
Analysis of the infection status of the health care workers in Wuhan during the COVID-19 outbreak: A cross-sectional study

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Summary

The present study is the first work to investigate the infection status of health care workers during the COVID-19 outbreak. The analysis of the infection status of health care workers is essential to gain knowledge and improve protective measures.

Abstract

Background Health care workers at the frontline are facing a substantial risk of infection during the coronavirus disease 2019 (COVID-19) outbreak.

Methods We acquired information and data on the general information, infection and death status of health care workers in Wuhan during the COVID-19 outbreak and completed statistical analyses.

Results We have obtained the data on 2,457 infected cases among health care workers in Wuhan, China. More than half of the infected individuals were nurses (52.06%), while 33.62% of infected cases were doctors and 14.33% of cases were medical staff. In particular, the case infection rate of nurses (2.22%) was remarkably higher than that of doctors (1.92%). Most infected cases among health care workers were female (72.28%). A majority of the infected health care workers (89.26%) came from general hospitals, followed by specialized hospitals (5.70%) and community hospitals (5.05%). The case infection rate of health care workers (2.10%) was dramatically higher than that of non-health care workers (0.43%). The case fatality rate of health care workers (0.69%) was significantly lower than that of non-health care workers (5.30%).

Conclusions The infection risk of HCWs is clearly higher than that of non-HCWs. HCWs play an essential role in fighting the pandemic. The analysis of the infection status of HCWs is essential to attract enough attention from the public, provide effective suggestions for government agencies and improve protective measures for HCWs.

Keywords: health care workers; infection; COVID-19

Introduction

On December 31, 2019, a series of patients affected with pneumonia of an unknown aetiology were identified in Wuhan, China [1]. Subsequently, the disease was named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO) on January 12, 2020 [2]. On March 11, 2020, the World Health Organization (WHO) announced that the COVID-19 outbreak could be characterized as a "pandemic," as the highly infectious virus severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) spread increasingly worldwide [3]. This is the third serious coronavirus outbreak in less than 20 years, following severe acute respiratory syndrome (SARS) in 2002–2003 and Middle East respiratory syndrome (MERS) in 2012 [4,5]. The number of confirmed cases continues to increase. Globally, on April 16, 2020, there were a total of 1,991,562 reported cases of COVID-19 in 213 countries and 130,885 deaths [6].

Facing a substantial risk of SARS-CoV-2 infection, health care workers (HCWs) at the frontline have been fighting COVID-19, saving human lives and making great efforts and sacrifices. According to the published articles, a great number of HCWs have been infected with SARS-CoV-2 worldwide, even died of COVID-19 [7-9]. Definitely, COVID-19 pandemic has a marked impact on physical and mental health of HCWs [10]. It is crucial to understand that we cannot stop the COVID-19 pandemic without HCWs. Therefore, effective protection for HCWs is currently of the utmost importance.

To the best of our knowledge, no published work about the infection status among health care workers (HCWs) with COVID-19 could be identified so far. In this study, we obtained data from some government official reports and carried out a data analysis of the infection status of the HCWs in Wuhan during the COVID-19 outbreak. By conducting the cross-sectional study, we aim to provide some thoughts and recommendations to protect HCWs worldwide.

Methods

Sources of data

Since January 26, 2020, the Red Cross Society of China had set up the Humanitarian Aid Fund to provide financial assistance for all the infected and dead HCWs due to COVID-19 nationwide. We retrieved and acquired the data of all the infected cases and deaths among HCWs in Wuhan from the HCWs lists supported by the Humanitarian Aid Fund from the Red Cross Society of China till March 26, 2020 (<https://www.redcross.org.cn/html/NewsList.html?type=news&cla=newrdjz>). We collected the total number of laboratory-confirmed cases and deaths with COVID-19 in Wuhan from publicly available disease databases of the National Health Commission of China (http://www.nhc.gov.cn/xcs/yqtb/list_gzbd_2.shtml). Information on the permanent population in Wuhan including all the HCWs originated from the statistical bulletin released by the Wuhan Statistics Bureau, Hubei Province (<http://tjj.wuhan.gov.cn/details.aspx?id=4615>). All the HCWs from other parts of China sent to Wuhan to assist were excluded from the present study. According to the scope of database, all the infected cases and deaths among HCWs in Wuhan from the HCWs lists supported by the Humanitarian Aid Fund are included in all the laboratory-confirmed cases and deaths in Wuhan from publicly available disease databases of the

National Health Commission of China, which are part of the permanent population in Wuhan reported by the statistical bulletin released by the Wuhan Statistics Bureau. Based on the various sources, we established a dataset after record cleaning, exclusion of duplicate cases and completion of missing information as described previously [11]. All case records contain national identification numbers, and therefore, all cases have records in the dataset and no records are duplicated.

The case infection rate (CIR) was defined as the percentage of the cumulative number of laboratory-confirmed COVID-19 infections divided by the total number of HCWs or non-HCWs in Wuhan. The case fatality rate (CFR) was defined as the percentage of the cumulative number of deaths divided by the total number of laboratory-confirmed COVID-19 infections among HCWs or non-HCWs in Wuhan.

Data collection and analysis of these cases were determined by the National Health Commission of China to be part of an outbreak investigation. The study was thus deemed exempt from institutional review board approval.

Definition of COVID-19

All COVID-19 cases were confirmed based on the diagnostic criteria of the recommendation by the National Health Commission of China (<http://www.nhc.gov.cn/xcs/zhengcwj/202003/4856d5b0458141fa9f376853224d41d7/files/4132bf035bc242478a6eaf157eb0d979.pdf>). According to the national diagnostic criteria, confirmed case was defined as both (1) fulfilled two clinical criteria plus one epidemiological clue, or all three clinical criteria, and (2) had the throat-swab specimens tested positive for SARS-CoV-2 using real-time RT-PCR assay. Clinical criteria: (i) fever and/or symptoms of acute respiratory infection; (ii) radiographic evidence of pneumonia; (iii) low or normal white cell count or low lymphocyte count. Epidemiological clues: (i) residence in Wuhan city within 14 days prior to symptom onset; (ii) close contact with a confirmed or probable case of COVID-19 within 14 days prior to symptom onset; (iii) close contact with persons who had fever or symptoms of acute respiratory infection or local community with reported cases, within 14 days prior to symptom onset; (iv) a cluster of persons with similar symptoms was identified [12]. The laboratory protocol for SARS-CoV-2 real-time RT-PCR assay was described previously [13]. All the HCWs and non-HCWs cases were laboratory-confirmed as described previously [8,14]. The tests were screened by Wuhan CDC (Centre for Disease Control) and confirmed by Hubei Provincial CDC.

Statistical Analysis

The confirmed COVID-19 cases among HCWs were categorized according to the following parameters: sex, occupation type, hospital type, infection status, death status. The occupation types of HCWs include nurse, doctor and medical staff. Medical staff is defined as other HCWs working in hospitals except for nurses and doctors, such as pharmacists, laboratory technicians, and medical imaging technicians, etc. Categorical variables are represented as frequency and percentage and were analysed by χ^2 test or Fisher's exact test. All statistical analyses were performed using SPSS (Statistical Package for the Social Sciences) version 23.0 software (SPSS Inc). A 2-sided α of less than 0.05 was considered statistically significant. The analyses were adjusted for multiple comparisons for type I error with Bonferroni adjustment approaches.

Results

In early 2020, the population was 11.212 million people in Wuhan, and there were 117,100 HCWs, including 43,100 doctors, 57,700 nurses and 16,300 medical staff. As of March 26, 2020, a total of 50,006 infected cases were confirmed in Wuhan, and the Humanitarian Aid Fund provided humanitarian assistance for 2,457 HCWs from 145 hospitals in Wuhan. Among the 2457 HCWs, 17 died of COVID-19.

Demographic data and general information on infection status are summarized in Table 1. A total of 72.28% of the HCWs were female. More than half of the infected individuals were nurses (52.06%), while 33.62% of infected cases were doctors and 14.33% of cases were medical staff. A majority of the infected HCWs (89.26%) came from general hospitals, followed by specialized hospitals (5.70%) and community hospitals (5.05%) (Table 1).

Our findings showed that no statistically significant difference was found in the CIR of HCWs by sex ($P = 0.591$). There was statistically significant difference in the CIR among three types of occupation and hospital ($P = 0.004$ and $P < 0.001$, respectively). The CIR of doctors was statistically significantly lower than that of nurses ($P = 0.001$), while the CIR was similar not statistically significantly different between nurses and medical staff or between doctors and medical staff ($P = 0.661$ and $P = 0.058$, respectively). The CIR of specialized hospitals or community hospitals was remarkably lower than that of general hospitals ($P < 0.001$ and $P < 0.001$, respectively), while the CIR of community hospitals was clearly lower than that of specialized hospitals ($P < 0.001$) (Table 1). The CIR of HCWs was dramatically higher than that of non-HCWs ($P < 0.001$). The CFR of HCWs was significantly lower than that of non-HCWs ($P < 0.001$) (Table 2).

Figure 1 reveals the distribution of laboratory-confirmed date and case number for HCWs affected with COVID-19. The major cases of HCWs were confirmed between January 20, 2020 and February 5, 2020, while a few cases (number of cases < 10) were daily confirmed after February 28, 2020.

Discussion

The present study provides the first insight into the infection status of HCWs in Wuhan during the COVID-19 outbreak. HCWs had a significantly higher CIR than non-HCWs. In particular, the CIR of nurses was higher than that of doctors, suggesting differential effects of occupation types on infection status. It is known that nurses have more patient contact time in general hospitals than doctors. In the early phase of the COVID-19 outbreak, the number of HCWs and personal protective equipment (PPE) were both insufficient, and the continuous working hours of HCWs were relatively longer. Therefore, the HCWs were exhausted physically and mentally. In this situation, decreased immunity and increased chance of infection could occur in HCWs. Therefore, it is recommended that HCWs at the frontline receive sufficient rest time to ensure adequate sleep, avoid overwork and consume a nutritious diet and supplements to ensure adequate nutrition to increase body immunity and reduce the likelihood of infection.

The majority of infected HCWs in Wuhan worked in general hospitals. However, the CIR of HCWs in specialized and community hospitals was relatively low in Wuhan.

This result in our study is consistent with that of some previous studies from a stomatological hospital, a maternal and child care hospital, and an infectious disease hospital [15-17]. A potential explanation may be that routine use of PPE in specialized hospitals, including face shields, goggles, medical masks and gloves, prevented further transmission of SARS-CoV-2 and limited cross infection. Another potential explanation may be that fewer cases in community and specialized hospitals could create fewer opportunities for COVID-19 transmission.

In our study, HCWs in Wuhan had a lower CFR than non-HCWs. Recent studies indicated that cases aged over 65, pre-existing comorbidities might face a greater risk of developing into mortality [18,19]. However, in China, most in-service HCWs are under the age of 60. The use of PPE and hospital protocols would seem to have more to do with the CIR than the CFR. Obviously, COVID-19 is serious and highly contagious. Further studies are needed to characterize this novel virus-infected disease.

Our results indicated that most COVID-19 cases of HCWs in Wuhan were confirmed between January 20, 2020 and February 5, 2020. The person-to-person transmission was confirmed on January 20, 2020 and some infections of HCWs had been determined in Wuhan [20]. Wuhan lockdown started on January 23, 2020 has greatly prevented COVID-19 transmission [12]. It was reported that more than 40,000 HCWs from other provinces of the Chinese mainland arrived in Hubei Province to offer help. As of March 31, none of them were identified to have been infected with SARS-CoV-2 [21]. This result indicated that a series of measures were effective in reducing HCWs infections. With the rapid spread of the epidemic, two new hospitals (Huoshenshan and Leishenshan) were built in Wuhan and put into use in ten days [22]. These facilities are specialized hospitals for infectious diseases, rather than simply units to receive and quarantine patients. Wuhan had also been building mobile Fangcang shelter hospitals (a Chinese name that came from Noah's Ark) and creating tens of thousands of beds to centralize the quarantined patients and provide medical treatment for confirmed patients with mild symptoms. The combination of construction of new infectious disease hospitals with mobile Fangcang shelter hospitals construction could reduce HCWs infections through controlling the source of infection to avoid cross infection, relieving huge pressure on the city's medical system, providing different medical care for mild or critical patients to improve treatment efficiencies, effectively preventing nosocomial infections, avoiding community infection due to home quarantine [23].

Our study has some notable limitations. Firstly, we compared all HCWs with non-HCWs regardless of their age, comorbidities and other characteristics that could have influenced the infection rate; therefore, our results should be interpreted carefully. Secondly, the detection bias with access to testing among healthcare providers vs. others also could have inevitably affected our assessment. Finally, we no doubt missed asymptomatic cases among HCWs and non-HCWs.

Conclusion

The COVID-19 outbreak is ongoing globally, and the safety of HCWs should be ensured to end the pandemic. The analysis of the infection status of HCWs is essential to attract enough attention from the public, provide effective suggestions for government agencies and improve protective measures for HCWs. Ensuring an adequate supply of PPE is just the first step. Other measures should be considered, including nutritious food supply, adequate rest time, and societal, familial, and psychological support.

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NOTES

Author contributions

WW and XW conceived, designed, and coordinated the study; LZ, XW, CZ, QL, SL and QS were responsible for data collection and accuracy confirmation; LZ, CZ and QL made substantial contributions to data analysis and interpretation; LZ was in charge of the manuscript draft with help from all the authors. XW made substantial revisions to the manuscript. MW, SL, QS and QZ participated in data analysis.

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Disclosure of Conflicts of Interest

The authors declare no conflicts of interest.

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Figure legend

Figure 1 Laboratory-confirmed date and cumulative case number of health care workers with COVID-19 in Wuhan from January 4 to March 12, 2020. Daily numbers of laboratory-confirmed cases are plotted by date of laboratory confirmation (blue) and cumulative percentage of laboratory-

confirmed cases (red). Major epidemic response actions taken by the Chinese government are shown in arrows of different colors.

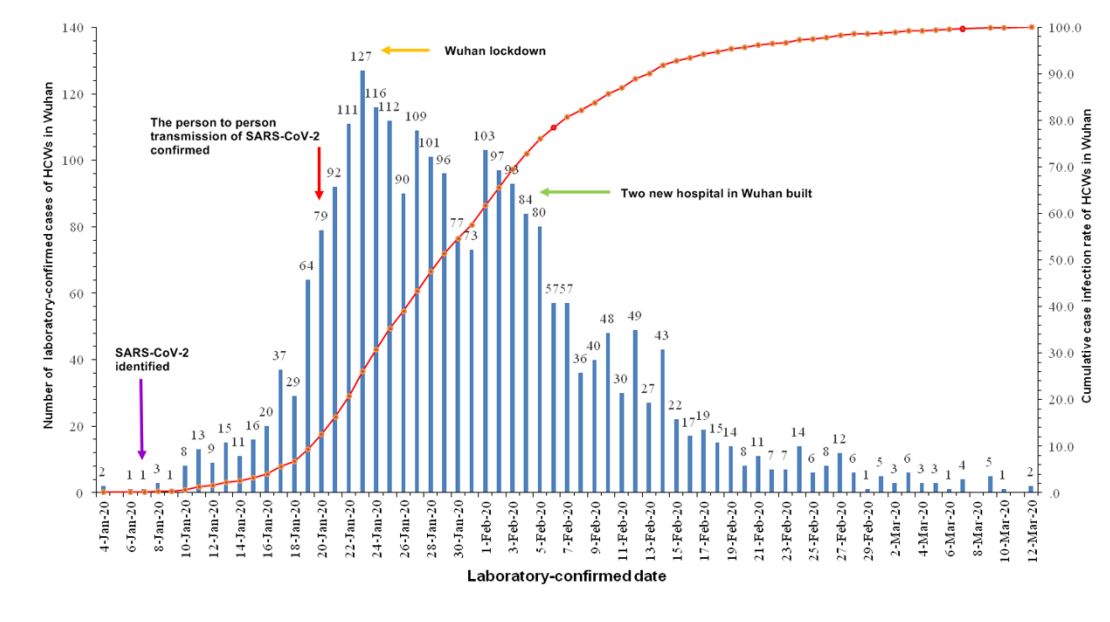


Table 1 General information on the infection status of HCWs in Wuhan

Parameters	Total number, N	Confirmed cases, N (%)	CIR, %	χ^2	P-value
Sex				0.289	0.591
Female	84078	1776(72.28)	2.11		
Male	33022	681(27.72)	2.06		
Types of occupation				11.168	0.004 ^a
Nurse	57700	1279(52.06)	2.22	10.871	0.001 ^b
Doctor	43100	826(33.62)	1.92	3.594	0.058 ^c
Medical staff	16300	352(14.33)	2.16	0.192	0.661 ^d
Types of hospital				699.034	<0.001 ^e
General hospital	74944	2193(89.26)	2.93	262.406	<0.001 ^f
Specialized hospital	17565	140(5.70)	0.80	14.114	<0.001 ^g
Community hospital	24591	124(5.05)	0.50	477.685	<0.001 ^h

HCWs: Health care workers; CIR: Case infection rate.

a denotes a comparison among three types of occupation.

b denotes a comparison between nurses and doctors.

c denotes a comparison between doctors and medical staff.

d denotes a comparison between nurses and medical staff.

e denotes a comparison among three types of hospital.

f denotes a comparison between general hospital and specialized hospital.

g denotes a comparison between specialized hospital and community hospital.

h denotes a comparison between general hospital and community hospital.

Table 2 Comparison of CIR and CFR between HCWs and non-HCWs in Wuhan

Parameters		Non-HCWs	HCWs	χ^2	<i>P-value</i>
Infection status	Infected individual	47549	2457	7275.207	<0.001
	Non-infected individual	11047351	114643		
	CIR (%)	0.43	2.10		
Death status	Death due to infection	2518	17	102.890	<0.001
	Non-death due to infection	45031	2440		
	CFR (%)	5.30	0.69		

HCWs: Health care workers; CIR: Case infection rate; CFR: Case fatality rate.