Global Health Journal 5 (2021) 215–219

Contents lists available at ScienceDirect

Global Health Journal

journal homepage: https://www.keaipublishing.com/en/journals/global-health-journal/

PERSPECTIVE

Occupational health protection for health workers during the coronavirus disease 2019 (COVID-19) pandemic: 6P-approach in China

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ARTICLE INFO

Article history:
Received 22 December 2020
Received in revised form 24 November 2021
Accepted 24 November 2021
Available online 25 November 2021

Keywords:
Occupational health protection
Health workers
Coronavirus disease 2019 (COVID-19)
China

ABSTRACT

Health workers (HW) are on the frontline fighting against the COVID-19 pandemic, they are exposed to multiple occupational hazards. This article analyzed the comprehensive measures of protecting HWs during the COVID-19 response in China. Occupational health protection of HWs was one of the key strategies of the public health measures adopted against the COVID-19 outbreak from the earliest stage in China. This prioritization of HWs health protection was based on the technical and policy guidance of WHO and International Labor Organization as well as the experiences from previous outbreaks in China. The comprehensive measures in China can be summarized as '6P-approach': public health emergency response, prompt learning from lessons, proactive measures of occupational health, precaution strategies against occupational hazards, personal protective equipment and medical devices supply, and professional networking. Through this 6P-approach, China was able to minimize the incidence of COVID-19 infection among HWs, while successfully containing the outbreak during the first quarter of 2020. Although the COVID-19 vaccines have been rolled out, however, the COVID-19 pandemic is still under rapidly evolving situation. Experiences from China may provide other countries with an example of prioritizing and incorporating occupational health protection of HWs in their public health measures responding to the COVID-19 pandemic.

1. Introduction

Health workers (HWs) are at the frontline in the fight against the coronavirus disease 2019 (COVID-19) outbreak, putting them at higher risk of infection. In addition to pathogen exposure, HWs are exposed to occupational hazards of long working hours, psychological distress, X-rays, noise, poor ergonomic condition, stigma, and physical and psychological violence and harassment. The occupational health and safety of HWs are among the top priorities when responding to the COVID-19 pandemic.[1-2]

As of 20 January 2020, the first official confirmed case of coronavirus infection among HWs in China were reported in 15 medical workers from a neurosurgery department during an operation in the epicenter of Wuhan City of Hubei Province (hereafter referred as Wuhan, Hubei, respectively).[3-4] According to the official announcement of the accumulated infection in February 2020, among 2 055 confirmed cases of coronavirus infection were reported among HWs in China, accounting for 2.7% of the total confirmed cases (75 465) in the same period.[5] However, the protection of frontline HWs in all settings was only implemented in January 24. Among more than 42 000 HWs, of whom 28 000 were women, dispatched to Hubei from provinces and military personnel in order to respond to the COVID-19 outbreak, none of them was infected until late March.[6]

To date, the publications and national situation reports that provide information on the number of HWs infections are still limited. The World Health Organization (WHO) highlighted the importance of protecting HWs from the start of the outbreak. According to *Coronavirus disease 2019 (COVID-19) Situation Report—82*, as of 8 April 2020, 22 073 cases of COVID-19 among HWs from 52 countries had been reported to WHO.[1] Due to the lack of global surveillance or systematic reporting of HWs COVID-19 infections from different countries to the WHO, this number might be an underestimation of the reality of the global situation. According to a study on the global burden of COVID-19 pandemic on HWs, accessed on 17 April 2020, the median HW infection rate among the total cases was 10.04% (0–24.09%). The median fatality rate was 0.8% (0%–18.95%) in 18 regions.[7]

General awareness on the occupational health of HWs in China was particularly raised since the severe acute respiratory syndrome outbreak in 2003. The policy framework of occupational health has been developed, including the amendment of *the Law of the People's Republic of China on the Prevention and Treatment Infectious Diseases* (in 2004 and 2013), the enforcement of *the Law on Mental Health of the People's Re-*

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https://doi.org/10.1016/j.glohj.2021.11.007

public of China (in 2012), and the *Guideline for Prevention and Control for Occupational Exposure Bloodborne Pathogen (GBZ/T 213–2008)* issued by the former Ministry of Health in 2009.[8-9] Meanwhile, international technical tools were used in China; e.g., since 2013, a joint International Labor Organization (ILO)/WHO technical tool for health and safety improvement at a certain workplace in the health sector (*HealthWISE*) had been promoted across China.[10-11] The Model of Hospital Initiative on Systematic Occupational Health (HISOH) was gradually created and developed in China.[12] At the beginning of 2018, the National Health Commission (NHC) of the People's Republic of China was established, aiming to promote the national health strategy "Healthy China 2030". From then on, the responsibility and functionality of occupational health management had been merged and assigned to NHC.[13] China is working closely with the WHO's Regional Office for Western Pacific, in order to maintain the occupational health of HWs, e.g., the public health emergency response.[14] Such efforts laid a solid foundation of the occupational health for HWs during the COVID-19 outbreak in China.

In this paper, we tried to summarize those China's lessons and experiences of protecting HWs during COVID-19 into "6P-approach": public health emergency response, prompt learning from lessons, proactive occupational health measures, preventive strategies against occupational hazards, personal protective equipment (PPE) and medical devices supply, and professional networking.

2. Public health emergency response

From 20 to 29 January 2020, China carried out the most comprehensive and rigorous prevention and control strategy against the epidemic, activating top-level public health emergency response in all provinces. Seven measures contributed to the successful containment of the COVID-19 in China: political determination, full response, comprehensive measures, mass mobilization, timely policy adjustment, easing economic pain while fighting the disease, transparency and coordinated action, and power of science and technology.[15] Among all of these measures, the government put a high priority on the protection and care of HWs.[16]

Different levels of public health emergency responses tailored to different situations were implemented in various provinces. The policies and practices for the protection of HWs were well integrated into all of these stages of public health emergency response. For example, there were four stages of the 67-day lockdown of Wuhan: (1) the first stage (date before 19 January 2020), investigated the occupational infection situation among HWs; (2) the second stage (date from 20 January to 7 February), developed and implemented specific guidelines for the occupational health protection of HWs; (3) the third stage (date from 8 February to 7 April), continually improved the comprehensive measures for HWs protection and life supports; and (4) the fourth stage (date after 8 April 2020), fully implemented the comprehensive measures for the protection and care of HWs. On 8 April 2020, the travel restrictions in Wuhan were lifted, ending the hardest-hit area since 23 January 2020, which was an important milestone against the COVID-19.[17]

3. Prompt learning from lessons

Alongside the outbreak and containment of the COVID-19 in China, the public available figures on the nationwide HWs infection rate were summarized as follows: (1) The first reported cases of infection among 15 HWs was published on 20 January 2020, which was the first evidence of the human transmission of COVID-19 in China;[4,18] (2) The first fatality of a doctor was confirmed on 25 January 2020;[19] (3) The first nationwide figures of infection among HWs were publicly announced on 11 February 2020; (4) The second nationwide figures were released by WHO-China joint mission on COVID-19, on 28 February 2020[5]—among 2 055 HWs with confirmed cases of COVID-19, 88% was from Hubei, while 12% of them was from outside of this province; and (5) Further detail information was released on 10 March 2020[20-22]—a total of 3 019 infected HWs (1 716 confirmed cases and 1 303 suspected cases) were reported till that time, of whom 1 502 were from the epicenter—Hubei (62.0% of them were from Wuhan); furthermore, 40% of the 3 019 HWs were infected at the workplace, while 60% of them were infected in the community.

Most of infected HWs from Hubei (especially Wuhan) was confirmed and diagnosed at the early stages of COVID-19 pandemic. Compared with the reported number on 11 February 2020, 339 HWs were as newly confirmed cases of COVID-19 on February 20; although at least 22 HWs died at the end of February 2020 reported by the local media.[23] No accurate figures of HWs who died due to COVID-19 were reported. However, some of the deaths may not be directly caused by COVID-19. For example, a doctor in a township hospital in Hubei experienced a sudden unexplained death in midnight at his home,[24] and an epidemiologist dispatched from Guangdong Province died in Hubei by a traffic accident while working.[25]

The infection rate among HWs was higher at the early stage of the initial phases of the outbreak, a possible reason for that was lack of PPE, such as suits, masks, and eye protection.[26-28] The top two hospital departments with high HWs infection rate were respiratory and emergency department. More than half of the infected HWs were nurses (51.46%).[29] After 11 February 2020, there were HWs who worked in other departments besides emergency department, infectious disease department, or the designated hospitals for COVID-19, reported being infected. For instance, five medical workers in a Beijing hospital's cardiology department were infected in April 2020.[30]

Comprehensive policies were introduced and strictly enforced to improve the occupational health protection of HWs since the initial phases of the fight against COVID-19, leading to a remarkable success. According to the official information, none of the 42 000 medical workers from different hospitals nationwide who were dispatched to Hubei were infected with COVID-19.[6]

4. Proactive measures to protect the occupational health of HWs

At least 12 proactive policies were issued and implemented for HWs by the ministries and commissions of Chinese government, until the mid of March 2020: (1) the State Council of the People's Republic of China have persistently urged greater priority for the protection and care of medical workers since the outbreak; (2) Policy of work-related injury insurance should be covered to the health workers who infected the COVID-19 due to occupational exposure; (3) Guideline on personal protective equipment for health workers during the COVID-19 outbreak; (4) Policy of medical waste management during the COVID-19 outbreak; (5) Technical and managerial guideline on emergency disposal of medical waste during the COVID-19; (6) Policy of medical protective equipment management during the COVID-19 outbreak; (7) Policy of specifying several illegal acts against health workers; (8) Policy of strengthening management of utilizing medical protective equipment by strict risk grade and region; (9) Measures of improving working condition and caring for physical and psychological health for frontline health workers; (10) Measures of improving working condition and caring for physical and psychological health for frontline health workers; (11) Measures of fully implementation of protection and care for health workers; and (12) Policy of strengthening infection control among healthcare settings during the COVID-19.

These policies and actions covered 14 aspects regarding to safety, health, and well-being of HWs: (1) top political commitment; (2) salary and benefits, including increasing of temporary subsidy, pay-for-performance, standard of epidemic allowance; (3) work-related injury insurance with recognition of infection or death of health workers due to COVID-19 occupational exposure; (4) daily life support, including providing good quality of food, basic medicine, sanitary accessories and special commute, accommodation around designated hospital for HWs' rest and isolation from their family; (5) providing qualified personal protective equipment based on risk-assessment; (6) good work organization, e.g., promoting communication, teamwork and supportive super-

vision, rational work schedule, rotation and rest, reservation of frontline workforce, free recuperate, additional pay leave; (7) mental health services, psychological intervention and counseling; (8) health surveillance, including timely health screening, unfitness staff transferring; (9) family support and temporary aid to HWs' family members who need; (10) keeping workplace free of violence and discrimination; (11) saving life of infected health workers with all-out effort; (12) publicity and rewards; (13) priority promotion of professional title; and (14) medical wastes separately with higher standard than ordinary medical wastes.

5. Preventive strategies against occupational hazards

The occupational health protection of HWs is largely dependent on the etiology and epidemiological characteristics of the novel coronavirus, whose evolution remains unknown; hence, further studies are warranted to obtain more evidence regarding the characteristics of this virus.

Along with airborne pathogens, HWs are also exposed to other multiple occupational risks such as blood borne pathogens, long working hours/workload, poor ergonomic condition, fatigue, psychosocial factors (such as stigma, discrimination, violence, depression, anxious, and burnout), chemical substances (such as disinfectants and medicine), physical agents (e.g. X-ray), mechanical injury, and skin diseases. Eventually, those occupational risks will cause complex physical and mental health problems.

Therefore, during the COVID-19 outbreak in China, the occupational health protection of HWs has been strictly implemented using holistic measures, including the infection prevention and control measures: (1) All patients/visitors to healthcare facilities should be regarded as potential COVID-19; (2) HWs should include members of different medical teams that provide comprehensive protective measures, such as epidemiological investigators, staff of isolation wards or medical observation sites, workers for transfer of cases and asymptomatic carriers, cadaver handlers, staff for environmental cleaning and disinfection, staff for specimen collection, and laboratory staff; (3) All positions, locations, and environments where the HWs are exposed to should be disinfected, including indoor air, pollutants (blood, secretions, vomit, and excreta of patients), floors and walls, surfaces of objects, clothing, beddings and other textiles, hands, skin and mucosa, tableware, transportation, household garbage from patients, clinical waste, and corpse disposal; (4) All workplaces of HWs should implement measures following the Hierarchy of Occupational Hazard Control, including sound layout and zone arrangement, triage, isolation, ventilation, disinfection, good work practice, on-site training and supervision, use of PPE, and health promotion; and (5) The different routes of COVID-19 transmission from HWs to the residence in the community (including their family members) should be cut off.[31-32]

In particular, universal precaution principles were followed in healthcare facilities. And various models based on the risk assessment were classified, in order to prevent and control the transmission of COVID-19, including HWs to HWs, HWs to patients, patients to HWs, HWs to community/family, and family/community to HWs.

All staff working at the healthcare facilities must wear medical surgical masks. All HWs working at the departments of emergency, outpatient infectious diseases, outpatient respiratory care, stomatology, and endoscopic examination (such as gastrointestinal endoscopy, bronchofibroscopy, and laryngoscopy) must upgrade their surgical masks to medical protective masks/N95 respirator according to the protection protocol level one. Standard precautions have been applied, which included: (1) provision of hand washing and eye cleaning facilities; ensuring that all hand hygiene products are available, such as clean water and alcohol-based hand rub; (2) use of appropriate PPE; (3) appropriate handling of patients; (4) establishing environmental hygiene protocols, including medical waste disposal, workplace cleaning, and cloth and bedding cleaning; (5) safe handling and disposal of sharps; (6) development of a reasonable process of occupational safety and health procedure; (7) ensuring the safe handling and transfer of biological samples; and (8) management and maintenance of equipment.

Accommodation arrangement was crucial for maintaining the safety, health, and well-being of HWs and their family/community. During their medical supports in Wuhan, the local authorities requisitioned hotels near hospitals to provide accommodation for every HW, with single living room and living support (i.e., healthy food, laundry machine, physical excise facilities, and transportation when commuting from the living place to the hospital). After that, all HWs undergo a 14-day quarantine and testing before they returned to their routine service.[33-34]

In May 2020, the development of COVID-19 vaccine was announced with a striking progress in China. By far, the Sinovac-CoronaVac COVID-19 vaccine and the Sinopharm COVID-19 vaccine were validated by the WHO for emergency use.[35] Until April 2021, 80% of HWs nationwide have been vaccinated as the priority groups.[36] In August 2021, Chinese government committed to provide a total of two billion doses of COVID-19 vaccines to the world within this year, to promote international vaccine cooperation and build a community with a shared future for humanity.[37]

6. Supply of personal protective equipment and medical devices

Sufficient supply of medical equipment was the key to winning the fight against the COVID-19 outbreak; the medical equipment shortage was a formidable challenge in the early stage. After the countrywide and worldwide efforts, ample supplies of PPE were provided to the HWs, and the designated COVID-19 treatment hospitals were equipped with essential devices. In Hubei, the daily supply of medical protective uniform increased from 21 000 before January 27 to 270 000 on February 29, while the daily supply of N95 respirators increased from 72 000 to 562 000.[38] Within a very short time, 86 designated hospitals and 16 Fangcang shelter hospitals were established with over 60 000 beds. Fangcang shelter hospitals were implemented for the first time in Wuhan; they were rapidly built by converting existing public venues (such as stadiums and exhibition centers) into healthcare facilities, which serviced to isolate patients with mild and moderate COVID-19 cases. Prevention of nosocomial infection is the priority of Fangcang shelter hospitals.[39]

7. Professional networking

Science and technology is the most powerful weapon in the battle against the COVID-19 in China; professional network played a critical role. Virus respects no borders; hence, a collective action has been carried out in China by applying international standards/guidelines. In this article, we introduced the participation of the occupational health team of Chinese Academy of Medical Sciences and Peking Union Medical College (hereafter referred as "the PUMC team") as an example, which collaborating through its professional occupational health-related networking especially with WHO and ILO.

In 2018, shortly after ILO and WHO published *the Occupational safety and health in public health emergencies: A manual for protecting health workers and responders,* the PUMC team applied copy authorization of this publication and translated it into Chinese, which was provided to government departments and professional organizations since the beginning of COVID-19 outbreak in China. By the end of February 2020, the Chinese version of the manual was formally published.[40-41] People could get it online for free. It was widely used in making treatment decisions and assisting organizations and workplaces to prepare and respond to the outbreak of infectious diseases and public health emergencies under the ILO and WHO's principle. Based-on the promotion of *HealthWISE* and the HISOH model by PUMC team, many health professionals who participated training-of-trainer course and pilot program worked in the frontlines in the fight against COVID-19 pandemic.

The PUMC team accepted the invitation from the Occupational Health Department of NHC and provided technical recommendations

about the practical scope and orientation of the policies against COVID-19. For example, we suggested that the work-related insurance list should be not only covered HWs in emergency units, specialized treatment units, laboratories, treatment of affected communities, but also included other workers with risk of contact with diagnosed and undiagnosed patients, such as cleaners, funeral and burial workers, point-of-entry and exit screening personnel, and travel industry staff (i.e., on aircraft, ground transport, and ships), taxi drivers, security forces (guards, police and soldiers), and workers handling waste. Under the requests of a national expert team in Wuhan and some national guidance teams in other provinces, the PUMC team continually provided technical advice in detail on the universal and standard precautions, and the various national and international standards on the use of PPE.

8. Discussion and conclusion

Based on the experiences and lessons in learned in China's fight against the COVID-19 pandemic, comprehensive measures to protect the occupational health of HWs (6P-approach) played a critical role. The core of 6P-approach is the safety, health, and well-being of HWs. To prevent and control the occupational hazards of it, the key policies and actions are developed. These three elements are essential and all necessary for 6P-approach's implementation.

The achievement of the battle against COVID-19 in China was based on the former system, especially the regulation of occupational health and comprehensive measures for HWs, with the contributions of international organizations and national institutions.

Although the COVID-19 vaccines have already been rolled out worldwide, none of these vaccines provide 100% protection against the infection. Infection cases still occurred among vaccinated HWs. Therefore, comprehensive measures should be employed to protect HWs from occupational health hazards. Long-term mechanism is fundamental to tackling the formidable challenges of protecting HWs from complex occupational risks.

Moreover, we suggest some recommendations in three levels. For China, the emergency response HWs should timely submit action reports to gather information on the deployment process and improve the further operation plans. Both isolation and monitoring are essential of the health of HWs and, helpful to identify the adverse effects for health or functional consequences that potentially associated with emergency response (e.g., illness, injury, disability, and emotional trauma), in order to provide early interventions and maximize the chances of recovery. Furthermore, the government should make these measures becoming a comprehensive system, to ensure that the occupational health investment for HWs could be included in the annual budget of all healthcare facilities and provide them comprehensive health protection. In the long term, the national occupational health programmes for health workers need to be initiated, as a substantial action in the *14th Five-Year-Plan* in the health sector of China.

For other countries, policy makers and health professionals could learn from China and other countries with experiences against the infectious disease pandemic, because most issues related to the occupational health of HWs during the COVID-19 pandemic were similar globally. The international and national tools are recommended. However, the differences among economic, social, and political contexts should be considering. In addition, lessons could learn from the historical practices. Industrial and occupational data must be incorporated into the public health surveillance and healthcare information system.[42,43]

For international society, WHO, ILO and other international organizations should focus on addressing the issues on laws, policies, regulations, and standards, to improve the occupational health of HWs. The theme of the World Patient Safety Day 2020 "Health Worker Safety: A Priority for Patient Safety" and the slogan "Safe health workers, Safe patients" were advocated by WHO. 2021 has been designated by the WHO as the International Year of Health and Care Workers in appreciation and gratitude for their unwavering dedication in the fight against the COVID-19 pandemic.[44] Hence, WHO developed *COVID-19: Occupational health and safety for health workers: interim guidance, 2 February 2021*, which complements the relevant other WHO guidelines and should be used in conjunction with them. Collaboration and communications are crucial. Professional network will contribute to the identification, review, and synthesis of the evidence related to the occupational health impacts and the preventive strategies for HWs and healthcare facilities against the COVID-19 pandemic. The best talents around the world working together will help to find a much better and faster solution.

Acknowledgement

The authors would like to thank Dr. Ivan D. Ivanov (Occupational and Workplace Health, WHO headquarter) for his professional comments to this article.

CRediT author statement

Min Zhang: Conceptualization, Methodology, Data curation, Writing—Original draft, Reviewing and Editing. **Rokho Kim:** Writing—Reviewing.

Funding

This study was supported by the Project of International Expert Consultation for the National Occupational Health System Innovation funded by the Ministry of Science and Technology of China in 2020-2022 (Grant No. G20200001489).

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Edited by Jie Yan