



## Characteristics of healthcare workers infected with COVID-19: A cross-sectional observational study



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### ABSTRACT

**Introduction:** Coronavirus disease 2019 (COVID-19) is a new emerging infectious disease, first identified in China in December 2019, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This study describes the characteristics of healthcare workers (HCWs) who tested positive for COVID-19 in a tertiary care hospital in Oman.

**Methods:** This was a cross-sectional descriptive analysis of HCWs with COVID-19.

**Results:** During the study period, 204 HCWs tested positive for COVID-19 by rRT-PCR test, with a test positivity rate of 21.2%; the percentage of infected hospital staff was 4.3%. Their mean age was 36 years. Overall, 2.2% of the male staff were infected, while 9.3% of the female staff were infected. Among the clinicians, 4.7% were infected; among the nurses, 4.1% were infected. Regarding acquisition, 61.3% of infections ( $n = 125$ ) were community-acquired and 25.5% ( $n = 52$ ) were hospital-acquired; no source was identified in 13.2% of cases ( $n = 27$ ). There was a significant difference between hospital-acquired and community-acquired COVID-19 according to the different HCW categories ( $p < 0.001$ ), sex ( $p = 0.041$ ), and being at risk of COVID-19 exposure in the hospital ( $p < 0.001$ ). There were no significant differences in relation to nationality ( $p = 0.498$ ), age ( $p = 0.119$ ), or the presence of co-morbidities ( $p = 0.326$ ). Seventy-eight percent ( $n = 160$ ) had no chronic diseases and 44% presented with fever and an acute respiratory infection ( $n = 90$ ); all made an uneventful full recovery. The peak of infection acquisition was after the Eid Al Fitr festival.

**Conclusions:** HCWs are at an increased risk of COVID-19 in the workplace. The strengthening of infection control measures to prevent exposures from infected patients and colleagues and to reduce the spread of COVID-19 is a necessity.

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### Introduction

Coronavirus disease 2019 (COVID-19) is a newly emerging infectious disease that was first identified in China in December 2019. It is caused by infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). On January 30, 2020, the World Health Organization (WHO) declared the disease a Public Health Emergency of International Concern (PHEIC) and later on March 11, 2020, COVID-19 was declared a pandemic (Gan et al., 2020). In Oman, the first two cases of COVID-19 were diagnosed on February 24, 2020; both cases were travel-related (Khamis et al.,

2020). Community transmission was declared by the public health authorities on March 26, 2020 (Anon, 2020a).

Healthcare workers (HCWs) are at risk of acquiring COVID-19 in the workplace. Several reports have described the reasons leading to COVID-19 acquisition by HCWs within healthcare settings. A shortage of personal protective equipment (PPE), long-time exposure to large numbers of infected patients, inadequate training in infection prevention and control, and exposure to unrecognized COVID-19 patients have been the most prominent causes (Wang et al., 2020; Heinzerling et al., 2020; Zhou et al., 2020).

This study describes the characteristics of HCWs who tested positive for COVID-19 at Royal Hospital, Muscat, Oman, which is the main hospital providing care for patients with moderate to severe COVID-19.

## Methods

This was a cross-sectional descriptive analysis of all HCWs who tested positive for COVID-19 during the period from March 18 to July 11, 2020 at the Royal Hospital in Muscat, Oman. The hospital is the largest tertiary care hospital in the country and employs a total of 4703 HCWs. The HCWs were tested if they reported symptoms or were exposed in the hospital or community to a confirmed case. All positive cases were notified to the Infection Prevention and Control Department and investigated by a trained infection control practitioner (ICP) to determine the type of acquisition and collect the data required using a checklist. These data included baseline demographic data, the type of acquisition based on a risk assessment done by the ICP following Centers for Disease Control and Prevention (CDC) and national guidelines (Anon, 2020b; Anon, 2020c), symptoms, and clinical outcomes. The diagnosis data were extracted from the hospital electronic system. This research was approved by the hospital research committee (SRC#35/2020).

Data were entered into an Excel spreadsheet and analyzed accordingly as numbers and percentages. The Excel data were transferred into IBM SPSS Statistics version 22 software (IBM Corp., Armonk, NY, USA) to compare hospital-acquired (HA) cases and community-acquired (CA) cases using the Chi-square test or Fisher's exact test, as indicated. A *p*-value of <0.05 was considered significant. In the comparison between HA and CA acquisition of the infection, cases with an unknown source of infection were excluded.

## Definitions

A HCW was defined as any paid or unpaid person serving in a healthcare setting who had the potential for direct or indirect exposure to patients or their infectious secretions and materials, including, for example, doctors, nurses, laboratory workers, facility or maintenance workers, clinical trainees, and volunteers (Anon, 2020b).

Significant exposure was considered an exposure of 15 min or more while not wearing PPE and being within 6 feet (approximately 2 m) of a person with confirmed COVID-19 and/or having unprotected direct contact with infectious secretions or excretions from a person with confirmed COVID-19. Any duration was considered prolonged if the exposure occurred during the performance of an aerosol-generating procedure (Anon, 2020b).

The infection was considered community-acquired if the HCW reported contact with a confirmed COVID-19 case in the community setting. The infection was considered hospital-acquired if the HCW reported exposure to a confirmed or suspected COVID-19 case in the hospital setting and had not had any contact with a symptomatic or confirmed COVID-19 case in the community setting or been exposed as per Infection Prevention and Control

Department records. Those HCWs with no exposure to symptomatic or suspected/confirmed cases in the hospital or in the community setting were recorded as having an unknown or unidentified source.

HCWs in the 'at risk' category were those who were exposed either directly through delivering direct care to patients with suspected or confirmed COVID-19 or indirectly, such as cleaners and medical records staff.

## Results

During the study period, 963 COVID-19 RT-PCR tests were done, of which 204 were positive, giving a test positivity rate of 21.2%. The percentage of infected hospital staff was 4.3% (204/4703). The mean age of those infected was 36 years, and 88 (43.1%) HCWs were in the age group 26–35 years, 72 (35.3%) were in the age group 36–45 years, 24 (11.8%) were in the age group 46–55 years, and six (2.5%) were in the age group >55 years. Further demographic data are given in Table 1.

Overall, 2.2% (74/3299) of the male staff tested positive for COVID-19, while 9.3% (130/1404) of the female staff tested positive. Among the clinicians, 4.7% (26/556) were infected; among the nurses, 4.1% (77/1870) were infected. Regarding the category of HCW, 2.8% of paramedics and 5.6% of the support and administrative staff were infected. The percentage of infection among the Omani hospital staff was 5.9%, while the percentage of infection among the non-Omani hospital staff was 2.9% (Table 2).

More than three-quarters of the infected HCWs (78%, *n* = 160) had no chronic diseases or risk factors for severe COVID-19, while 7% (*n* = 15) had hypertension, 11% (*n* = 23) had diabetes mellitus, and 3% (*n* = 6) had other chronic diseases such as systemic lupus erythematosus (SLE) and asthma (Table 1).

The most common acquisition of COVID-19 among HCWs was from the community (61.3%, *n* = 125), followed by hospital acquisition (25.5%, *n* = 52); no source was identified in 13.2% of cases (*n* = 27). Among those who acquired COVID-19 in the hospital, 18 (35%) acquired the infection from a confirmed positive COVID-19 colleague and 33 (65%) from exposure to patients. The peak acquisition of infection was from June 7 to June 20, 2020, as shown in Figure 1.

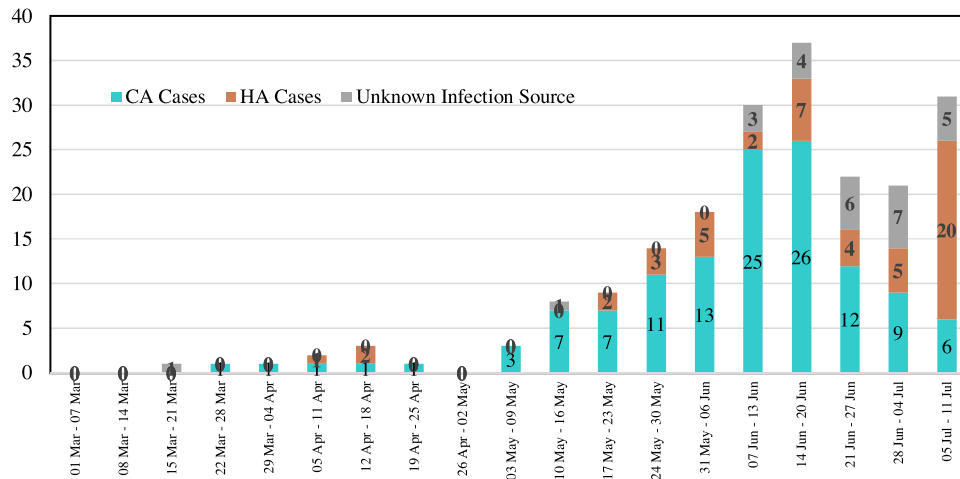
**Table 1**  
Characteristics of healthcare workers who tested positive for SARS-CoV-2.

Variable	Number of HCWs	Percentage
Age (years) (mean 36 years)		
<26	14	6.9%
26–35	88	43.1%
36–45	72	35.3%
46–55	24	11.8%
>55	6	2.5%
Sex		
Male	74	36%
Female	130	64%
Nationality		
Omani	134	66%
Non-Omani	70	34%
Risk factors		
None present	160	78.4%
Hypertension	15	7.3%
Diabetes mellitus	23	11.3%
Others	6	3%
Outcome		
Required hospitalization	1	0.5%
Outpatient care	203	99.5%

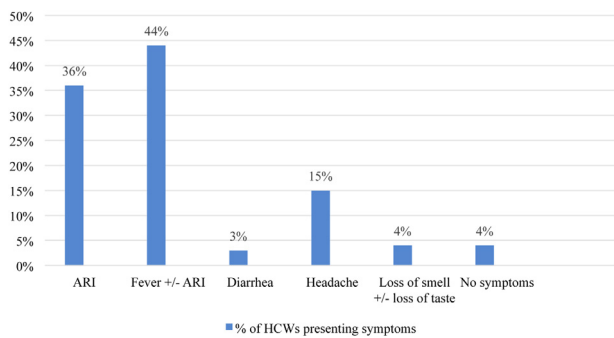
COVID-19, coronavirus disease 2019; HCWs, healthcare workers.

**Table 2**  
Percentage of infected healthcare workers among the overall hospital healthcare workers by category.

	Overall hospital staff category	Total infected in category	% infected in category
Male	3299	74	2.2%
Female	1404	130	9.3%
Doctors	556	26	4.7%
Nurses	1870	77	4.1%
Paramedics	969	27	2.8%
Support/administrative	1308	74	5.6%
Omani	2265	134	5.9%
Non-Omani	2438	70	2.9%

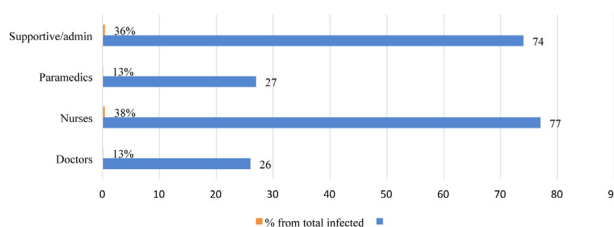


**Figure 1.** Chronology of the different types of acquisition: community-acquired (CA), hospital-acquired (HA), unknown.



**Figure 2.** Percentage of healthcare workers presenting symptoms on diagnosis.

The most common presentation in affected HCWs was an acute respiratory infection (ARI) with fever (44%,  $n = 90$ ), followed by ARI with no fever (36%,  $n = 73$ ) and headache (15%,  $n = 31$ ). The other symptoms such as diarrhea and loss of smell and/or taste represented small percentages, as shown in Figure 2.



**Figure 3.** Percentage of infected healthcare workers of the total infected ( $N = 204$ ).

Figure 3 summarizes the numbers and categories of HCWs who tested positive for COVID-19. The majority of the infected HCWs were nurses (38%,  $n = 77$ ), followed by support staff and administrative staff (36%,  $n = 36$ ), including housekeeping, engineering, laundry, and catering staff. Doctors and paramedics each constituted 13% ( $n = 26$  and  $n = 27$ , respectively).

All HCWs in this cohort had mild infections and did not require hospitalization, with the exception of one HCW who had pneumonia and was admitted to the hospital. This HCW received hydroxychloroquine and an oral antibiotic.

In the univariate analysis, HA and CA cases were compared among the different categories of HCW and other variables. No significant difference was found between the two groups in relation to nationality, age group, or presence of co-morbidities. However, a significant difference was found between the sexes, with 35% of the female HCWs compared to 20% of the male HCWs having a HA infection. A significant association ( $p < 0.001$ ) was found between acquiring COVID-19 in the hospital and working in a high-risk department or working as a doctor or nurse, as shown on Table 3.

### Discussion

The mean age of HCWs in this study was 36 years, which is close to the average national community age, as published by Khamis et al. (2020). However, 64% of infected HCWs were female, which is in contrast to the community data (Khamis et al., 2020). The percentage of infected female HCWs in the study cohort is closer to that reported in the USA (73%), but higher than the percentage reported by Chu et al. in China (33.3%) and by Glonar et al. in Iran (53.5%) (CDC COVID-19 Response Team, 2020; Chu et al., 2020; Sabetian et al., 2020).

**Table 3**  
Univariate analysis of the type of acquisition—hospital-acquired (HA) versus community-acquired (CA)—and the variables studied.

Variable	Category	CA (n = 123)	HA (n = 52)	Total	p-Value
Nationality	Omani	80 (65%)	31 (59.6%)	111 (63.4%)	0.498
	Non-Omani	43 (35%)	21 (40.4%)	64 (36.6%)	
Sex	Male	51 (41.5%)	13 (25%)	64 (36.6%)	0.041
	Female	72 (58.5%)	39 (75%)	111 (63.4%)	
Age (years)	<26	10 (8.1%)	4 (7.7%)	14 (8.0%)	0.119
	26–35	51 (41.5%)	23 (44.2%)	74 (42.3%)	
	36–45	48 (39.0%)	14 (26.9%)	62 (35.4%)	
	46–55	13 (10.6%)	7 (13.5%)	20 (11.4%)	
	>55	1 (0.8%)	4 (7.7%)	5 (2.9%)	
Co-morbidity	No	92 (74.8%)	43 (82.7%)	135 (77.1%)	0.326
	Yes	31 (25.2%)	9 (17.3%)	40 (22.9%)	
HCW category	Admin staff	9 (7.3%)	4 (7.7%)	13 (7.4%)	<0.001
	Doctor	7 (5.7%)	12 (23.1%)	19 (10.9%)	
	Nurse	36 (29.3%)	29 (55.8%)	65 (37.1%)	
	Paramedic	18 (14.6%)	6 (11.5%)	24 (13.7%)	
	Support staff	53 (43.1%)	1 (1.9%)	54 (30.9%)	
	At risk of exposure to COVID-19	No	74 (60.2%)	8 (15.4%)	
	Yes	49 (39.8%)	44 (84.6%)	93 (53.1%)	

HCW, healthcare worker; COVID-19, coronavirus disease 2019.

The Omani staff had a higher infection rate (5.9%) in comparison to expatriate staff (2.9%); however, there was no significant difference in HA versus CA infection between these two groups.

In this cohort, 38% of the infected HCWs were nurses, with an infection rate of 4.1%. This is lower than in the study by Glomar et al. from Iran, where nurses accounted 51.3% of infected HCWs (Sabetian et al., 2020). The infection rate among support and administrative staff was 5.6%, and most of the infections were community-acquired (43%), while the infection rate among doctors was 4.7%, with 23.1% of their infections being hospital-acquired, which is higher than in a cohort reported from Iran, where the infection rate among doctors was 3.2%.

The majority of HCWs acquired the infection during the 2 weeks from June 7 to June 20, 2020. This coincided with the period after Eid Al Fitr (May 23–26, 2020), which is an important religious festival for Muslims characterized by large social gatherings and family visits. Additionally, hospital acquisition among HCWs increased in the last week of the study period, after the hospital experienced an outbreak due to HCWs and patients being exposed to a patient diagnosed with COVID-19 who received non-invasive ventilation in an open ward.

Among the categories of HCW, the highest percentage of infection was found for the support and administrative staff, at 5.6%; however, 43.1% of these infections were community-acquired.

In this study, 35% of hospital-acquired infections were a result of contact with another infected colleague, particularly during 'break' times, as the HCWs were not compliant with social distancing and universal masking when eating. In this group, it was observed that the index HCW would have mild ARI symptoms and a prior history of chronic sinusitis or allergic rhinitis that delayed the clinical suspicion and diagnosis of COVID-19, resulting in them infecting other colleagues. The same situation was reported by Klompas et al. (2020).

Most of the HCWs in this cohort suffered from a mild infection, and only one HCW required hospitalization for moderate pneumonia and was treated with hydroxychloroquine and an oral antibiotic. This might be due to the younger age of this cohort as compared with that in the study by Chu et al., who reported that age was inversely related to the severity of illness (median age for severe/critical disease was 47 years versus 38 years for non-severe disease;  $p = 0.0015$ ) (Chu et al., 2020). Also, only a small percentage of the HCWs had chronic diseases, which might explain the good outcome.

This study has several limitations. First, the actual number of infected HCWs might be underestimated, due to under-reporting, especially of infected HCWs who were diagnosed in other institutions. Second, data on antibiotic use and chest X-ray findings were not available for all of the infected HCWs. Third, there may be an underestimation of the symptoms, as these were reported at the time of the interview or during the staff clinic visit at diagnosis. The HCWs might have developed more symptoms later that were not reported.

In conclusion, HCWs are at a high risk of acquiring COVID-19 in the workplace. In the study cohort, there were many reasons that might account for the acquisition of COVID-19 among HCWs, such as low compliance with infection control precautions, non-compliance with social distancing and universal masking during eating times, and late diagnosis of HCWs who had mild symptoms. The infection control measures for COVID-19 that apply to the community, such as social distancing and universal masking, must be applied meticulously in the hospital among HCWs to prevent hospital-acquired infections.

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#### Ethical approval

This research was approved by the hospital research committee (SRC#35/2020).

#### Conflict of interest

All authors declare no conflict of interest.

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