DOI: 10.4274/csmedj.galenos.2022.2022-6-3
Cam and Sakura Med J 2022;2(3):110-114

CSMJ

The Risk Factors for SARS-CoV-2 Transmission in Healthcare Workers of Secondary Level Intensive Care Units

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What is known on this subject?

The infection risk in the departments with a high of aerosol release and the risk factors affecting the infection were not determined, even though a few studies were performed to evaluate this job security problem.

What this study adds?

We evaluate the risk factors for the severity of the infection in the healthcare workers of the intensive care unit in which there are many viral aerosol-generating procedures.

ABSTRACT

Objective: Health workers are at the front line of the coronavirus disease-2019 (COVID-19) outbreak response during the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) pandemics, the healthcare workers have been the most affected people by the infection overall the world. Eleven times higher risk for the severe infection in the healthcare workers in the current studies, especially in departments with a higher among of viral aerosols. This information would be useful to formulate job security policies and minimize occupational transmission. We evaluate the risk factors for the SARS-CoV-2 transmission in the healthcare workers of secondary level intensive care units (ICU) in which there are many viral aerosols because of the use of a non-invasive mechanic ventilator and high flow nasal oxygen treatment.

Material and Methods: Fourty healthcare workers of secondary level ICU with a capacity of 16 patients were included in our study between November and December 2020. The risk factors and incidence of COVID-19 infection were evaluated by making a questionnaire.

Results: 25% of the healthcare workers (n=10) were infected by SARS-CoV-2. The infected ones were remarkable with younger age, less experienced, and long duty hours ($p<0.05$). There were no significant differences between the gender, daily duty hour, smoking, marital status, body weight, history of cardiopulmonary resuscitation, duration of rest after the duty of the two groups ($p>0.05$).

Conclusion: As a result, younger age, less experience and longer duty hours were the risk factors for COVID-19 infection. Our study can be useful to ensure that all necessary preventive and protective measures are taken to reduce occupational risks of SARS-CoV-2 transmission to healthcare workers.

Keywords: Healthcare, worker, COVID-19, risk, factor

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Received: 21.06.2022 **Accepted:** 28.11.2022

Introduction

During the syndrome coronavirus-2 (SARS-CoV-2) pandemics the healthcare workers have been the most affected people by the infection overall the world. Eleven times higher risk for severe infection in the healthcare workers than in society was reported in the current studies (1). The World Health Organisation (WHO) classified the department of the healthcare workers with a history of cardiopulmonary resuscitation (CPR) and those who perform the treatment of the patients releasing aerosols because of the use of a non-invasive mechanic ventilator (NIMV) and high flow nasal oxygen (HFNO) treatments as "very high risk" in the classification of job security (2). In the early phases of the pandemics, several studies have reported a lack of personal protective equipment, low control of the infection, comorbidities, harsh working conditions associated with higher infection risk in the healthcare workers (3). The infection risk in the departments with a high of aerosol release and the risk factors affecting the infection was not determined, even though a few studies have been performed to evaluate this job security problem (4). We evaluate the risk factors for the severity of the infection in the healthcare workers of the intensive care unit (ICU) in which there are many viral aerosol-generating procedures.

Material and methods

Subjects

We conducted a retrospective cohort study with 40 healthcare workers of a secondary level ICU with a capacity of 16 patients between November and December 2020. The risk factors and history of coronavirus disease-2019 (COVID-19) infection were evaluated by making a questionnaire. In the ICU, there was 1 nurse per every 3 patients in all working periods. The nurses were working with a routine of 24 h working and after that 48 h resting. Medical doctors did not have any working routine. The patients were hospitalized in the ICU with a capacity of 16 negative air pressured rooms for each patient. In severe respiratory failure, those patients were supported with a non-invasive mechanical ventilator and high flow oxygen therapy.

According to the guidelines of the Ministry of Health, only symptomatic healthcare workers were tested with COVID-19 polymerase chain reaction (PCR). Symptomatic and PCR negative ones were evaluated by thorax computed tomography (CT). PCR-positive ones were accepted as infected. The healthcare workers with a history of COVID-19 infection before working in the ICU and the ones who refuse to answer the questionnaire were excluded. A questionnaire with 25 questions was sent to them via a web link. The demographic data and history of COVID-19 infection were recorded. Subjects were separated as infected and non-infected.

The study protocol was approved by the Istanbul Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, Clinical Research Ethics Committee (decision no: 2021-97, date: 11.03.2021).

Statistical Analysis

Continuous variables were presented as mean ± standard deviation or median (range) and categorical data as percentages as appropriate. Differences between the groups were assessed using a Student's test. Categorical data were compared using the X^2 test: A p value of <0.05 was accepted as significant. Data analysis was performed using SPSS version 22 (SPSS Inc., Chicago, IL, USA).

Results

The median age was 32.2±8.8 (23-55). 65% of the subjects (n=26) were female. His median working experience was 8.2 years (1-33). Daily duty hours varied between 8 and 24 h. The median duration of rest after the duty was 35.1 hours (0-48). 87% of the subjects had a history of CPR existed. The demographic data of the subjects are shown in Table 1.

Table 1. Demographic data

Total	n=40
Median age (mean ± SD)	32.2±8.8 (23-55)
Female/male	26 (65%)/14 (35%)
Marital status married/single	14 (35%)/26 (65%)
Comorbidities	1 (2.5%)
Smoker	15 (37.5%)
Smoking pack/year	3.4±6.7 (0-30)
Position distribution specialist/ assistant doctor/nurse	21 (52.5%)/4 (10%)/15 (37.5%)
Working experience (years)	8.2±8.5 (1-33)
Daily working duration (hours)	17.4±7.8 (8-24)
Duration of resting after work (hours)	35.1±15.8 (0-48)
COVID-19 infection	10 (25%)
COVID-19 severity mild/middle/ severe	4/6/0
History of cardiopulmonary resuscitation	35 (87.5%)

SD: Standard deviation, COVID-19: Coronavirus disease-2019

25% of the subjects (n=10) were infected. Nine subjects were COVID-19 PCR positive and 1 subject was diagnosed with thorax CT. When 60% of the infected subjects had mild covid-19 infection, 40% of them had moderate COVID-19 infection. There was not severe pneumonia which necessitated hospitalization. The median duration of hospitalization was 14.3±3.5 days (10-20).

The median period between SARS-CoV-2 transmission and beginning to work in the ICU was 22.3±9.5 days (7-30). The household transmission rate was 25%.

The infected healthcare workers had significantly younger age, lower working experience, longer monthly duty hours, and there was not any significant difference between marital status, median body weight, smoking, daily duty hours, history of CPR of the two groups. 46.7% of the nurses (n=7/15), 12%of the doctors (n=3/25) were infected. The infection risk was significantly higher among the nurses (Table 2).

Discussion

When in the early phase of the SARS-CoV-2 pandemics, several studies reported a higher infection risk in the healthcare workers than society (5), the severity and mortality were lower in the healthcare workers. When the infection risk was higher for the nurses, older age and male doctors were remarkable with a higher mortality (5). Another study found the infected healthcare workers to be 84% female and 54% nurses (6). We did not find any significant differences between the genders of the two groups. Half of the nurses were infected and 70% of the infected subjects were nurses.

In our study, the median age of all subjects was 32.2 years and the median age of the infected healthcare workers was 25.7, lower than that in the previous studies. Our comorbidity rate was 2.5% and lower than other studies which were evaluated to be related to lower median age. In our study, there were not any subjects with severe pneumonia necessitating hospitalization. This finding is consistent with the lower severity and mortality in younger patients without comorbidities, as reported in several studies (7).

It is known that non-invasive mechanical ventilators and high-flow nasal oxygen treatment reduce the risk of intubation in severe pneumonia with respiratory failure (8,9,10).

Although HFNO treatment has been performed for non-hypercapnic respiratory failure in ICUs for many years, in the early phase of the SARS-CoV-2 pandemics the treatments, which release viral aerosols -like NIMV and HFNO- were not suggested due to the transmission risk (11). Later the studies showed the efficiency and reliability of those treatments and became the first option in the guidelines for treating severe COVID-19 pneumonia with respiratory failure (12,13). Besides, some studies showed no association between high flow oxygen therapy and increased risk of infection in healthcare workers (14). The factors related to the patients' symptoms like cough and sneeze affect the aerosol release (15). The transmission risk is affected by the of the pathogen, environmental factors like air flow (16).

It has been reported that HFNO and NIMV release aerosols bigger than 10 µm, the relative risk for the transmission to healthcare workers is 2.2 for NIMV and 0.6 for HFNO and it is being reduced by the use of negatively pressured rooms and appropriate protective equipments (4).

Our findings follow those studies and lower infection rates in our study might be related to the existence of negatively

Table 2. Clinical features of the infected and non-infected subjects

	COVID (+)	COVID (-)	p value
Age	25.7±3.3	34.4±9.0	0.005
Gender (female/male)	6/4	20/10	0.70
Marital status married/single	8/2	18/12	0.44
Working experience (years)	2.4±3.4	10.2±8.9	0.01
Daily working duration (hours)	20.8±6.7	16.2±7.9	0.11
Monthly working duration (hours)	228.8±35.2	171.3±62.7	0.009
Duration of resting after work (hours)	40.8±11.5	33.2±16.7	0.19
Position doctor/nurse	3/7 (12%/46.7)	22/8 (88%/53.3)	0.008
History of cardiopulmonary resuscitation (yes/no)	9/1	26/4	0.1
Smoking pack/year	2.0±3.8	3.8±7.4	0.48
Median weight	72.8±20.7	68.7±16.4	0.54

COVID: Coronavirus disease

pressured rooms and careful use of personal protective equipment. Besides, the infection rate of healthcare workers with no specification of departments was 57.4% in a study of the Turkish Thoracic Society which performed by questionnaire (17).

In a study in France, only 1 nurse from 44 healthcare workers of an inpatient clinic with 14 rooms with HFNO was infected. There was a household transmission in the family of the infected healthcare worker (18). In our study in 25% of the infected subjects, there was a household transmission and it seemed to be associated with being single in 65% of the subjects. Daily duty hours longer than 10 h and suboptimal hand hygiene after contact with patients were linked to COVID-19 increases the risk of healthcare workers' infection risk (19). The high infection rate of the nurses is related to longer duty hours and is following those studies.

In our study, the history of CPR was not a risk factor of COVID-19 infection in the healthcare workers. The relative risk was 0.63 for a history of CPR in a previous study (19). Duty hours were longer in the infected subjects. We did not evaluate the use of personal protective equipment and suboptimal hand hygiene in our study but enough existence of the personal protective devices seems to increase the compliance of the healthcare workers with the preventions against the transmission.

Another study in our country found 7.1% of 703 patients to be infected. Working at the departments where COVID-19 patients were treated, working as cleaning staff, being in contact with the COVID-19 patients closer than 1 meter, staying and eating in the same room with the other healthcare workers without any protective equipment, suboptimal hand hygiene after contacting with patients were linked to COVID-19, contact with a COVID-19 case in the family was the risk factors (20). This study emphasized the control of paying attention to the prevention of healthcare workers (20). We implicate the relationship between the high infection rate of the nurse and not paying attention to the protective preventions in the social area. WHO suggests working plan management for healthcare workers, especially in ICU: Duty hours 8 hours/5 days or 10 hours/4 days, taking a break per 1-2 hours, resting for minimum 10 h between shifts (2). Even though the duty hours were longer in the infected group, there was no significant difference between daily duty hours and resting durations after the duty of the two groups.

In the quarantine period (14 days) after the infection, the lack of those healthcare workers causes major labor loss. Reducing the duty hours of nurses was suggested to prevent labor loss and reduce the infection risk (21). Protection of the healthcare workers, reducing mortality and morbidity are important to prevent secondary transmission and labor loss (7).

Study Limitations

Our limitations are that our study is designed single-center, retrospectively with a small sample size. Our sample included only symptomatic healthcare workers, with no control group. Also, we could not separate household transmission or hospital transmission.

Conclusion

As result, our study showed that personal protective equipment and the existence of negatively pressured rooms reduce the infection risk of healthcare workers, especially in the departments where aerosol releasing treatments like NIMV and HFNO have been performed. Taking effective preventions would be important to the effectiveness of use of labor.

However, we think that our study emphasizes the risk factors for infecting the healthcare workers in secondary level ICUs.

Ethics

Ethics Committee Approval: İstanbul Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, Clinical Research Ethics Committee (decision no: 2021-97, date: 11.03.2021).

Informed Consent: An informed consent form was signed by each subject included in the study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Concept: A.B., H.S.Ö., Design: A.B., S.Y., C.A., G.Ü., Data Collection or Processing: A.B., H.S.Ö., G.Ü., Analysis or Interpretation: A.B., S.Y., Literature Search: H.S.Ö., G.Ü., Writing: A.B., C.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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