

COVID-19 Screening Program Should be Performed in Healthcare Workers

Necati Çitak¹ , Atilla Pekçolaklar² 

¹Department of Thoracic Surgery, Bakırköy Dr. Sadi Konuk Research and Education Hospital, Istanbul, Turkey

²Department of Thoracic Surgery, Bursa City Hospital, Bursa, Turkey

Cite this article as: Çitak N, Pekçolaklar A. COVID-19 Screening Program Should be Performed in Healthcare Workers. Turk Thorac J 2021; 22(2): 169-74.

Abstract

The screening test for severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) disease 2019 (COVID-19) has not been performed in healthcare workers (HCWs) yet, although HCWs are at a high risk of infection. COVID-19 is detected in 5%–15% of HCWs according to published studies. Nevertheless, it may be higher than the rates indicated in published studies. Based on this fact, the current recommendation of studies in the literature is to screen COVID-19 in HCWs. In this review, studies on SARS-CoV-2 screening in HCWs will be reconsidered, and the frequency and target group in whom screening should be performed will be emphasized.

KEYWORDS: SARS-CoV-2, healthcare workers, real-time polymerase chain reaction testing, screening

Received: September 2, 2020

Accepted: February 3, 2021

INTRODUCTION

The outbreak of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) disease 2019 (COVID-19) in mainland China has been declared as a public health emergency by the World Health Organization (WHO) [1]. More than 20 million people worldwide have COVID-19, and more than 700,000 people have died as of September 2020 [2]. However, the number of healthcare workers (HCWs) having COVID-19 and who lost their lives is still unclear. China provided the first reports of HCWs infected with COVID-19. At a press conference of the WHO–China Joint Mission on COVID-19, the National Health Commission of the People’s Republic of China reported that until February 24, 2,055 HCWs (community/hospital-acquired not to be defined) had been confirmed to be infected with SARS-CoV-2, with 22 (1.1%) deaths [3]. Most HCWs were thought to have been infected within household settings rather than in a healthcare setting, although conclusive evidence is scant [4]. Nonetheless, it has been stated that HCWs are infected with SARS-CoV-2 at a higher rate (between 10 and 45 times) than the normal population [5, 6]. This proves that HCWs are more likely to be infected within healthcare settings than in household settings.

After WHO declared the pandemic, reports on HCWs with COVID-19 were published from different countries [7, 8]. In June 2020, the International Council of Nurses reported that at least 450,000 HCWs had COVID-19 [9]. According to statistics announced by the Minister of Health on April 7, 428 HCWs had COVID-19 in Turkey. It has been stated that among all patients with COVID-19, the rate of incidence of COVID-19 in HCWs is 6.5%. At the beginning of September, the Minister of Health reported that 29,000 HCWs had COVID-19 and 52 of them died [10].

Despite WHO suggesting widespread testing for SARS-CoV-2, national capacities and national health policies for implementation diverge considerably [11]. Although it is well known that HCWs are at an increased risk of being exposed to SARS-CoV-2 and could potentially have a role in hospital transmission, there is currently no screening for SARS-CoV-2 in HCWs. No national or international agreement has been reached on this issue. In this review, we will evaluate the published studies on SARS-CoV-2 screening in HCWs in three sections.

CLINICAL AND RESEARCH CONSEQUENCES

Published Studies Related to SARS-CoV-2-Infected HCWs and SARS-CoV-2 Screening in HCWs

A study published by British scientists in *The Lancet* reported that nasopharyngeal swabs from 266 HCWs (more than 50% of the health center’s workforce) were tested for SARS-CoV-2 real-time polymerase chain reaction (RT-PCR). SARS-CoV-2 positivity was found in 47 (18%) of the HCWs [31 of them were symptomatic (12%) and 16 of them were asymptomatic (6%)]. The study indicated that those over the age of 50, those in direct contact with the patient, and those with a higher

Address for Correspondence: Necati Çitak, Department of Thoracic Surgery, Bakırköy Dr. Sadi Konuk Research and Education Hospital, Istanbul, Turkey

E-mail: necomomus@gmail.com

©Copyright 2020 by Turkish Thoracic Society - Available online at www.turkthoracj.org

rate of deprivation (i.e., those who were disadvantaged) had a higher chance of getting infected. Symptomatic HCWs who were initially tested negative (n=25) were retested within a week, and only one of them was found to be positive. There is no information about the retesting status of asymptomatic patients in this study. According to these results, if the first tests of the HCWs are SARS-CoV-2 negative, the probability of being positive within a week is 0.4%, even if they have symptoms. Although the authors stated that there is the necessity of international SARS-CoV-2 screening in HCWs, they did not mention how often (weekly, fortnightly, or monthly) the screening should be performed [12].

In the early study published on the screening of HCWs for COVID-19, the authors focused on two different models. In both models, fever measurement at hospital entrance and symptom follow-up with personal daily questionnaires were applied. Model 1 was planned as a test every 7 days, and the result was obtained within 24 h, whereas Model 2 was planned as a test every 7 days, and the result was obtained within 8 h. In the comparisons made by assuming that the RT-PCR test sensitivity is 90% on days 3-21 of infection, it was calculated that there will be a 16%–23% decrease in the contagiousness of the disease with Model 1 and 25%–33% decrease with Model 2. The increase in effectiveness to 33% may be attributed to the fact that tests will be performed at the end of a shift and results will be available before the next shift. Thus, the time delay between testing and isolation would effectively be zero. This study showed that screening every 14 days, obtaining the results within 3 days after the test, and isolating positive individuals will only provide a 5% reduction in contamination (Figure 1). The authors recommend that HCWs should be screened weekly [13].

In another study in which 13% (n=592) of the workforce in a health center was tested, it was reported that those with symptoms limited to nasal congestion/sore throat or asymptomatic HCWs frequently had negative test results. In this study, 14% of the employees had positive SARS-CoV-2 RT-PCR results. The employees who had symptoms limited to nasal congestion/sore throat or those who were asymptomatic had a negative PCR result of 97% (p=0.006). The authors suggested that symptom-based screening may prioritize testing and increase diagnostic accuracy because of limited testing capacity [14].

Another recent study in which 400 asymptomatic HCWs were tested at the beginning of the United Kingdom (UK) lockdown (March 23, 2020) has shown a positivity of 7.1, 4.9, 1.5, 1.5, and 1.1% in the first, second, third, fourth, and fifth weeks, respectively. Considering that it is observed at a similar rate with London’s population, the authors suggested that HCWs should be tested regularly even if they are asymptomatic [15].

MAIN POINTS

- Healthcare workers (HCWs) are at a potentially higher risk of emerging COVID-19.
- Early COVID-19 detection among HCWs is crucial for protecting patients and the healthcare workforce.
- HCWs should be screened for COVID-19.

In another 3-week screening study, the RT-PCR test was performed in 1,032 asymptomatic and 184 symptomatic HCWs in 18 days. The positive rate was 3% in asymptomatic HCWs, while it was 14% in symptomatic HCWs (p<0.001). The authors reported that HCWs who work in high-risk clinics (SARS-CoV-2-positive patients and those with high clinical suspicion) and intermediate-risk clinics (symptomatic patients who are waiting for test results and suspicious patients) were infected with SARS-CoV-2 more than HCWs who work in low-risk clinics (SARS-CoV-2-negative patients and non-suspicious patients) (p=0.004, Table 1) [16].

Although this study revealed a significantly lower viral load in the asymptomatic group than in the symptomatic group, the authors did not provide information on contracting SARS-CoV-2 in the following days or months after the first test was performed. The authors suggested that HCWs who are working in high-risk and intermediate-risk clinics should be screened frequently. However, the study does not provide a suggestion on the frequency of screening.

Nonetheless, some studies did not support the findings about the differences between the clinics and HCWs (working in high-risk clinics versus in low-risk clinics) [14, 15]. In a study conducted in England, the positive PCR rate was 15% in HCWs who were in direct contact with infected patients and 16% in those who were not in contact with infected patients [17]. Another study was conducted in 41 HCWs exposed to aerosol-producing procedures (i.e., endotracheal intubation, extubation, and noninvasive ventilation) performed at least for 10 min at a distance of less than 2 m in patients diagnosed with COVID-19. Swab tests were taken in HCWs on days 1, 2, 4, or 5 from the last exposure to infected patients and 14th day after their last exposure. None of the symptoms developed during follow-up, and all RT-PCR tests were negative [18].

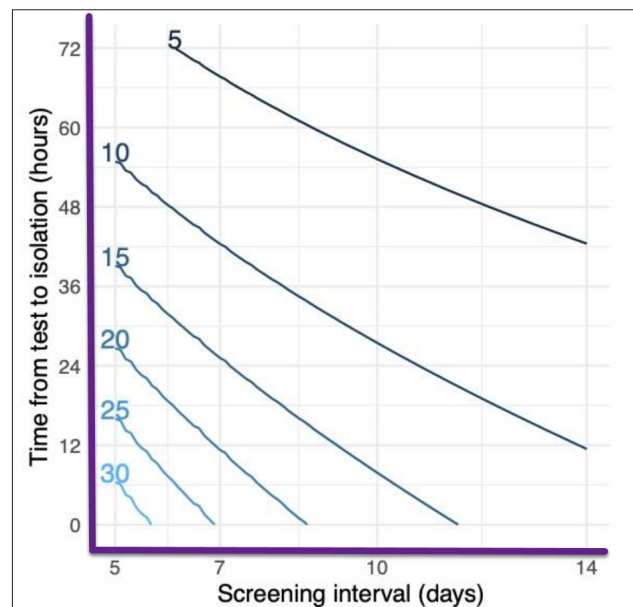


Figure 1. Additional percentage reduction in the reproduction number by a policy of repeated PCR testing at regular intervals with different timeliness from sample collection to isolation, assuming that one third of infections are asymptomatic and they are 10% as infectious as symptomatic infections (It was adapted from reference 13)

Table 1. Total Number of SARS-CoV-2 tests performed in each screening group categorized according to the highest risk ward of potential exposure (It was adapted from reference 16).

	Green ward (low risk)	Amber ward (medium risk)	Red ward (high risk)	Total*
HCW asymptomatic screening group	7/454 (1.5%)	4/78 (5.1%)	20/466 (4.3%)	31/1032
HCW symptomatic screening group	8/66 (12.1%)	1/9 (11.1%)	17/88 (19.3%)	26/169 (15.4%)
HCW symptomatic household contacts	2/14 (14.3%)	0/1 (0%)	0/14	4/52 (7.7%)
Total*	17/538 (3.2%)	5/88 (5.7%)	37/575 (6.4%)	61/1268 (4.8%)
Ward definitions	Areas with no known SARS-CoV-2 RT-PCR-positive patients, and none with clinically suspected COVID-19	Areas with patients awaiting SARS-CoV-2 RT-PCR test results or those who have been exposed and may be incubating infection	Areas with confirmed SARS-CoV-2 RT-PCR-positive patients or patients with very high clinical suspicion of COVID-19	

*There were 67 HCWs for whom details on the place of work and whether they were in contact with a COVID-19 patient were unknown.

HCW: healthcare worker; SARS-CoV-2: severe acute respiratory syndrome coronavirus-2; RT-PCR: real-time polymerase chain reaction; na: not applicable

In a recent seroprevalence study of COVID-19 published in our country, 813 noninfected and 119 PCR-confirmed infected HCWs in 3 pandemic hospitals in Istanbul and Kocaeli were investigated. There were different seropositivity rates among the HCWs (6% in cleaning staff, 4% in physicians, 2.2% in nurses, and 1% in radiology technicians). HCWs who were working in nonpandemic clinics and intensive care unit had the highest seroprevalence rate (6.4% and 4.3%, respectively). HCWs in “high-risk group” had similar seropositivity rate as the “no risk” group ($p=0.7$) [19].

A cross-sectional study conducted in the Netherlands screened 1,796 HCWs, and 5% were found positive. Symptomatic HCWs ($n=50$) and patients ($n=10$) were tested for up to 10 days, and SARS-CoV-2 whole-genome sequencing was compared. *The genomic diversity recorded in this study was consistent with multiple introductions through community-acquired infections and some local amplification related to specific social events in the community rather than widespread within-hospital transmission. Although direct transmission in the hospitals could not be ruled out, this study does not support widespread nosocomial transmission as the source of infection in patients or HCWs.* The source of SARS-CoV-2 is widespread nosocomial transmission in HCWs who isolated themselves even from their families although this study does not support this finding [20].

All staff members working in the COVID-19 units in Centre Hospitalier Universitaire Saint-Pierre in Brussels, a tertiary reference hospital for infectious diseases, were invited to participate voluntarily in a 6-month study on the carriage and seroprevalence of SARS-CoV-2. In this study, after 2 weeks of follow-up, 41 of 326 tested HCWs had SARS-CoV-2 infection (overall infection rate of 12.6%). No significant difference in positivity was observed in terms of work units (COVID-19 clinics, COVID-19 intensive care unit, or Emergency Room) or professions (physician or nurse). The RT-PCR tests performed on the first day were positive at a rate of 11.3%, and the tests performed on the 15th day were positive at a rate of 2.4%. The authors attributed this decrease in positivity to the use of more careful personal protective equipment by HCWs upon seeing the initial positivity rate. Unlike other screening

studies, immunoglobulin G scanning was also performed in this study, and it was determined that 62.5% of SARS-CoV-2 infection cases among HCWs would be missed if RT-PCR was performed alone. The authors recommend screening all groups of HCWs in highly exposed COVID-19 units and not just those HCWs who are in close contact with patients [21].

The studies detailed in this section are summarized in Table 2.

Why Should HCWs be Routinely Screened for COVID-19?

HCWs potentially experience more significant risks for emerging infectious diseases owing to occupational exposure to sick patients and virus-contaminated surfaces [22-25]. A recent prospective, observational cohort study investigated the risk of COVID-19 among HCWs compared with the general community. In 2,135,190 individuals (2,035,395 community individuals and 99,795 HCWs), 5,545 incident reports of a positive COVID-19 test were recorded. The authors found that the risk of reporting a positive test for COVID-19 was higher among HCWs. HCWs were at an increased risk for reporting a positive COVID-19 test (adjusted hazard ratio: 11.61 and 95% confidence interval: 10.93–12.33) compared with the general community [26].

HCWs with COVID-19 may transmit the disease to their patients, colleagues, and family members. Moreover, removing infected HCWs from duty can threaten essential healthcare staffing during an epidemic [27]. Therefore, some authors suggested that infection prevention and quick accurate diagnosis of potential COVID-19 in HCWs are crucial to maintaining hospital operations [28]. Testing HCWs has been restricted to symptomatic individuals, and no studies have reported serial testing in high-exposure asymptomatic volunteers.

There are several potential benefits of screening HCWs. First, screening programs may reduce the transmission between in-hospital employees and patients. A retrospective, single-center study conducted in Wuhan assumed that 41% of 138 patients were infected from the hospital [29]. In addition, if the test of symptomatic personnel is negative, their participation in the workforce will increase because their self-isolation will be reduced. In one study, it was found that only 1 of every 7 HCWs who isolated themselves owing to their symp-

Table 2. A Summary of the published studies about HCWs' screening program

Study	Number of HCWs	Rate of SARS-CoV-2 positivity	Proposal	Limitations
Khalil et al. 12	266	18%	International SARS-CoV-2 screening in HCWs is required.	No information on the frequency of screening.
Grassly et al. 13	A modeling study	na	Screening every 14 days and obtaining results in 3 days after the test will only provide a 5% reduction in contamination. HCWs should be screened weekly.	No explanation about who should be tested.
Lan et al. 14	592	14%	Symptom-based screening may prioritize testing and increase diagnostic accuracy because of limited testing capacity.	It is not clear how to detect asymptomatic HCWs.
Treibel et al. 15	400 (asymptomatic)	7.1% (first week) 4.9% (second week) 1.5% (third week)	A similar rate with London's population. Asymptomatic HCWs should be tested regularly.	The definition of "Regularly" has not been clarified.
Rivett et al. 16	1,032 asymptomatic, and 184 symptomatic	3%, and 14%	HCWs who are working at high-risk and intermediate-risk clinics should be screened frequently.	No information on contracting SARS-CoV-2 in the following days after the first test. No suggestion on the frequency of screening.
Hunter et al. 17	1,654	14% (No difference according to where HCWs work)	Testing protocol has enabled HCWs to return more rapidly to health service and might have additional positive effects on health behavior.	The small number of nonclinical staff tested means that it was not possible to meaningfully compare transmission dynamics between the groups, where more complex patterns might exist.
Ng et al. 18	813	2.7%	HCWs in "high-risk group" had similar seropositivity rate as the "no risk" group.	Screening larger cohorts from hospitals could serve more information to monitor the course of pandemic among HCWs.
Sikkema et al. 20	1,796	5%	At the beginning of the SARS-CoV-2 outbreak in the Netherlands, HCWs were probably infected in the community rather than at the hospitals.	A study conducted in early March. In the later periods, the findings may change.
Martin et al. 21	326	12.6%	62.5% of SARS-CoV-2 infection cases among HCWs would be missed if RT-PCR was performed alone. Authors recommend screening all groups of HCWs in highly exposed COVID-19 units.	No suggestion on the frequency of screening.

HCW: healthcare worker; SARS-CoV-2: severe acute respiratory syndrome coronavirus-2; RT-PCR: real-time polymerase chain reaction

toms actually had the virus [30]. In another study in which HCWs were screened, 85% of HCWs were able to return to the health workforce early because of the screening policy [17].

Another benefit of screening HCWs who are asymptomatic and have the potential to infect the surrounding communities is preventing them from becoming a possible transmission source even in a lockdown. *Furthermore, screening of HCWs can be used to assess the level of local community transmission, but this can only be done if the patient-to-HCW transmission can be reliably excluded.*

Frequency of Screening, Policies in Countries, and Applicability in Our Country

There is no agreement on how and how often the test screening policy should be applied to HCWs. As seen in the studies mentioned above, some studies applied weekly screening, whereas some studies implemented a monthly testing policy. Although all the studies suggest screening in HCWs, there is no suggestion about how often HCWs should be screened. In addition, there is no such screening policy for COVID-19 testing for HCWs worldwide. According to the Center for Disease Control and Prevention's recommendations in the UK and USA, HCWs should be questioned daily in terms of fever and symptoms, and those with symptoms should be tested

quickly for RT-PCR. There is no screening recommendation for asymptomatic HCWs [31–32]. However, studies revealed that high rates of COVID-19 positivity were also detected in asymptomatic HCWs.

In our country, before and after football matches, those in the sports clubs and the deputies in the Turkish Grand National Assembly are screened for COVID-19 [33, 34]. However, there is no national COVID-19 screening program for HCWs. In the press release published by the Ankara Medical Chamber at the beginning of April, it was stated that the COVID-19 screening test was initiated for HCWs in the high-risk group in Ankara, but the screening was stopped after the test results of 9 (3%) of 300 HCWs were positive [35].

The Health Minister announced that there were the number of HCWs in Turkey -- including public and private -- 1 million (165,000 of these are doctors and 204,000 are nurses). [36]. In the case of weekly tests for all HCWs, we require 150,000 tests per day; for 14-day tests for all HCWs, we require 75,000 tests per day; and for monthly tests for all HCWs, we require 37,500 tests per day. Nevertheless, even if there is no statement regarding our country's daily test capacity, it is clear that our daily test capacity was approximately 50,000–60,000 tests per day in July. Even if a monthly screening test is performed for HCWs, 37,000 tests are required daily, although the effect of monthly screening will be very low. In these conditions, screening tests will be 60% of our daily test capacity. Furthermore, testing symptomatic individuals and screening COVID-19 patients require significant financial and workforce resources. Therefore, it is obvious that a screening program should be planned, but planning should be done by taking into consideration how often, how, and who should be screened (such as emergency clinics, clinic staff, and intensive care units' staff).

CONCLUSION

The information on SARS-CoV-2 screening among HCWs could help for the revision of health policies and immunization strategies in hospitals for a possible resurgence of the outbreak. Although many studies in the literature discuss how HCWs should be screened, to the best of our knowledge, there is no COVID-19 screening protocol for HCWs in any country worldwide. After it is decided to conduct a nationally and international screening program for HCWs, the other questions that will have to be answered will be to whom and how often the screening test should be performed. Considering our current testing capacity, initiating a national screening program will still be unclear. However, there is no need to argue that HCWs should be screened for COVID-19.

Peer-review: Externally peer-reviewed.

Author Contributions: Supervision – N.Ç., A.P.; Design – N.Ç.; Resources – N.Ç., A.P.; Materials – N.Ç.; Data Collection and/or Processing – N.Ç., A.P.; Analysis and/or Interpretation – N.Ç., A.P.; Literature Search – N.Ç., A.P.; Writing Manuscript – N.Ç.; Critical Review – N.Ç., A.P.

Conflict of Interest: The authors have no conflict of interest to declare.

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

Acknowledgements: We would like to thank all healthcare workers who performed their duties at the cost of losing their health and lives during the pandemic period.

REFERENCES

1. World Health Organization. 2020. Coronavirus disease (COVID-19) outbreak. Available at: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>.
2. Worldometer COVID-19 Data Available at: <https://www.worldometers.info/coronavirus/>.
3. World Health Organization. 2020. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). Available at: <https://www.who.int/docs/default-source/coronaviruse/whochina-joint-mission-on-covid-19-final-report.pdf>.
4. Sikkema RS, Pas SD, Nieuwenhuijse DF, et al. COVID-19 in health-care workers in three hospitals in the south of the Netherlands: a cross-sectional study. *Lancet Infect Dis* 2020;20:1273–80. [CrossRef]
5. Turkish Thoracic Society. 2020. Healthcare Workers Have Caught COVID-19 Disease together with Their Families. Available at: <https://www.toraks.org.tr/site/community/news/10018>
6. Turkish Thoracic Society. 2020. The Acceptance of COVID-19 as an Occupational Disease in Healthcare Professionals TTD Press Release. Available at: <https://toraks.org.tr/site/news/10130>
7. New York Times. Virus Knocks Thousands of Health Workers Out of Action in Europe. Available at: <https://www.nytimes.com/2020/03/24/world/europe/coronavirus-europe-covid-19.html>.
8. The Local/AFP. More than 100 doctors have now died in Italy's coronavirus outbreak. 2020. Available at: <https://www.thelocal.it/20200409/more-than-100-doctors-have-now-died-in-italys-coronavirus-outbreak>.
9. World News. 2020. COVID-19 death toll among nurses doubled in past month, says nurses group Available at: <https://www.reuters.com/article/us-health-coronavirus-nurses/covid-19-death-toll-among-nurses-doubled-in-past-month-says-nurses-group-idUSKBN23A1KY>.
10. Medimagazin. Fahrettin Koca gave the number of infected healthcare workers for the first time: 29.865 healthcare workers are infected... Available at: <https://www.medimagazin.com.tr/guncel/genel/tr-fahrettin-koca-ilk-kez-sayi-verdi-29-bin-865-saglik-calisani-enfekte-11-681-91089.html>.
11. WHO. 2020. COVID-19 Strategy Update. Available at: https://www.who.int/docs/default-source/coronaviruse/covidstrategy-update-14april2020.pdf?sfvrsn=29da3ba0_19.
12. Khalil A, Hill R, Ladhani S, Pattison K, O'Brien P. COVID-19 screening of health-care workers in a London maternity hospital. *Lancet Infect Dis* 2021;21:23–4. [CrossRef]
13. Grassly NC, Salort MP, Parker EP, et al. Role of testing in COVID-19 control. Imperial College London (23-04-2020), doi: <https://doi.org/10.25561/78439>. Available at: <https://www.imperial.ac.uk/media/imperial-college/medicine/mrc-gida/2020-04-23-COVID19-Report-16.pdf>.
14. Lan FY, Filler R, Mathew S, et al. COVID-19 symptoms predictive of healthcare workers' SARS-CoV-2 PCR results. *PLoS One* 2020;15:e0235460. [CrossRef]
15. Treibel TA, Manisty C, Burton M, et al. COVID-19: PCR screening of asymptomatic healthcare workers at London hospital. *Lancet* 2020;395(10237):1608–10. [CrossRef]
16. Rivett L, Sridhar S, Sparkes D, et al. Screening of healthcare workers for SARS-CoV-2 highlights the role of asymptomatic carriage in COVID-19 transmission. *Elife* 2020;9:e58728. [CrossRef]

17. Hunter E, Price DA, Murphy E, et al. First experience of COVID-19 screening of health-care workers in England. *Lancet* 2020;395:e77-e78. [\[CrossRef\]](#)
18. Ng K, Poon BH, Kiat Puar TH, et al. COVID-19 and the risk to health care workers: a case report. *Ann Intern Med* 2020;172:766-7. [\[CrossRef\]](#)
19. Alkurt G, Murt A, Aydın Z, et al. Seroprevalence of coronavirus disease 2019 (COVID-19) among health care workers from three pandemic hospitals of Turkey. *PLoS One* 2021;16:e0247865. [\[CrossRef\]](#)
20. Sikkema RS, Pas SD, Nieuwenhuijse DF, et al. COVID-19 in health-care workers in three hospitals in the south of the Netherlands: a cross-sectional study. *Lancet Infect Dis* 2020;20:1273-80. [\[CrossRef\]](#)
21. Martin C, Montesinos I, Dauby N, et al. Dynamics of SARS-CoV-2 RT-PCR positivity and seroprevalence among high-risk health-care workers and hospital staff. *J Hosp Infect* 2020;106:102-6. [\[CrossRef\]](#)
22. Lan FY, Wei CF, Hsu YT, Christiani DC, Kales SN. Work-related COVID-19 transmission in six Asian countries/areas: a follow-up study. *PLoS One* 2020;15:e0233588. [\[CrossRef\]](#)
23. Selvaraj SA, Lee KE, Harrell M, Ivanov I, Allegranzi B. Infection rates and risk factors for infection among health workers during ebola and Marburg virus outbreaks: a systematic review. *J Infect Dis* 2018;218:S679-S689. [\[CrossRef\]](#)
24. Offeddu V, Yung CF, Low MSF, Tam CC. Effectiveness of masks and respirators against respiratory infections in healthcare workers: a systematic review and meta-analysis. *Clin Infect Dis* 2017;65:1934-42. [\[CrossRef\]](#)
25. Reusken CB, Buiting A, Bleeker-Rovers C, et al. Rapid assessment of regional SARS-CoV-2 community transmission through a convenience sample of healthcare workers, the Netherlands, March 2020. *Euro Surveill* 2020;25:200034 [\[CrossRef\]](#)
26. Nguyen LH, Drew DA, Graham SM, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study *Lancet Public Health* 2020;5:e475-e483 [\[CrossRef\]](#)
27. Fraher EP, Pittman P, Frogner BK, et al. Ensuring and sustaining a pandemic workforce. *N Engl J Med* 2020;382:2181-3. [\[CrossRef\]](#)
28. Lan FY, Fernandez-Montero A, Kales SN. COVID-19 and health-care workers: emerging patterns in Pamplona, Asia and Boston. *Occup Med (Lond)* 2020;70:340-1. [\[CrossRef\]](#)
29. Wang D, Hu B, Hu C, et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA* 2020;323:1061-9. [\[CrossRef\]](#)
30. The Economist. 2020. What's gone wrong with covid-19 testing in Britain. Available at: <https://www.economist.com/britain/2020/04/04/whats-gone-wrong-with-covid-19-testing-in-britain>.
31. GOV.UK. COVID-19: management of staff and exposed patients or residents in health and social care settings. Available at: <https://www.gov.uk/government/publications/covid-19-management-of-exposed-healthcare-workers-and-patients-in-hospital-settings/covid-19-management-of-exposed-healthcare-workers-and-patients-in-hospital-settings>.
32. Centers for Disease Control and Prevention. 2020. Operational Considerations for the Identification of Healthcare Workers and Inpatients with Suspected COVID-19 in non-US Healthcare Settings. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/non-us-settings/guidance-identify-hcw-patients.html>.
33. TFF. "Return to football" protocol proposal. Available at: https://www.tff.org/Resources/TFF/Documents/SaglikKurulu/Futbola_Donus_Oneri_Protokolu.PDF
34. DW. Does COVID-19 tests performed with privilege in Turkey? Available at: <https://www.dw.com/tr/t%C3%BCrkiyede-covid-19-testlerinde-ayr%C4%B1cal%C4%B1k-m%C4%B1-yap%C4%B1l%C4%B1yor/a-54697764>.
35. ATO. 2020. Why was the screening test for healthcare workers suspended? We want the response and solution for 112 emergency healthcare services. Available at: <https://ato.org.tr/news/show/783>.
36. Sozcu. How many healthcare workers are in Turkey? The Health Minister announced the total number of healthcare workers in Turkey! Available at: <https://www.sozcu.com.tr/2020/saglik/turkiyede-kac-saglik-personeli-var-bakan-koca-turkiyedeki-toplam-saglik-personel-sayisini-acikladi-5739923/>