (3). Dr Yixin Zeng, deputy director of the National Health Commission, said in a press conference on February 14, 2020, that by midnight on February 11, 2020, a total of 1,716 confirmed cases had been reported by medical staff, accounting for 3.8% of all confirmed cases in China (4). Among those six patients died, accounting for 0.4% of all COVID-19-associated deaths in China (4). In addition, Hubei province reported 1,502 cases confirmed by medical staff, accounting for 87.5% of the total (4). Wuhan reported 1,102 cases confirmed by medical staff, accounting for 73.4% of the cases confirmed by medical staff in Hubei province (4). Therefore, reasonable analysis of risk factors for the occupational exposure to medical staff and effective prevention measures may reduce the incidence of infection among medical staff.

Hubei 672 Orthopedics Hospital of Integrated Chinese and Western Medicine has been designated as one of the hospitals that has treated a large number of patients with COVID-19

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in January 2020. According to the actual situation in this hospital, a series of preventative measures have been formulated. The present study summarizes the relevant experience, risk factors of occupational exposure and prevention strategies for front-line medical staff.

2. Risk factors

Insufficient understanding. COVID-19 is an entirely new disease that remains poorly understood. The majority of the front-line medical staff are not experts in respiratory and infectious diseases who lack in-depth understanding (5). Prior to the development of the national diagnosis and treatment program, understanding of the route of transmission and severity of this disease was insufficient.

Lack of early protection. This sudden epidemic caused a severe shortage of personal protective equipment (PPE), including N95 face masks, protective clothing and goggles, within the population, especially in Wuhan (6). This resulted in a high level of occupational exposure by the medical staff during the early stages of the epidemic.

Environmental factors. At present, it is considered that the main methods of coronavirus transmission are respiratory droplets (7), close contact (7) aerosol (7), fecal-oral or urine-oral (3,8) and ocular mucosa (9) transmission. A certain amount of virus is present in the respiratory droplets, vomit and feces of the patients (7). In addition, the airtight environment in the isolation area leads to a high concentration of virus being present, which increases the risk of occupational exposure by medical staff during extended stay.

Routine procedures. A number of routine procedures, including sputum suction, endotracheal intubation and life nursing (including the cleaning and hygiene of patients), involve direct contact with respiratory droplets, vomit, feces and other bodily fluids of the patients, which increases the risk of coronavirus exposure.

Psychological factors. Emotional tension is manifested as a sense of powerlessness towards patients who are at the highest risk (10). These are exacerbated by long shifts and endocrine disorders due to the shortage of staff, expectations of overcoming this epidemic, psychological pressure caused by the diagnosis or death of relatives, colleagues and peers. This may increase the psychological burden of front-line medical staff, resulting in the reduction of alertness and elevation of the risk of occupational exposure.

Other factors. Psychological tension experienced by the patients, or even minor damage to the PPE worn by the medical staff may also lead to the accidental occupational exposure to coronavirus.

3. Prevention strategies

Training. Hospital infection office and quality control office should perform effective professional training on COVID-19 prevention and control in all departments of the hospital,

especially those that are not associated with respiratory medicine or infection. This training program should include knowledge on the etiology of COVID-19, hand hygiene, the disinfection process, prevention and treatment process in case of occupational exposure. Through training, understanding by the medical staff on how to prevent and control occupational exposure can be improved with the assistance of doctors and nurses in charge of infection control. Staff can then train and practice again in the clinical department to maintain an appropriate level of knowledge among all staff within the hospital.

Strengthening the personal protection of front-line medical staff. It is necessary to prepare a sufficient amount of PPE and disinfection facilities to strengthen the personal protection of front-line medical staff. Technical Guidelines for the Prevention and Control of Novel Coronavirus Infection in Medical Institutions (First Edition) issued by the National Health Commission on January 23, 2020, specifies the types of PPE required, how to wear and remove them, along with a list of potential issues (11). Subsequently, Guidelines on the Scope of Use of Common Medical Protective Equipment (Trial) in The Prevention and Control of COVID-19, issued by the National Health Commission on January 27, 2020 (12), further clarified the requirements for the use of medical PPE. Standardized and effective use of PPE is an effective preventive measure for cutting the transmission of infection (13) and to prevent infection spreading from patients and carriers to others (13), which is also a key measure to ensure the safety of medical staff during diagnosis and treatment. Therefore, it is necessary to perform effective training and practical exercises to enhance medical staff proficiency with the PPE, so that everybody can pass security check before entering the quarantine area to treat patients.

Rational area layout and regular disinfection. Hubei 672 Orthopedics Hospital of Integrated Chinese & Western Medicine controls the source of infection, which is patients in this case, by establishing the following requirements of physical isolation: i) Strictly defining the layout of three areas, namely clean, potentially hazardous and hazardous areas; ii) two channels of personnel, specifically the medical staff and patient channel; and iii) two buffer zones, namely between the clean and the potentially hazardous areas and between the potentially hazardous and the hazardous area. In addition, the disinfection system has been improved, where daily disinfection is performed in the isolation area. The following protocols have been adopted: i) Air disinfection, where occupied rooms are ventilated twice a day for ~30 min each time, whilst unoccupied rooms are irradiated with ultraviolet light once a day for >1 h each time; ii) surface and floor disinfection, where the surfaces and floors in the ward are wiped and sprayed daily with 1,000 mg/l chlorine and wiped with clean water after 30 min. If waste particles that are visible to the naked eye is present, the waste is first completely removed, before being covered with 2,000 mg/l chlorine. Cleaning tools, including rags and mops, are used exclusively for the designated areas; iii) treatment of medical waste, where the medical waste of a patient is treated as infectious waste and are transported in a sealed, double-layered yellow waste bag. This bag is marked as 'special infection' before being transported to the temporary

medical waste storage room immediately after contact by telephone; and iv) final disinfection. Here, after a patient is discharged, transferred or has died, a final disinfection is performed in the ward.

Enhancing the awareness of occupational protection and standardizing routine procedures. All medical staff should strictly comply with the routine procedure process, develop good operation practice, raise awareness of occupational protection, perform all routine procedures by following the standard prevention principles, stay alert and avoid the risk of occupational exposure caused by operational errors. Protective face screen or mask should be worn when performing daily care procedures, including feeding, sputum suction and life nursing, which typically involve contact with body fluids or secreted materials from the patient. Quick-drying hand sanitizer should be used following every patient contact and the outer gloves should be replaced after contacting three different patients to reduce the risk of occupational exposure.

Reasonable scheduling and early psychological intervention. It is necessary to implement reasonable shift systems and rest rotation to avoid overworking and ensure sufficient rest time. This can potentially prevent physical and mental fatigue and to protect the mental health of medical staff. Hubei 672 Orthopedics Hospital of Integrated Chinese and Western Medicine provides a psychological hotline and online consultations to release psychological pressure. These methods were established with aims to understand the situation in the family and properly distribute essential provisions including food, masks and disinfectant, to the families of medical staff on the frontline to alleviate additional worries.

Psychological counseling for patients. Following COVID-19 diagnosis, the immediate reaction of the patients may include panic, despair, refusal of treatment, self-injury and attempting to injure others (14). Medical staff should provide timely and effective psychological counseling to such patients to ensure that they can accept the reality of their illness and cooperate with treatment to appropriately release pressure and limit impulsive behaviors, in turn reducing the risks to occupational exposure experienced by medical staff caused by violent injury.

4. Treatment after occupational exposure

It is necessary to formulate a standardized contingency plan for occupational exposure. Following occupational exposure, it should be immediately handled in accordance with this plan. After occupational exposure, the person should remove PPE according to the standard procedure. They should be regarded as a close contact (15) and moved to the designated area for medical observation. Nucleic acid (16), antibody (16), chest CT and other examinations should be performed as appropriate. Other medical staff in the isolation area should also immediately contact the shift preparation staff in the cleaning area, who should in turn report the situation to the department director, head nurse and hospital infection office so that protective preparations can be performed to take over the work in the isolation area. In addition, following occupational

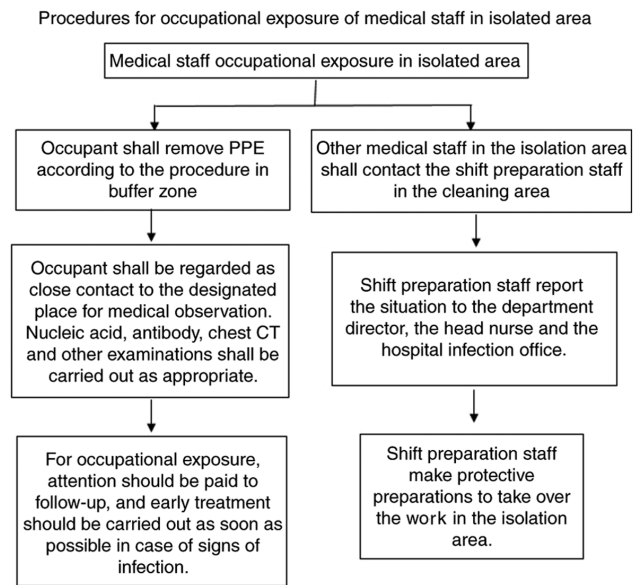


Figure 1. Procedures proposed for the minimization of occupational exposure by medical staff in an isolated area. PPE, personal protective equipment.

exposure, staff should be carefully followed up, such that early treatment should be immediately administered when signs of infection are observed. A pipeline of this specific process is presented in Fig. 1.

5. Conclusions

In conclusion, the outbreak of COVID-19 has brought major challenges to infection control in hospitals around the world. In particular, occupational exposure has the potential to adversely affect the health of each member of medical staff. Therefore, it is necessary to engage everyone in the hospital, master the relevant knowledge of COVID-19 and use PPEs to protect the safety of themselves and their colleagues. The present article summarized the relevant risk factors for occupational exposure and proposed a number of management strategies for these risks, which may serve as a referencing point for the prevention and control of this disease in hospitals.

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Authors' contributions

JT and XGL contributed to the study conception and design, the acquisition of data and the analysis and interpretation of data. YL, QLL, WX, SJZ, YLL and QCZ contributed to drafting the manuscript and critically revising the manuscript

for important intellectual content. JT prepared the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

References

1. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, *et al*: Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 323: 1061-1069, 2020.
2. National Health Commission: Up to 24:00 on March 10, the latest update on the epidemic situation of NCP[EB/OL](2020-03-11). (In Chinese). http://www.gov.cn/xinwen/20203/11/content_5489767.htm.
3. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, Shan H, Lei CL, Hui DS, *et al*: Clinical characteristics of 2019 novel coronavirus infection in China. *medRxiv*: Feb 9, 2020 (Epub ahead of print). doi: 10.1101/2020.02.06.20020974.
4. Zhang XT, Wang ZB and Liu WZ: The theoretical and legal basis for the inclusion of the new coronavirus pneumonia in the occupational disease classification catalogue of medical staff. *Occup Health Emerg Rescue* 38, 2020 (In Chinese).
5. Chu NJ, Wang J and Jia YD: Protection against COVID-19 infection among medical staff in designated hospitals. *J Nurs (China)* 27: 56-60, 2020 (In Chinese).
6. Fu Q, Zhang X and Lishi-Wen: Risk management strategies for occupational exposure of medical staff with novel coronavirus infections. *Chin J Nosocomiol* 30: 801-805, 2020 (In Chinese).
7. National Health Commission: Notice on issuing COVID-19's diagnosis and treatment Plan (trial Seventh Edition) [EB/OL]. (2020-03-03). (In Chinese). http://www.gov.cn/zhengce/zhengceku/2020-03/04/content_5486705.htm.
8. Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, Spitters C, Ericson K, Wilkerson S, Tural A, *et al*: First case of 2019 novel coronavirus in the United States. *N Engl J Med* 382: 929-936, 2020.
9. Lu CW, Liu XF and Jia ZF: 2019-nCoV transmission through the ocular surface must not be ignored. *Lancet* 395: e39, 2020.
10. Ma C and Yan XK: Research progress in psychological stress expression and revention and control strategy of COVID-19. *Journal of Jilin University (Medicine Edition)* 46: 1-6, 2020 (In Chinese).
11. National Health Commission: Notice of the general office of the national health commission on the issuance of technical guidelines for the prevention and control of novel coronavirus infections in medical institutions (1st edition) [EB/OL](2020-01-22). (In Chinese). http://www.gov.cn/zhengce/zhengceku/2020-01/23/content_5471857.htm.
12. National Health Commission: Guidelines on the scope of use of common medical protective equipment in the prevention and control of novel coronavirus infections (trial) [EB/OL](2020-01-27). (In Chinese). <http://www.nhc.gov.cn/xcs/zhengcwj/202001/e71c5de925a64eafbelce790debab5c6.shtml>.
13. Honda H and Iwata K: Personal protective equipment and improving compliance among healthcare workers in high-risk settings. *Curr Opin Infect Dis* 29: 400-406, 2016.
14. Yang Y, Li W, Zhang Q, Zhang L, Cheung T and Xiang YT: Mental health services for older adults in China during the COVID-19 outbreak. *Lancet Psychiatry* 7: e19, 2020.
15. National Health Commission: Notice of the General Office of the National Health Commission on the issuance of the COVID-19 Prevention and control Programme (4th edition) [EB/OL](2020-02-06). (In Chinese). http://www.gov.cn/zhengce/zhengceku/2020-02/07/content_5475813.htm.
16. Li H, Pan J, Su Y, Wang B and Ge J: SARS-CoV-2 IgM/IgG antibody detection confirms the infection after three negative nucleic acid detection. *J Cell Mol Med* 24: 8262-8265, 2020.



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