

## Correlation of the COVID-19 Infection and Outcomes with Workload among Emergency Healthcare Workers in an Iranian Referral Hospital

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### ABSTRACT

The immediate spread of COVID-19 posed a great deal of strain on healthcare personnel, particularly emergency personnel. Considering the critical role of frontline health care personnel (HCPs) during the pandemic and the life-threatening effects of COVID-19 on them, the present study aimed to evaluate the hospital database among frontline emergency personnel, and to assess the factors affecting the health status of the emergency HCPs. In the current study, we collected data on coronavirus clinical features from 58 HCPs with confirmed COVID-19 who worked in the emergency ward of Baqiyatallah Hospital, Tehran, one of the most referral hospitals in Iran. We also assessed the factors affecting the health status of the emergency HCPs from February 2020 to November 2020. All of the 58 HCPs infected with COVID-19 were the personnel of the emergency ward with an age range of 20-59 years old. The median (interquartile range) of hospital length of stay (LOS) among all patients was 8 days. Length of stay is a critical factor in predicting hospital resource needs. Twelve (21.8%) patients had ground-glass opacity (GGO) alone, and 20 (35.7%) patients had patchy GGO. In our multivariable analysis, high levels of patient liver enzymes ( $P=0.04$ ) and lymphopenia ( $P=0.01$ ) were significantly associated with the LOS. In our study, there was an association between high levels of patient's ESR and CRP and longer LOS. We also found that age and gender had no effect on LOS. Nurses contributed to the highest number of COVID-19 infection. It was also found that HCPs who had more working shifts were more infected, and the intensive care unit of the emergency ward was the most infected area of the Emergency Room.

**Keywords:** COVID-19, Emergency ward, Health care workers, Hospital length of stay

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## 1. Introduction

The novel coronavirus pneumonia disease 2019 (COVID-19) outbreak spread out the entire world and became a terrible tragedy. Since the Health Care Professionals (HCPs) carry almost all the burden as the first line and have tolerated a lot of morbidities and mortalities, it is a top priority to prevent intra-hospital transmission (1). Ample documents have shown that the COVID-19 virus is transmitted via droplets, small 5-10  $\mu\text{m}$  particles, in direct person-to-person contacts (2, 3). Although observing social distancing, staying at home, as well as wearing a face mask can reduce the risk of infection (4), HCPs were subjected to more task load and hours at the workplace (5). Reports demonstrated that the burden of COVID-19 on HCPs was high COVID-19, raising concerns for global health. Furthermore, COVID-19 infections among HCPs affect personnel's sick leave (7). As the HCPs are in the first line of fighting COVID-19, the negligence of their safety as well as their insufficient Personal Protective Equipment (PPE) can easily transmit the disease to others and pose a threat to the healthcare system. Hence, the lack of PPE puts HCPs in danger of infection and more COVID-19 viral loads (8).

Although plenty of infected cases in Iran are HCPs, there was not enough scientific evidence to demonstrate the estimated cases so far, especially in major hospitals in Iran. Therefore, at Baqiyatollah Hospital in Tehran, the main referral center in Iran, we gathered informative data, including laboratory data, from COVID-19-infected HCPs. This data provided insight into the clinical features of the coronavirus.

It is well accepted that laboratory markers, such as serum erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels, increase during inflammatory events. These factors can activate the complement system and raise phagocytosis (9, 10). Numerous studies have reported that severe COVID-19 patients expressed significantly higher ESR and CRP levels than their non-severe counterparts (11,

12). The current study can be of high importance due to the lack of information regarding the HCP population as the front line of COVID-19 disease in Iran.

## 2. Materials and Methods

### 2.1. Data collection

The present study was conducted on 58 HCPs with COVID-19 in the Baqiyatallah Hospital as a reference hospital (Emergency Ward). Data were collected during the first year of the COVID-19 pandemic from February to November 2020. The required data were collected from HCPs, including medical doctors, nurses, healthcare assistants, and administrative personnel. We assessed HCPs who had a positive test result of real-time reverse transcription-polymerase chain reaction (PCR) performed by oropharyngeal swab. Besides, based on the Iranian National Committee for COVID-19, we included patients with a history of COVID-19 manifestations along with Ground-Glass Opacity (GGO) alone or GGO accompanied with consolidation in chest computed tomography (CT) scan. The researchers documented demographic characteristics, symptoms, and underlying health conditions of HCPs, as well as family members' exposure to affected HCPs prior to COVID-19 confirmation. All samples were working in different parts of the Emergency Room (ER). The factor of PPE employment was also considered. The main symptoms (e.g., fever, cough, dyspnea, myalgia, anorexia, and sore throat) were recorded. We calculated the length of stay (LOS) and the interquartile range (IQR) in the present study. The length of stay is a critical indicator of the efficiency of hospital management. To elaborate, a decrease in the number of inpatient days leads to reduced risk of infection and medication side effects, as well as improvement in the quality of treatment. The IQR is the range of values that resides in the middle of the scores. The difference between the upper and lower quartile is known as the IQR. The formula for calculating the interquartile range is as below:

Interquartile range = Upper Quartile – Lower Quartile = Q-3 – Q-1

, where Q1 is the first quartile and Q3 the third quartile of the series (13).

## 2.2. Ethical Considerations

The current retrospective study was approved by the Research Ethics Committee of Baqiyatallah University of Medical Sciences, Tehran, Iran (IR.BMSU.REC.1399.240).

## 2.3. Statistical Analyses

The current data were analyzed using the SPSS software (IBM. SPSS Statistic., version 24.0). The qualitative variables were analyzed using Pearson's chi-square test. Quantitative variables were presented as mean  $\pm$  standard error of mean (SEM), while qualitative variables were described as frequency and percentage.

## 3. Results

This study was performed on 58 HCPs of Baqiyatallah Hospital with an age range of 20-59 years. Most cases (n=42, 72.4%) were in 30-49 age group. Among these individuals, 14 subjects (24.1%) were women. Nine (15.5%) individuals had close contact with confirmed COVID-19 patients. In this study, 6 (10.3%) patients were confirmed for COVID-19 by positive PCR tests, 18 (31%) by radiographs (CT scan), and 34 (58.7%) by both positive PCR test and CT scan. Regarding the ward type, 51 (13.1%) patients were the personnel of COVID-19 wards, 43 (11.1%) were the personnel of COVID-19 intensive care unit, and 46 (11.8%) were COVID-19 emergency department personnel.

In our study, HCPs who were on working shifts at the hospital between 30 and 59 h/week contributed to the highest frequency (n=29, 50%). Among the different parts of emergency departments, HCPs who worked in the COVID-19 ICU had the highest rate of infection (72.41%). Table 1 gives information about the frequency of cases (n=58) working in the different sections of the emergency ward of Baqiyatallah Hospital.

**Table 1.** Frequency of shift working of HCPs in the different parts of emergency ward.

Section of shift working of HCPs in the different parts of emergency ward	Frequency (%)
Acute care	42 (72.41)
Observation services	10 (17.24)
Outpatient services	2 (3.44)
Reception	2 (3.44)
Triage	2 (3.44)

The median (IQR) of hospital LOS was 8 days for all patients. The LOS for 34.2% of patients was 1-3 days. Information on sick leave (for COVID-19) is presented in table 2. Only 38 (65.5%) individuals were hospitalized, all of whom were discharged in good condition. There was no death in total. Eleven patients (19%) had more than one underlying disease. Hypertension, diabetes mellitus, irritant gas inhalation injury, coronary artery disease, and hypothyroidism were present in 3 (5.2%), 3 (5.2%), 2 (3.44%), 1 (1.72%), and 1 (1.72%) patients, respectively. Among the underlying diseases, hypertension, diabetes mellitus, and irritant gas inhalation injury were the most common ones. The hospital LOS did not significantly associate with the patients' comorbidities.

As shown in table 3, of initial symptoms, fatigue (89.7%), muscle pain (84.5%), chilling (79.3%), fever (77.6%), and headache (72.4%) were the most common complaints.

The results of the chest CT scan, which was performed for 51 patients, revealed that all of them had pulmonary involvement in favor of COVID-19. Twelve (21.8%) patients had GGO alone, and 20 (35.7%) had patchy GGO. Lung involvement was mostly reported bilaterally (70.6%) (Table 4). The CT

**Table 2.** Frequency of Sick leave of HCPs for COVID-19

Sick leave for COVID-19 (Day)	Frequency (%)
9-19	35 (60.3)
20-29	14 (24.1)
30-39	6 (10.2)
40-49	1 (1.8)
50-59	1 (1.8)
60-69	1 (1.8)

**Table 3.** Frequency (%) of symptoms of COVID-19 in HCPs

Symptoms	No	Yes
Fever	13 (22.4 %)	45 (77.6 %)
Coughing Dry	23 (39.7 %)	35 (60.3 %)
Productive Coughing	50 (86.2 %)	8 (13.8 %)
Dyspnea	26 (44.8 %)	32 (55.2 %)
Sour throat	33 (56.9 %)	25 (43.1 %)
Chilling	12 (20.7 %)	46 (79.3 %)
Olfactory change	25 (43.1 %)	33 (56.9 %)
Taste change	50 (86.2 %)	8 (13.8 %)
Headache	16 (27.6 %)	42 (72.4 %)
Diarrhea	30 (51.7 %)	28 (48.3 %)
Anorexia	26 (44.8 %)	32 (55.2 %)
Muscle pain	9 (15.5 %)	49 (84.5 %)
Globus sensation	54 (93.1 %)	4 (6.9 %)
Fatigue	6 (10.3 %)	52 (89.7 %)
Nausea and Vomiting	32 (55.2 %)	26 (44.8 %)
Constipation	54 (93.1 %)	4 (6.9 %)

criteria of patients did not significantly associate with the comorbidities. Of the 58 individuals with COVID-19 infection, 33 (57.9%) utilized PPE. Based on current data, the high level of laboratory results was as follows: CRP (53.4%), D-dimer (39.7%), aspartate transaminase and alanine transaminase (34.5%), lactate dehydrogenase (32.8%), ESR (32.8%), prothrombin time (29.3%), lymphopenia (25.9%), creatine phosphokinase (24.1%). In the multivariable analysis, high levels of liver enzymes ( $P=0.04$ ) and lymphopenia ( $P=0.01$ ) were significantly associated with LOS. Furthermore, high levels of the patient's ESR ( $P=0.022$ , Pearson chi-square=7.668,  $df=2$ ) and CRP ( $P=0.006$ , Pearson chi-square=10.189,  $df=2$ ) were significantly associated with lung involvement. The hospital LOS was not significantly associated

**Table 4.** Frequency (%) of lung involvement of COVID-19 in HCPs.

Lung Involvement	Frequency (%)
GGO	12 (21.8 %)
Patchy Infiltration	1 (2.7 %)
GGO + Consolidation	2 (4.4 %)
GGO + Consolidation+Reticular	1 (2.7 %)
GGO + Nodules	1 (2.7 %)
GGO + Patchy	20 (35.7 %)
GGO + Reticular	4 (7.9 %)
GGO + Patchy+Crazy Paving+Reticular	1 (2.7 %)
GGO + Patchy+Crazy Paving	4 (7.9 %)
GGO + Consolidation+Patchy	2 (4.4 %)
GGO + Crazy Paving	2 (4.4 %)
GGO + Consolidation+Patchy+Crazy Paving	1 (2.7 %)

with the patient's gender, age, and the type of ward.

#### 4. Discussion

From February 2020 to November 2020, we investigated the hospital database for 58 patients with COVID-19 among the emergency HCPs in Baqiyatallah Hospital in Tehran, Iran. In our hospital, we assessed both symptomatic and asymptomatic HCPs and found that 58 staff were positive for COVID-19 infection. Several studies have reported that HCPs are highly exposed to the COVID-19 infection. In the observational cohort study conducted by Iversenet et al. (2020) to investigate the incidence of infection among the HCPs in Denmark, 1,163 out of 29,295 screened personnel were detected with COVID-19 positive tests. They reported that frontline HCPs in hospitals, including nurses and medical students, were effectively more involved than other HCPs. They also found that the risk of COVID-19 in HCPs was related to exposure to infected patients (8). Similarly, in a study by Rivett et al., in a UK teaching hospital, of 1,032 asymptomatic HCPs evaluated for COVID-19 infection, 3% were positive. The researchers of the mentioned study noted that people could transmit viruses to others (14). Furthermore, Kluytmans-van den Bergh et al. evaluated the incidence of COVID-19 among the HCPs of 52 different Dutch hospitals. Of 9,705 HCPs with fever and respiratory symptoms, 6% were positive, accounting for 1% of all staff (15).

In the present study, HCPs who were on working shifts at the hospital between 30 and 59 h/week formed the highest frequency ( $n=29$ , 50%). Moreover, in our study, nurses formed the highest percentage of COVID-19 infection (44.8% of total cases). Our findings were in line with those of a study by Villar et al. demonstrating that nurses spent more time with COVID-19 patients (16). Additionally, our hospital nurses were under stress because they had to encounter a novel and not well-recognized virus. None of the nurses in our study worked in a similar situation to the COVID-19 pandemic and they had to

adjust to this new condition in a short period. Maybe this is why nurses are more likely to become infected (17, 18). Therefore, education and training should focus on increasing HCPs knowledge of COVID-19 infection.

There are various protocols from different countries for PPE access. To give an example, based on a study by Holland et al., all emergency physicians should wear N-95 masks, disposable gloves, isolation gowns, and face shields. Furthermore, avoiding hand-to-face contact is a beneficial measure (19). The results of A considerable number of prospective observational studies in the UK and USA have revealed that the risk of COVID-19 increased among HCPs with inadequate PPE or reused PPE (20). In the current study, 57.9% of the infected personnel utilized PPE, such as medical or N95 masks, gowns, gloves, and shields. Hence, one of the probable reasons for the transmission of the disease among HCPs would be their failure to use PPE properly or not observing hand hygiene precautions closely. The second probability of transmission might be not using PPEs during the rest time. Therefore, we suggested that failing to follow the PPE protocols was one of the critical factors that could increase the prevalence of the COVID-19 infection among HCPs.

In our study, the most prevalent comorbidities were diabetes and hypertension. However, the hospital LOS did not significantly associate with the patients' comorbidities. Similar to our results, Rees et al. also concluded that disease severity was not associated with LOS.

The findings of our research were also indicative of the existence of a relationship between high levels of patient ESR and CRP and longer LOS. We also found that age and gender had no effect on LOS, which is a critical factor in predicting hospital resource needs. Previous results also suggest that neither age nor gender affects LOS (13). Despite some similarities, our results showed that LOS and its associated factors were different from that published in the literature. For instance, Rees et al. found that every 1-year

increase in age was correlated with a rise in patients' LOS (21). This discrepancy in the findings is not surprising due to the still incomplete knowledge of the COVID-19 infection.

One of the limitations of the present study was related to the restricted sample size from a single center; as a result, the data analysis cannot be representative of the characteristics of COVID-19 healthcare workers. Furthermore, since the study was limited in scope, it might have biases to the analysis. It was revealed that HCPs who had more working shifts were more infected and the ICU of the emergency ward was the most infected part of the ER.

Failure to follow PPE protocols is one of the critical factors that can increase the prevalence of COVID-19 infection in HCPs. Therefore, this critical factor should be addressed by administrative health officials. Most of the HCPs were under 40 years old, which might be justified by the higher frequency of this age group in emergency personnel. Moreover, in the present study, nurses accounted for the highest number of COVID-19 infections. HCPs who had more working shifts were more infected, and the Chemical, Biological, Radiologic, Nuclear, and Explosive section was the most infected area of the ER.

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### **Authors' Contribution**

Study concept and design: M. J. B.  
Acquisition of data: A. V.  
Analysis and interpretation of data: Z. B.  
Drafting of the manuscript: Z.B.  
Critical revision of the manuscript: M. J. B and Z. B.  
Statistical analysis: Z.B.

### **Ethics**

It is declared that all ethical considerations were

taken into account in the preparation of the submitted manuscript.

### Conflict of Interest

The authors declare that they have no conflict of interest.

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