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Evaluation of the Route of Transmission and Clinical Course of SARS-CoV-2 Infection in Healthcare Workers at Istanbul Medipol University Hospital

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What is known on this subject?

Hospital workers are considered to be at high-risk in the coronavirus disease-2019 pandemic. Besides environmental and individual factors, inevitable contact with infected cases and exposure to high virulence concentrations makes healthcare workers susceptible to severe disease course and even death. Though the source of transmission may be predictable, this study targeted the most common source of infection for optimal protection.

What this study adds?

The main transmission route of the infection among hospital workers was found to be in-hospital. More intensive training and education should be given to the hospital staff who do not comply with infection control guidelines and to those without sufficient knowledge on transmission routes of severe acute respiratory syndrome coronavirus-2. Supervision on proper implementation of social distancing and hospital infection control policies, screening of asymptomatic patients and evaluation of personal protective equipment quality and accessibility is suggested.

ABSTRACT

Objective: Healthcare workers (HCW) have been the occupational group at highest risk of coronavirus disease-2019 infection despite early availability of guidelines for infection control, administrative management, and application of required conditions on field since the beginning of the pandemic. In this survey study our aim is to investigate environmental and individual factors which facilitate transmission of the virus among HCW in order to target preventative measures to be taken in the future.

Material and Methods: This current study is a single center based retrospective study conducted by analysing 446 telephone surveys conducted on HCW in Medipol Mega University Hospital who tested positive for severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) between 15.03.2020-14.01.2021. Demographic details, comorbidities, department of work, occupation, symptoms, clinical course, choice of pulmonary imaging, use and availability of personel protective equipment (PPE) as well as adherance to social distancing rules was determined.

Results: Among the 3,013 HCW's at our hospital, 877 (29%) were tested positive for SARS-CoV-2, of which 446 were included in the survey. It was shown that 337 (85%) of those included in the study were adherent to the infection prevention protocols. Despite the high application of preventative measures at our hospital in-hospital transmission rates were still found to be high. In-hospital transmission was observed to be in groups of workers simultaneously among different departments of the hospital. The source of transmission was unknown in 33.78% of our HCW. Advanced age and those with comorbidities were found to have higher rates of severe infection. Infection rate was low in pregnant HCW due to the granted administrative leave.

Conclusion: Overall transmission of the infection among HCW is seen to be substantially in-hospital. More extensive training and education should be given to hospital staff who do not comply with infection control guidelines as well as to those who are unable to identify the source of transmission. Supervision of the implementation of hospital infection control policies, screening of asymptomatic cases as well as evaluation of PPE quality is valuable in the protection of HCW. In the event of a pandemic, elderly healthcare workers and those who have comorbidities may benefit from working in secluded environments within the hospital due to the severe course of disease seen in this group of patients.

Keywords: COVID-19, healthcare workers, SARS-CoV-2, personal protective equipment

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Introducion

In December 2019, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), a novel virus causing acute respiratory distress, quickly spread across the world after its initial emergence in China. Causing great concern to people of all countries, the World Health Organization (WHO) declared a pandemic on the 11th of March 2020 in an attempt to protect global health by increasing all preventative measures taken against the virus. The SARS-CoV-2 pandemic poses a serious threat to public health by causing physical, psychological, economical, social disturbances as well as loss of lives. The occupational group at highest risk of suffering the consequences of this pandemic has healthcare workers (HCW) (1). The total number of HCW who have been infected by the virus and lost their lives at the beginning of the pandemic is unknown. What is common among the data presented from different countries is the increased prevalence of SARS-CoV-2 infection among HCW compared to the general population. The prevalence of SARS-CoV-2 infection among HCW in China is 3.46-28.9% (2,3), 12.9% in Massachusetts (USA) (4), between 10.6-20% across various studies in Italy (5,6), 38% in the city of Madrid (Spain) (7), 14% in accordance with the Health Ministry of Spain (8), and reported to be 14.5% in the United Kingdom (9). The WHO reports 3% of the world population in April 2020 to be HCW, and at least 14% of SARS-CoV-2 infections to be in HCW. According to these statistics 1 in every 7 SARS-CoV-2 cases is a healthcare worker (10).

Due to the availability of epidemiological studies on this topic in our country, this study is based on reliable data provided by the Health Ministry of Turkey on the relationship between SARS-CoV-2 infection and HCW. The Health Ministry revealed that HCW constituted 6.3% of the 117,589 SARS-CoV-2 cases seen by 29th of April 2021 (11). On 2nd of September 2020, 29,865 of the 273,301 cases were HCW and 52 HCW had lost their lives to the infection (12). The Health Ministry further revealed that by 10th of December 2020, the number of infected HCW had passed 120,000, and that more than 10% of HCW were infected with 216 lives lost (13). In the 25th of February edition of The Turkish Thorax Society, it was revealed that a total of 28,138 lives were lost in Turkey to the SARS-CoV-2 pandemic of which 380 were HCW. According to these data, at the same date 1 of 74 of the lives lost to SARS-CoV-2 was unfortunately a healthcare worker (14).

HCW play an active role in the diagnosis, treatment and observation of the SARS-CoV-2 infection. In the SARS-CoV guidelines published by the T.C. Health Ministry of Turkey, routes of transmission, diagnostic methods, strategy and protocols to be followed in the management of SARS-CoV-2-positive patients and those with close-contact is described in detail, with regular updates made accessible to all healthcare institutions.

Studies on the incidence of infection among HCW, screening, clinical course, and radiological findings found in literature, however the precise route of transmission among HCW has been difficult to determine during a pandemic. This study aims to investigate the route of infection among HCW to target further preventative measures that can be taken. We identify environmental and individual risk factors contributing to the spread of the disease, and to provide recommendations based on the variable risk factors. In addition to this we observed the different factors, which affect the clinical course of the disease among our HCW to improve preventative measures that may be taken.

Material and Methods

This is a single center based retrospective study with written informed consent forms and is approved by both the Health Ministry (2020-06-22T16_19_42) as well as the Istanbul Medipol University Institutional Review Board (04.03.2021/286).

Data obtained between the date of the first case of SARS-CoV-2 infection in a healthcare worker at our hospital and the first Synovac vaccination was included in this study. Thus, data screening was retrospectively conducted on positive SARS-CoV-2 PCR tests between 15.03.2020-14.01.2021 in the occupational medicine records of HCW at our hospital.

Of the 3013 HCW at our hospital 2127 are female (70.59%) and the remaining 886 are male (13.80%). At our hospital, we have 312 medical doctors (10.35%), 739 nurses (24.52%), 416 patient assistants (13.80%), 140 translators (4.64%). According to the occupational medicine records, in the duration of the aforementioned dates 877 of our HCW (29%) were found to have a positive SARS-CoV-2 test. Of these people, 446 [326 (73.09%) female, 120 (26.91%) male] who gave informed consent were included in the study. Those who did not respond to the survey or were unable to be contacted due to changes in their contact information were excluded from the study.

A telephone survey was conducted on our infected HCW. Data on demographic details, comorbidities, department of work, occupation, symptoms in the duration of the disease, clinical course, the choice of pulmonary imaging were collected from the hospital information system and surveys. In addition the survey also consisted of data on whether the HCW believed to be infected in-hospital or outside of the hospital, the availability of personal protective equipment (PPE) inside the hospital

and how well they adhered to social distancing rules such as wearing a surgical mask and standing at a 1 meter distance from others. Compliance to using PPE (surgical mask, coveralls, gloves, goggles/face shields) when in contact with an infected patient and using gloves, goggles/face shield, coverall and FFP2, N95, or other equal protective masks during aerosol generating procedures was also questioned in the survey. Education on hand hygiene, social distancing, usage of PPE and other standard infection prevention and control precautions were given online to all employees working at the hospital.

The clinical course of SARS-CoV-2 can be graded to be mild, moderate, serious and critical based on the symptoms of the infected individual (15). Mild cases commonly experience symptoms such as fever, myalgia, fatigue, headache and throat ache without any radiological findings. Moderate cases may have fever, respiratory symptoms, and radiological findings indicative of pneumonia. Cases with greater than 50% pneumonic infiltration within the first 24-48 hours after diagnosis are excluded in this group. Serious cases include at least one of the following symptoms; dyspnea, tachypnea (respiratory rate >30/min) or arterial oxygen saturation <93% in room air or PaO_2/FiO_2 >300 mmHg. Critical cases are identified by respiratory failure, septic shock, or multiorgan failure.

On thorax computed tomography, typical findings such as ground glass opacities, crazy paving pattern, irregular multifocal consolidation and/or interstitial changes with peripheral distribution were deemed pozitif for SARS-CoV-2 pneumonia in the context of the pandemic.

Statistical Analysis

Statistical analysis was performed using SPSS 16.0 software (Chicago, IL). Normally distributed continuous variables were expressed as mean ± standard deviation and categorical variables were reported as counts and percentages.

Results

Our level III hospital located in the Bagcilar district of Istanbul, an area with the highest rate of SARS-CoV-2 infection, our HCW were exposed to this infection to a large extent (infection rate among hospital workers 29%). The highest number of infected HCW in our hospital was seen in November 98 cases (11.17%), followed by October and December (Figure 1).

Occupational medicine records show the occupation of the infected HCW to be 89 (10.14%) doctors, 261 (29.76%) nurses/midwives, 34 (3.87%) laboratory technicians, 12 (1.36%) anestezia technicians, 16 (1.82%) radiology technicians, 168 (19.15%) patient consoulers, 31 (3.53%) translators, 20 (2.28%) administrative staff, 76 (8.66%) office staff, 65 (7.41%) technical health staff, and 105 (11.55%) miscellaneous staff (Figure 2). The age range of our HCW: 7 (1.57%) aged >20, 311 (69.73%) aged 21-30 (69.73%), 80 (17.94%) aged 31-40, 37 (8.30%) aged 40-51, 11 (2.47%) workers aged <51. It was observed that 129 of our HCW (28.92%) worked in the SARS-CoV-2 infection wards, while 317 (71.07%) did not.

Nine (2.01%) of the HCW were pregnant. Of these pregnant women 4 underwent a c-section, whereas one had a spontaneous vaginal delivery at term without any complications. Among those who had a c-section, one was a surgical nurse who was being treated in the intensive care unit and had a premature delivery due to the disease. The remaining 4 pregnant cases are being followed up with no complications related to the infection.

Among the HCW who were infected, 79 (17.71%) of the cases were found to have chronic diseases whereas 367 (82.28%) did not. 10 (2.24%) had hypertension, 7 (1.56%) had diabetes mellitus, 4 (0.89%) had chronic kidney disease, 24 (5.38%) had asthma, 7 (1.56%) had heart disease, 5 (1.12%) had autoimmune disease, 1 (0.22%) had cirrhosis, 1 (0.22%) had cerebrovascular disease, 3 (0.67%) had hematological disease and 17 (3.81%) had other miscellaneous diseases. One hundred ten (24.66%) were smokers, 336 (75.33%) were non-smokers.

Our healthcare professionals were asked the question, "How do you think you infected?" and answered "Infected

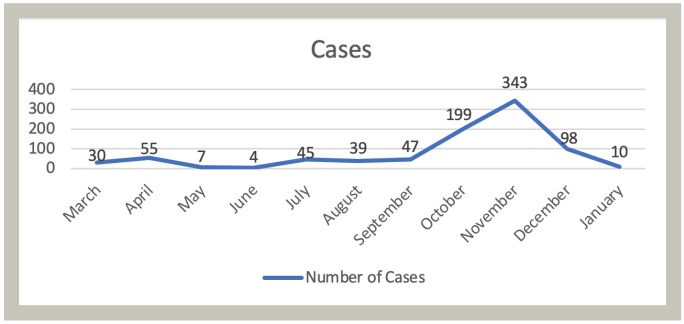

Figure 1. Monthly distribution of cases at the hospital

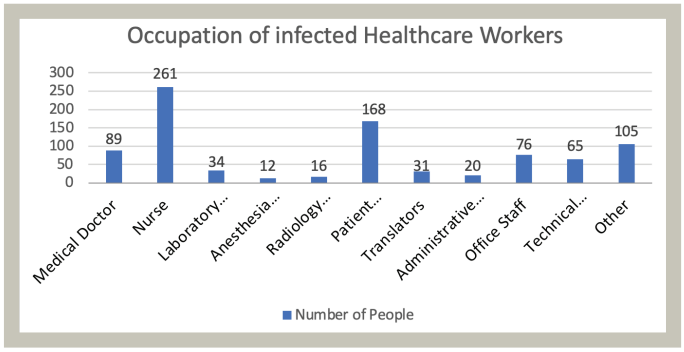

Figure 2. Occupational title of infected healthcare workers

from a patient inside the hospital by 170 of the cases (38.11%)", "infected by hospital staff" by 83 (18.60%) of the cases, infected from a patient outside the hospital by 74 (16.59%) of the cases, and "I don't know" by the remaining 119 (26.68%) (Figure 3).

Three hundred eighty nine (87.21%) of the HCW reported maintaining a 1-meter distance and wearing a medical mask when in contact with people who are not sick, while 57 (12.78%) did not. Three hundred thirty seven (85.10%) confirmed using surgical masks, gowns, gloves, goggles/face shield when in contact with infected patients, while 59 (14.90%) were not complient.

While performing aerosol generating procedures, 128 (77.58%) HCW used N95 or FFP2, or equivalent mask, gloves, goggles/face shields, apron, 37 (22.42%) did not. Access to PPE was said to be "sufficient" by 299 (69.21%) HCW, "insufficient" by 22 (5.09%), and "partially sufficient" by 111 (25.69%).

Among the HCW who responded to the survey, symptoms of SARS-CoV-2 infection were observed to be fever in 191 (43.61%) of the cases, cough in 184 (42.01%), shortness of breath in 118 (26.94%), muscle-bone pain in 291 (66.44%), nausea-vomiting in 56 (12.79%), abdominal pain in 44 (10.05%), diarrhea in 90 (20.55%), loss of taste (ageusia) and loss of smell (anosmia) in 244 (55.71%), sore throat in 154 (36.16%), nasal discharge in 102 (23.29%), and lastly various other symptoms were experienced by 22 (5.02%) of the workers (Figure 4).

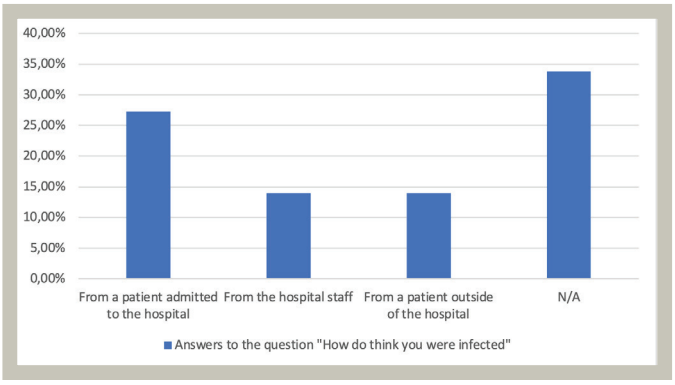

Figure 3. Route of transmission

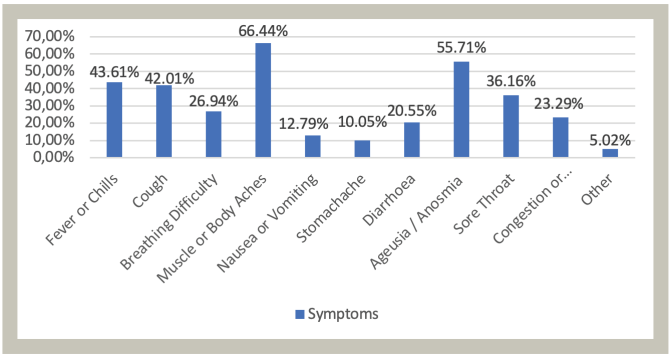

Figure 4. Symptoms of infected healthcare workers

Four hundred thirty one (96.63%) of our HCW were treated in the outpatient clinic while 5 (1.12%) were admitted into the hospital for inpatient care. Nasal oxygen therapy was given to 4 (0.89%), reservoir mask therapy to 1 (0.22%), and high flow oxygen therapy to 3 (0.67%) of our healthcare professionals. Intensive care treatment was required for 2 (0.44%) of the workers. According to the severity of the symptoms, 362 of the cases were classified to be mild, 78 moderate, 4 severe and 2 were considered critical.

Among the HCW who had a prescription for the management of their chronic diseases 6 (1.34%) were using corticosteroids, 7 (%1.56) were using immunosuppressants, and 6 (1.34%) were using angiotensin-converting-enzyme -inhibitor containing antihypertensive drugs.

The preferred pulmonary imaging modality was chest X-ray in 54 patients (13.43%), thorax tomography in 116 (28.86%), and lung ultrasonography in 5 (1.24%). Two hundred and twenty seven (56.47%) of the HCW did not undergo any imaging.

Discussion

In a study conducted in two referral hospitals in Italy, the rate of SARS-CoV-2 infection among hospital workers was reported to be 11.3% (16). Similarly, this rate was reported to be 11.1% (17) in a hospital in Madrid, Spain. Data from various countries were evaluated in the August 2020 edition of Chou et al. (18) review of "the epidemiology and risk factors of coronavirus infections in HCW." It has been observed that the frequency of SARS-CoV-2 in HCW varies between 1.9% and 12.6% (18). However, the rate of SARS-CoV-2 infection among the staff of our hospital is 29%, which is quite high compared to the rate seen in other countries. This may be associated with multiple factors such as the location of the hospital being in a region with the highest cases in Istanbul, the fact that most of the hospital staff reside in the same area and the active role that the hospital played in serving SARS-CoV-2 patients during the pandemic.

At our hospital 29.76% of the cases were nurses, 19.15% were patient assistants, 10.14% were doctors. These data are supportive of literature (19) which has shown nurses to be the healthcare subgroup to be most infected by the virus.

From March 2020 to January 2021, the incidence of infection at our hospital had fluctuating peaks which were seen to be parallel to the number of cases in the country. As the number of cases increased in the country, so did the

number of SARS CoV-2-positive HCW (Figure 1, 5).

In a large epidemiological study by the Chinese Center for Disease Control and Prevention (CDC), 80.9% of patients were reported as milemoderate 13.8% as severe and 4.7% as critical. The mean age of the patients in the study was 47 (15). Among our hospital staff, 81.16% of those infected were mild, 17.48% moderate, 0.89% severe, and 0.44% were critically infected. Fortunately, we have not had a case resulting in death. Most of the infected HCW at our hospital were between the ages of 21-30 (with the average age of our employees being 29). The number of people with chronic diseases among them was 17.71%. The average age of the HCW at our hospital requiring inpatient treatment was 41.7, of which 40% had coexisting chronic diseases. The lower rate of comorbidities as well as the younger age of our employees can explain the decreased rate of serious/critical cases and increased rate of mild cases seen at our hospital.

In a study of more than 370,000 confirmed cases of coronavirus disease-2019 (COVID-19) reported to the CDC in the United States, symptoms were found to be cough 50%, fever 43%, myalgia 36%, headache 34%, shortness of breath 29%, sore throat 20%, 19% diarrhea, 12% nausea/vomiting, <10% loss of smell or taste, 7.6% abdominal pain and 6.1% runny nose (20). It is emphasized in the study that the complaints of anosmia-ageusia was probably under-reported. Myalgia (60%) and loss of smell and taste (55%) were more common among our hospital staff. Other symptoms were found to occur at similar rates.

The chronic diseases seen among the COVID-19 cases reported to the CDC in the United States were as follows; 32% had cardiovascular disease (including hypertension), 30% had diabetes mellitus, 18% had lung disease, and lastly 11% were pregnant at the time of infection. In our study, 3.80% had cardiovascular disease (including hypertension), 1.56% had diabetes mellitus, 5.38% had lung disease, and only 2% were pregnant. The rate of our pregnant group is low due to the administrative leave granted to pregnant women after their 24th gestational week.

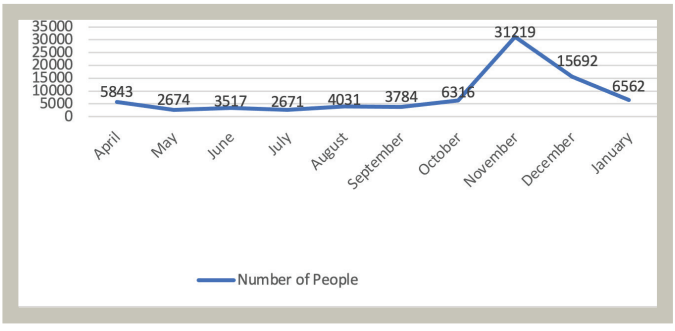

Figure 5. Monthly distribution of the 100 thousand cases seen in our country

Since the average age of our employees is young, the rate of chronic diseases is not compliant with literature.

According to the results of "COVID-19 survey in the hospital workers", a multicenter study conducted by the Turkish Infectious Diseases and Clinical Microbiology Specialization Association in our country, an average of 14.7% people do not know the possible source of transmission. In our hospital, 56.71% of our HCW were infected inside the hospital, 16.59% outside the hospital, and 26.68% were unable to detect the source of transmission. The fact that the source of transmission is not known by healthcare professionals requires more detailed investigation. The rate of inaccessibility to PPE was 5.09%, and the rate of applying protective measures as required in the hospital was 85.10%. With these results, our in-hospital contamination rate is high despite the precautions taken by our employees. This may be due to asymptomatic carriers that can be found in all environments. The spread of the virus in the hospital was seen to be as groups among various departments. Table

Table 1. Classification of infected healthcare workers according to hospital department

Month	Classification of infected healthcare workers according to the hospital department
April	Operating room (4), emergency (4), 6th floor patient service (6), cardiovascular surgery service (5), biochemistry (4), training nurse (4)
July	Biomedical (7), security (8), archive (4), neonatal intensive care (5), international patient services (9), pediatric polyclinic (5)
August	Archive (5), blood collection (2), IVF (2), neonatal intensive care (3), international patient services (6), operating room (4)
September	Dental service (5), 3rd patient floor service (6), cardiovascular surgery (5), 6th floor (4), cardiovascular surgery (3), general intensive care (5)
October	Medical directorate (4), 4th floor patient service (5), 6th floor service (4), baby room (8), call center (4), angio room (8), interventional radiology (5), gynecology and obsetetrician polyclinic (5), pharmacy (7), 8th floor patient service (4), 7th floor patient service (4), child polyclinic (9), radiology polyclinic (6)
November	Emergency (14), 5th floor (27), physical therapy (12), operating room (11), eye polyclinic (5), ENT (3)*, call center (9), IVF (4)**, VIP services (6), neurology service (4), dental polyclinic (6), dental service (6), chemotherapy (8), international patient services (17), oncology service (3), medical directorate (4)
December	Radiology (4), 6th floor (4), 8th floor patient service (7), support services (6), emergency (4), corporate marketing (4), sterilization (2), dental polyclinic (4)

ENT: Ear nose throat, IVF: In vitro fertilization***

1 shows that 27 people from our 5th floor ward, 12 people from the physical therapy department, 9 people from the call center, and 17 people from the international relations department were infected simultaneously within their units. It can be understood that HCW apply protective measures when in contact with patients however are less compliant with these rules (such as 10-15 min of eating and drinking breaks) in their social working environment. Here, it can be thought that HCW in the same department may be a source of contamination amongst themselves and cause separate epidemics within their departments.

Conclusion

Hospital workers are deemed a high-risk group during the pandemic. The main transmission route of the infection among hospital workers is most probably in-hospital. More intensive training and education should be given to the hospital staff who do not comply with infection control guidelines and to those without sufficient knowledge on transmission routes of SARS-CoV-19. Supervision on proper implementation of social distancing and hospital infection control policies, screening of asymptomatic patients and evaluation of PPE quality and accessibility is suggested.

Ethics

Ethics Committee Approval: The Health Ministry (2020-06-22T16_19_42) as well as the Istanbul Medipol University Institutional Review Board (04.03.2021/286).

Informed Consent: Written informed consent.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: G.P., Concept: G.P., Design: F.M., Data Collection or Processing: G.P., Analysis or Interpretation: G.P., İ.P., Literature Search: G.P., Writing: G.P., H.K.A.

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

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