


Assessment of Potential Risk Factors for 2019-Novel Coronavirus (2019-nCov) Infection among Health Care Workers in a Tertiary Care Hospital, North India

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Sugandhi Sharma^{1*}, Ritin Mohindra^{1*}, Kirtan Rana¹, Vikas Suri¹,
Ashish Bhalla¹, Manisha Biswal¹, Mini P. Singh¹, Kapil Goyal¹,
and Pinnaka Venkata Maha Lakshmi¹ 

Abstract

Introduction: Health care workers (HCWs) are at the forefront to fight against COVID-19 pandemic. They are at more risk of contracting the infection. This study was planned to assess potential risk factors of 2019-novel coronavirus infection among HCWs working in a health facility and to evaluate the effectiveness of infection prevention and control measures among them. **Methods:** A study was conducted in a tertiary care hospital among HCWs who were directly or indirectly involved in the management of a confirmed or suspected case of COVID-19. The socio-demographic characteristics, history of exposure, IPC measures followed and clinical symptoms were compared between health care workers in COVID and non-COVID areas. **Results:** Majority (45%) of HCWs were nurses, followed by hospital/sanitary/technical attendants (30%) and doctors (24%). Out of a total of 256 HCWs, 2% tested positive. Around 80% of HCWs had ever attended any IPC training. A statistically significant association was found between posting area of HCWs and their exposure to COVID patients (duration of exposure, PPE has worn by HCWs, direct contact of HCWs with the patient's material) and COVID positivity (P value $<.001$). **Conclusion:** If health care workers were trained and take adequate precautions then the risk of getting an infection is minimized.

Keywords

health care workers, infection prevention and control practices, personal protection equipment, hand hygiene, COVID-19

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Introduction

Starting from a few cases of pneumonia reported in Wuhan, China, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection has achieved pandemic proportions. Worldwide, a total of 6416828 confirmed cases and 382867 deaths have been reported, as on June 4, 2020.¹ The first confirmed case of COVID-19 was reported on 30th January 2020. Since then the number of cases is increasing continuously. As on 4th June, 2020 a total of 216919 cases of COVID-19 have been reported from India with 6075 deaths.²

Health care workers (HCWs) are at the forefront in the fight against COVID-19 pandemic. They have higher risk of contracting infection as they are in direct contact with the

COVID-19 patients and their surroundings. Environmental surfaces including the hospital bed, bedside table, and television remote control in the hospital have been reported to be contaminated with influenza viruses and SARS-CoV-2.³⁻⁵ Besides the patients, the surfaces of the beds, and bedside tables were among the most frequently touched surfaces by HCWs and patients.^{6,7} During Severe Acute Respiratory

¹PGIMER, Chandigarh, India

*Joint first authorship: These authors contributed equally to this work.

Corresponding Author:

Pinnaka Venkata Maha Lakshmi, Department of Community Medicine and School of Public Health, PGIMER, Chandigarh 160012, India.
Email: pvm_lakshmi@yahoo.com



Syndrome (SARS) outbreak in 2002 about 24% of the healthcare workers were found to be infected.⁸

Apart from being highly susceptible themselves, HCWs also pose a great risk of transmitting the infection to their contacts. They play a critical role in the management of patients, and also ensure that adequate infection prevention and control (IPC) measures are implemented in health care facilities to prevent healthcare-associated infection.⁹ Their adherence to IPC guidelines is vital in combating the current COVID-19 pandemic.

To reduce the risk of transmission of respiratory pathogens to HCWs and other people interacting with the patients in the health-care facility, appropriate use of personal protective equipment (PPE) is necessary. The appropriate use of PPE depends on the availability of PPE and training of the HCWs regarding its use. Other factors that might increase the susceptibility of HCWs is prolonged exposure to large numbers of COVID-19 patients in the health facilities.¹⁰

Understanding the risk factors COVID-19 infection among healthcare workers is essential for preventing future infections among them and other patients. It will also help in updating the infection prevention and control measures at a healthcare facility and also aid in developing/revising guidelines for reducing secondary COVID 19 infections within healthcare settings.

At this stage of the pandemic, neither the extent of COVID-19 infection in health care settings, nor the risk factors associated with infection in health care workers are known. The preparedness for the ongoing COVID-19 pandemic and its spread in India, calls for setting up of adequately equipped and dedicated health facilities to manage sick patients while protecting healthcare workers and the environment.¹¹ Therefore, follow-up of health care workers for the development of symptoms and testing for COVID-19 is essential for providing useful information on transmissibility and routes of transmission, which will help to limit amplification events in health care facilities.

In view of this, we planned this study to assess potential risk factors and clinical presentation of 2019-novel coronavirus infection among HCWs working in a health facility and to evaluate the effectiveness of infection prevention and control measures among them.

Methods

A study was conducted in a tertiary care hospital, situated in the Union Territory of Chandigarh in North India. It has a dedicated COVID hospital with 250 beds exclusively for the management of COVID-19 patients. Initially, all the positive cases diagnosed in Chandigarh were admitted in our hospital, and subsequently with the increase in numbers the hospital catered mostly the sicker patients requiring specialized care. IPC trainings were conducted for all HCWs.

COVID-19 hospital is located in the Nehru Hospital Extension (NHE) part of PGIMER. This area is a separate building physically disconnected from rest of the hospital. All COVID-19 positive patients who are sick and needs admission are shifted to the COVID 19 area. There is separate staff of health care providers who works in NHE.

Non COVID areas are places in hospital where those patients are kept who has unconfirmed COVID 19 status. These areas are located in the main hospital building demarcated from other structures. The health care workers here are from the staff doing routine duties. They were also trained for infection prevention control practices but they don't wear full PPE kit while performing their duties. The night duty of persons posted in COVID hospital is for 6h and hence they don and doff their PPE only once during the duty. Whereas, the night duty of people in non COVID areas (Sever Acute Respiratory Illness ward and Triage) is for 12h. The staff partially doff their PPE during rest and don the same after rest instead of complete doffing and donning of fresh PPE after rest. This leads to breach and contamination and thus increasing the chance of infection among the staff.

Our study included HCWs who were involved in the management of confirmed or suspected case of COVID-19, and were exposed to the patient's blood and body fluids and to contaminated materials or devices. HCWs who were having confirmed 2019-nCoV case among his/her household/close contacts were excluded. The study was conducted over a period of 1 month from 30th March to 30th April 2020 after obtaining the approval from the Institutional Ethics Committee.

The details of all HCWs posted in the COVID hospital were obtained. Those posted in the COVID hospital were quarantined for 14 days after 7 days of duty. If any COVID-19 patient was diagnosed in non-COVID area, all HCWs who had come in contact with that patient were traced, assessed for the risk of exposure and all HCWs with high risk exposures were quarantined for 14 days.

HCWs were interviewed telephonically using WHO questionnaire "Protocol for assessment of potential risk factors for coronavirus disease 2019 among health workers in a health care setting."¹² Information was collected regarding demographic characteristics of HCWs, duration of contact and possible exposure with the COVID-19 infected patient and IPC measures followed by HCWs. Information regarding prophylactic use of hydroxychloroquine (HCQ) was also collected. The information was collected telephonically from all the participants after explaining about the purpose of the study in their native language and obtaining verbal informed consent.

For the purpose of the study, HCW is defined as all staff in the health care facility involved in the provision of care for a COVID-19 suspected/infected patient, including those who have been present in the same area as the patient as

well as those who may not have provided direct care to the patient but who have had contact with the patient's body fluids, potentially contaminated items or environmental surfaces.¹²

IPC standard precautions are precautions meant to reduce the risk of transmission of blood borne and other pathogens from both recognized and unrecognized sources. They are the basic level of infection control measures which are to be used while taking care of any patients. These include hand hygiene, use of disposable medical examination gloves before contact with body fluids, mucous membrane, non-intact skin and contaminated items, and gown and eye protection before procedures and patient-care activities likely to involve contact with or projection of blood or body fluids.¹³

A nasopharyngeal swab was collected to confirm the diagnosis of COVID-19 using real-time reverse transcription-polymerase chain reaction (RT-PCR) between day 12 and day 14 of post-duty quarantine. For HCWs working in COVID and non COVID areas of health facility, who had high risk exposure to COVID-19 positive patient, nasopharyngeal swab was taken on day 12 to 14 of their quarantine period from the last day of exposure. If any HCW became symptomatic for COVID-19 at any point of time during quarantine period, she/he was tested immediately.

Data was analyzed using the SPSS, version 24.0. Descriptive statistics such as mean (SD) for continuous variables and frequency along with their percentage for categorical variables were computed. Chi square test was used to see whether there was any significant difference in the exposure or clinical symptoms among HCWs working in COVID and Non COVID areas. A *P* value of less than .05 was considered to be significant.

Results

A total of 256 HCWs were included in the study, out of which nearly half were males. Maximum HCWs were in the age group 20 to 30 years. Mean age of the HCWs was 30.8 years (SD: 6.7 years). Majority (45%) of them were nurses, followed by hospital/sanitary/technical attendants (30%) and doctors (24%) (Table 1).

Around 80% of HCWs reported to have attended IPC trainings. Among those who had attended any IPC training, almost 14% had attended it for more than 2 h. About 87% of HCWs told that they always follow standard IPC precaution measures during patient care whereas 3% of HCWs were not aware of these precautions. More than 90% HCWs reported to be adherent to the recommended PPE. About 77% of the HCWs reported that adequate PPE was available (Table 2).

Majority (93%) of HCWs followed recommended hand hygiene practices after exposure to infectious materials. Amongst the doctors, 82% reported to be always compliant

Table 1. Distribution of Health Care Workers based on their Demographic Characteristics (N=256).

Characteristics	N	%
Gender		
Male	130	50.8
Female	126	49.2
Age category (years)		
20-<30	130	50.8
30-<40	101	39.5
≥40	25	9.8
Occupation		
Nurses	116	45.3
Doctors	62	24.2
Hospital attendants	32	12.5
Sanitary attendants	27	10.5
Technical assistants	19	7.4

Table 2. Adherence of Health Care Workers to Infection Prevention and Control (IPC) Measures (N=256).

Variables	N	%
No. of HCWs ever attended any IPC training.		
Yes	204	79.7
No	52	20.3
Cumulative hours of IPC training attended at this health care facility? (n=169)		
Less than 2h	175	85.8
More than 2h	29	14.2
Follow IPC standard precautions when in contact with any patient?		
Always, as recommended	222	86.7
Most of the time	24	9.4
Occasionally/rarely	3	1.2
Don't know what these guidelines are	7	2.7
Wear PPE when indicated?		
Always, according to the risk assessment	238	93.0
Most of the time, according to the risk assessment	12	4.7
Occasionally/rarely	6	2.3
Is PPE available in sufficient quantity in the health care facility?		
Yes	198	77.3
No	48	18.8
Don't know	10	3.9

to hand hygiene practices whereas the compliance in the support staff was more than 93% (Figure 1).

Out of total HCWs, about one-third (31%) were exposed accidentally to COVID-19 cases during their posting in Non-COVID unit. Majority (82%) of these had close contact with the patient and out of those who had closed contact, 13% had an exposure of more than 15 min. Mean cumulative hours of duty done by all HCWs were 41.3h (SD: 15.7h). All HCWs working in COVID unit were wearing

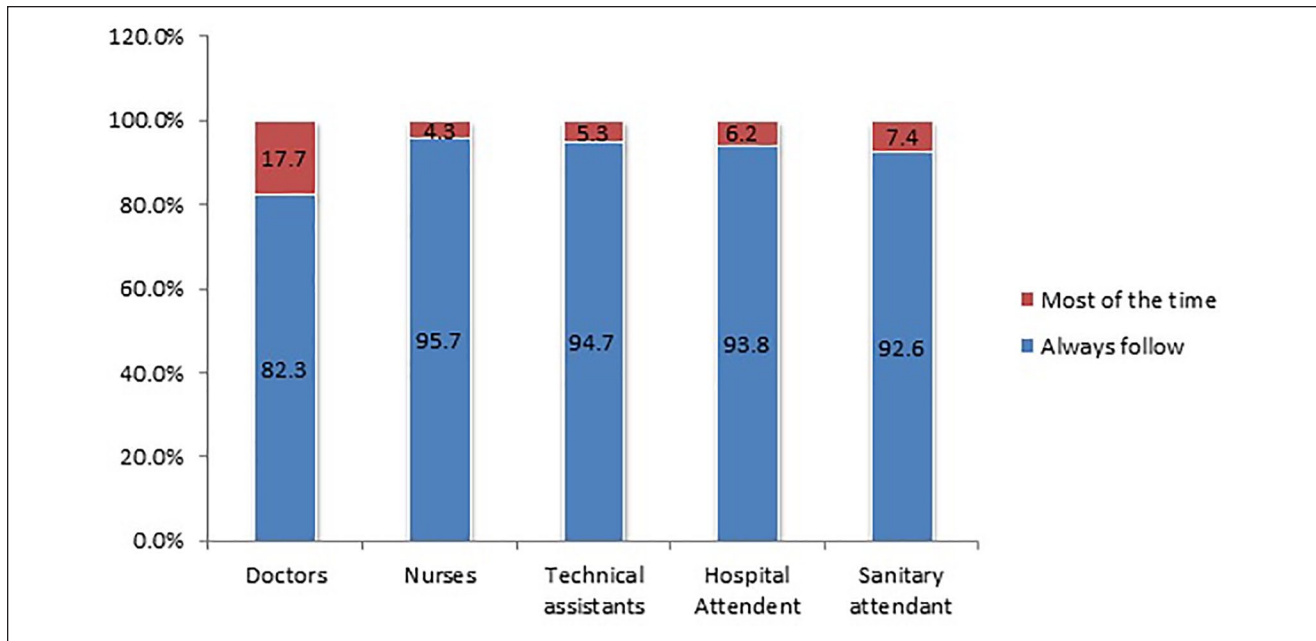


Figure 1. Frequency of hand hygiene practices among various cadres of HCWs.

complete set of recommended PPE whereas in Non-COVID units only 43% were wearing complete PPE. About 45% of HCWs in Non-COVID unit were wearing medical mask, gown and gloves only. Around 15% of HCWs were involved in aerosol generating procedures and about 63% of HCWs had direct contact with the surfaces, which were in contact with the COVID-19 positive patients. A statistically significant association was found between posting area of HCWs and their exposure to COVID patients (duration of exposure, PPE worn by HCWs, direct contact of HCWs with the patient's material) (P value $<.001$) (Table 3).

Around 10% of all HCWs experienced any respiratory symptom since the exposure to the patient and maximum HCWs had sore throat and fever followed by cough and running nose. About one-third HCWs posted in COVID unit took HCQ prophylactically while in Non-COVID unit only 21% took HCQ prophylaxis. Out of total 256 HCWs, 5 (2%) tested positive. None of the HCW posted in COVID Unit tested positive but 6.3% of HCWs from Non-COVID Unit tested positive. A statistically significant association was found between posting area of HCWs and COVID positivity (P value $<.001$) (Table 4).

In-depth interviews were conducted for all the HCW who came positive to understand the source of infection.

HCW 1 who came positive used to work in non COVID area without full PPE. He had high risk exposure while taking care of the COVID 19 positive patient. He had breach in his mask while he took sample from the COVID 19 positive patient.

HCW 2 and HCW 3 both contacted infection at the same time. They used to work in communicable disease

(CD) ward of the hospital. Their families were also tested for the COVID 19 infection, and all the family members of HCW 2 came positive. It was postulated that may be HCW 2 contacted infection from the community and HCW 3 got it from HCW 2, as they both had tea together removing masks during duty hours at a distance less than 1 m for more than 15 min. But contacting infection from COVID 19 positive patient from CD ward can also not ruled out.

HCW 4 contacted infection from HCW 2 and HCW 3 while taking their blood sample. During in-depth interview it was found that he had breach in his PPE which was the mode of contacting infection.

HCW 5 contacted her infection while working in the emergency area of the hospital. She reported that she used to had coffee and tea in between her duties (though not permitted by the authorities) whenever she used to feel hungry. She had contact with her mask multiple times during taking it off for having the beverages, which as the mode of infection in this HCW.

Discussion

The present study was undertaken to assess potential risk factors and clinical presentation of 2019-novel coronavirus infection among HCWs working in a health facility and to evaluate the effectiveness of infection prevention and control measures among them. Previous studies also reported the problems of COVID-19 IPC in healthcare settings, particularly highlighting the problems of personal protection of healthcare workers.¹⁴

Table 3. Information of Health Care Workers Regarding Their Exposure to Confirmed or Suspected Covid-19 Patients in a Tertiary Care Hospital (N=256).

	COVID unit	Non-COVID unit	P value
	n=177	n=79	
	N (%)	N (%)	
HCWs who had patients on respiratory support*			
Ventilator	75 (42.4)	54 (68.4)	<.001
Oxygen	101 (57.1)	35 (44.3)	.05
Nebulization	9 (5.1)	17 (21.5)	<.001
None of the above	48 (28.1)	7 (15.9)	
HCWs in close contact (within 1 m) with the patient	135 (76.3)	65 (82.3)	.28
Duration of Exposure [§]			<.001
5 min	93 (68.9)	22 (33.8)	
5-15 min	29 (21.5)	34 (52.3)	
>15 min	13 (9.6)	9 (13.8)	
PPE worn by HCWs			<.001
Respirator, face shield, goggles, gown, coverall, head cover, shoe cover	177 (100)	34 (43.0)	
Medical mask, gown, gloves	0	36 (45.6)	
Respirator, gown, gloves, goggles	0	7 (8.9)	
Medical mask only	0	2 (2.5)	
HCWs involved in any aerosol generating procedures performed on the patient	27 (15.3)	12 (15.2)	.50
HCWs in contact with the patient's body fluid	42 (23.7)	20 (25.3)	.78
HCWs had direct contact with patient's materials since his/her admission	120 (67.8)	70 (88.6)	<.001
HCWs had contact with patient's surface	110 (62.1)	51 (64.6)	.71

*Multiple response.

[§]Percentage is calculated out of 135 and 65 among Covid unit and Non-Covid unit respectively.**Table 4.** Clinical Characteristics of Health Care Workers in a Tertiary Care Hospital (N=256).

	COVID unit	Non-COVID unit	P value
	n=177	n=79	
	N (%)	N (%)	
HCWs with respiratory symptoms*			
Any symptom	15 (8.5)	10 (12.7)	.29
Fever	5 (2.8)	5 (6.3)	.18
Sore throat	8 (4.5)	4 (5.0)	.82
Cough	4 (2.3)	2 (2.5)	.89
Runny nose	3 (1.7)	2 (2.5)	.65
Shortness of breath	1 (0.6)	0	.50
HCWs on HCQ prophylaxis	45 (25.4)	17 (21.5)	.50
HCWs tested positive	0	5 (6.3)	<.001

*Multiple response.

This study shows that if health care workers take adequate precautions and IPC trainings then they can minimize the risk of getting infection. Proper donning and doffing practice of PPE by HCWs is a must to prevent their exposure to the pathogen. There are high chances of contamination while doffing PPE. In our health care facility, the HCW's were trained for the infection prevention control

(IPC) practices and wearing full personal protective equipment (PPE). Their donning (supervisor stay there while they don) and doffing (supervised through live video streaming using Closed Circuit TV and mic) are supervised. Any breach in PPE was documented and risk assessment was done so as to reduce the risk of infection among HCWs. In non COVID areas, the HCW used to wear full PPE but

their donning and doffing was unsupervised which may be a risk for contamination. A study conducted in a large tertiary care hospital had shown that improper doffing practices may put HCWs at risk for self-contamination, which was observed even when experienced HCWs were doffing in the presence of a trained observer.¹⁵ In another study, it was observed that overall, 90% of observed doffing was incorrect, with respect to the doffing sequence, doffing technique, or use of appropriate PPE.¹⁶

It was observed in the present study that majority (80%) of HCWs had attended IPC training. About 87% of HCWs always follow standard precautions for IPC while only 3% of HCWs didn't know what these standard IPC precautions are. These findings are in contrast with the results of other study where HCWs had demonstrated low knowledge and compliance to standard precautions.¹⁷ The high knowledge levels in our setting were due to the emphasis given for IPC measures by the Hospital Infection Control Committee and initiation of trainings even before the first COVID case got admitted in the hospital.

Almost 92% of HCWs in our study followed recommended hand hygiene practices. Such a high compliance in hand hygiene practices may be attributable to continuous trainings of HCWs as a part of good IPC measures. These observations are in line with the results of a study done in a tertiary care center in Pune where compliance to the adequate hand hygiene was also found to be higher (91.0%) among HCWs.¹⁸

The present study shows that majority (89%) of HCWs performed hand hygiene after contact with body fluids and patient's surrounding and before touching the body of patient and performing aseptic procedures. Similar to our findings, previous studies has also shown that the majority (95%) of HCWs performed hand hygiene after touching contaminated items.¹⁹

Hand hygiene is very important to prevent transmission of diseases and our study focused on the importance of hand hygiene during caring of the COVID-19 patients, similar to other research done previously.²⁰

It was noticed in our study that HCWs frequently touched the patient's material (74%) and surfaces (63%) around the patient which are potential source of infection. Previous studies have also reported that these surfaces have been found to be contaminated with respiratory viruses such as influenza viruses and severe acute respiratory syndrome coronavirus.³⁻⁵ Bed rails, IV poles, computer stations, and tray tables were among the most highly touched fomites.^{6,7} Hence, it is of utmost importance to disinfect these surfaces to prevent further transmission of infection.

Out of the total 5 positive cases, 3 HCWs were symptomatic. Sore throat was the most common symptom followed by fever, cough and running nose. In a study on COVID-19 symptomatic and asymptomatic infection on the Diamond Princess Cruise ship, about 50% of cases were

asymptomatic at the time of testing.²¹ Testing of all the HCWs who were exposed to COVID-19 patients provided an opportunity to identify the asymptomatic cases, thus further reducing the risk of transmission.

Among the HCWs tested for COVID-19, about 2% were found to be positive in the present study. According to Chinese Center for Disease Control and Prevention report updated through 11th February 2019, among the 44 672 cases, a total of 1716 were health workers (3.8%).²² This difference in the proportion of the HCWs who tested positive for COVID-19 could be attributed to the fact that by the time the initial cases were detected in India, we had more knowledge about the epidemiology and transmission routes of the virus which led to better preparation of the health system in the forms of IPC trainings and adequate supply of PPEs for HCWs.

Limitations of the study: The study was conducted only in 1 tertiary care hospital and cannot be generalized for all health care institutions. There is a need for similar multi-centric studies to get a better picture.

Conclusion

A well supervised donning and doffing practice, taking adequate precautions and IPC trainings for health care workers in COVID and Non COVID areas can minimize the risk of getting infection.

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ORCID iD

Pinnaka Venkata Maha Lakshmi  <https://orcid.org/0000-0002-6921-9794>

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