

The Association Between Symptoms and COVID-19 Test Results Among Healthcare Workers

Chana A. Sacks, MD, MPH,*†‡✉ Michael Dougan, MD, PhD,†§ Thomas H. McCoy Jr., MD,†¶||
 Amy Zheng, BA,† Giancarlo Buonomo, BA,* Crystal M. North, MD, MPH,†‡||
 Joshua P. Metlay, MD, PhD,*†‡ and Rochelle P. Walensky, MD, MPH†‡**

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As states reopen economies and new diagnoses of COVID-19 surge in certain regions of the country, maintaining effective infection control measures is critical. Many who are infected with SARS-CoV-2 are asymptomatic or have mild symptoms but may still be shedding infectious virus.^{1,2} Since the pandemic began to spread in the United States, healthcare workers with even mild symptoms were among the few with access to testing.³ Therefore, the early experience of healthcare workers provides an important opportunity, both for hospital systems and other large employers, to guide occupational health screening programs by determining whether any particular symptom, or group of symptoms, can effectively rule out COVID-19. This is especially important at a time when access to COVID-19 tests is still limited and therefore strategies for prioritizing testing are needed.⁴ We evaluated a cohort of healthcare workers who reported symptoms possibly attributable to a viral respiratory infection and underwent testing with nasopharyngeal (NP) polymerase chain reaction (PCR) to determine whether and which specific symptoms are associated with a positive COVID-19 test result.

METHODS

On March 13, 2020, Massachusetts General Hospital opened an outpatient clinic to evaluate and test employees with acute symptoms that were potentially consistent with COVID-19, based on the best information that we had at the time. All employees with symptoms including fevers, myalgias, gastrointestinal symptoms, runny nose, cough, shortness of breath, sore throat, and, later, anosmia were required to contact occupational health services who then referred them to the testing site. We reviewed the electronic medical record of those who presented and underwent testing from March 13 to April 2, 2020 (after which evaluations were more diffusely spread among different clinical sites) to extract

demographic information, exposure, travel and medical history, symptoms (recorded in free-text fields) and test results.

We used descriptive statistics to report demographic and clinical characteristics of the cohort. We evaluated the association between each symptom (whether it was present vs absent or not recorded) and test result and reported odds ratios, controlling for age and sex, and 95% confidence intervals. We reported unadjusted *P*-values and then Bonferroni corrected for multiple comparisons. We compared the mean number of symptoms reported among those who had a positive versus negative test using a *t*-test and plotted the distribution of the number of symptoms based on test result. Anosmia was consistently documented only after it was widely reported⁵; therefore, we evaluated the association between anosmia and a positive test result for those patients seen after March 23, 2020 – the point at which anosmia was reliably recorded.

To characterize the association between healthcare worker rates of test positivity and those of the surrounding community, we compared contemporaneous daily case rates in the state of Massachusetts at large⁶ to those of our healthcare worker cohort. We limited this comparison to the period of time in which the occupational health clinic was thought to be at its operational steady-state, defined as at least 90 patient encounters per day (March 15 through March 26, inclusive). To test this association, we used Pearson product moment correlation. The MGH Human Subjects Protection Committee approved this study.

RESULTS

In the first 21 days of this clinic's operation, 1747 healthcare workers were evaluated and underwent NP-PCR testing for SARS-CoV-2. This included physicians, nurses, laboratory technicians, administrative staff, and other nonclinical support staff at the hospital and associated clinics. The healthcare workers in the cohort had a mean age of 39 years. 73% of the cohort was female; most (69%) reported direct patient contact as part of their routine work, and 15% reported known contact inside or outside the hospital with someone who had been diagnosed with COVID-19.

Overall, 157 healthcare workers (9%) tested positive for COVID-19 (Table 1). Direct patient contact was associated with a negative test and use of immunosuppression (including biologics, small-molecule immune modulators and chronic glucocorticoids) was associated with a positive test, though the statistical significance for these disappeared when corrected for multiple comparisons. Those with a positive test were more likely to have reported anosmia (OR 11.9, 95% CI 5.9, 24.3), fever (OR 2.7, 95%CI 2.0, 3.8), or myalgias (OR 2.7, 95%CI 1.9, 3.7). Sore throat was associated with decreased odds of a positive test (OR 0.6, 95%CI 0.4, 0.8).

Those with a positive test reported a mean of 2.9 symptoms, compared with 2.5 among those with a negative test (*P* < 0.01, Fig. 1). The daily healthcare worker test positivity rate and the daily test positivity rate across Massachusetts state were significantly positively correlated, with a substantially lower positive rate among

From the *Division of General Internal Medicine, Department of Medicine, Massachusetts General Hospital, Boston, Massachusetts; †Harvard Medical School, Boston, Massachusetts; ‡Mongan Institute, Department of Medicine, Massachusetts General Hospital, Boston, Massachusetts; §Division of Gastroenterology, Department of Medicine, Massachusetts General Hospital; ¶Center for Quantitative Science and Department of Psychiatry, Massachusetts General Hospital, Boston, Massachusetts; ||Division of Pulmonary and Critical Care, Department of Medicine, Massachusetts General Hospital, Boston, Massachusetts; and **Division of Infectious Diseases, Department of Medicine, Massachusetts General Hospital, Boston, Massachusetts.

✉csacks@partners.org.

CAS and MD are co-first authors

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TABLE 1. Associations Between Baseline Characteristics and Symptoms and Odds of a Positive Test for COVID-19

Variable	Total (N = 1747)	COVID Test + (N = 157)	COVID Test - (N = 1590)	Odds Ratio 95% CI	P-value*
Baseline characteristics					
Male	464 (27%)	50 (32%)	414 (26%)	1.3 (0.9,1.9)	0.12
Direct patient contact	1211 (69%)	93 (59%)	1118 (70%)	0.6 (0.4,0.9)	0.004
Contact with known COVID +	267 (15%)	29 (18%)	238 (15%)	1.3 (0.8,2.0)	0.25
Recent travel	55 (3%)	2 (1%)	53 (3%)	0.4 (0.1,1.5)	0.18
Immunosuppression	30 (2%)	6 (4%)	24 (2%)	2.6 (1.0,6.4)	0.04
History of lung disease	326 (19%)	24 (15%)	302 (19%)	0.8 (0.5,1.2)	0.26
Symptoms					
Anosmia [†]	40 (9%)	25 (34%)	15 (4%)	11.9 (5.9,24.3)	<0.001
Fever	624 (36%)	90 (57%)	534 (34%)	2.7 (2.0,3.8)	<0.001
Myalgias	539 (31%)	80 (51%)	459 (29%)	2.7 (1.9,3.7)	<0.001
Nausea/vomiting/diarrhea	296 (17%)	38 (24%)	258 (16%)	1.7 (1.1,2.5)	0.009
Runny nose	226 (13%)	22 (14%)	204 (13%)	1.1 (0.7,1.8)	0.68
Cough	1251 (72%)	115 (73%)	1136 (71%)	1.1 (0.8,1.6)	0.64
Shortness of breath	483 (28%)	39 (25%)	444 (28%)	0.9 (0.6, 1.3)	0.55
Sore Throat	965 (55%)	68 (43%)	897 (56%)	0.6 (0.4,0.8)	0.002

Analyses for all symptoms control for age and sex.

*Table shows unadjusted *P*-values. When Bonferroni corrected for multiple comparisons, direct patient contact, immunosuppression and nausea/vomiting/diarrhea are no longer statistically significant with *P* < 0.05.

[†]The total number included in the anosmia analysis is 441, the number of healthcare workers evaluated between 3/23/20 (when anosmia was first regularly recorded) and the end of the study period; during this period, 74/441 tested positive for COVID-19, and 367/441 tested negative.

healthcare workers compared with the state at large ($r = 0.91$, 95% CI [0.69, 0.97], $t(10) = 6.80$, $P < .001$, Fig. 2).

DISCUSSION

Nearly 10% of a symptomatic health care worker cohort tested in the outpatient setting had a positive NP-PCR for SARS-CoV-2. Fever, myalgias and anosmia were associated with an increased odds of a positive test. Although some symptoms – such as sore throat – were associated with decreased odds of a positive test, no singular symptom seemed likely to effectively exclude a diagnosis of COVID-19 given the relatively small magnitude of an effect that each symptom had on the odds of a positive test. Those with a positive

test reported a greater number of symptoms, though whether this difference is clinically meaningful is unclear. Given the guidance by the World Health Organization that a positive test rate below 10% indicates adequate testing, these data also demonstrate the ability of a large employer to develop and implement a mandatory, large-scale program with onsite capacity to test all symptomatic health care workers.⁷

As COVID-19 began to spread throughout the country, the Centers for Disease Control and Prevention issued testing recommendations that identified healthcare workers as one of the few groups who should be tested with even mild symptoms. Because health care workers are in a unique position to potentially transmit

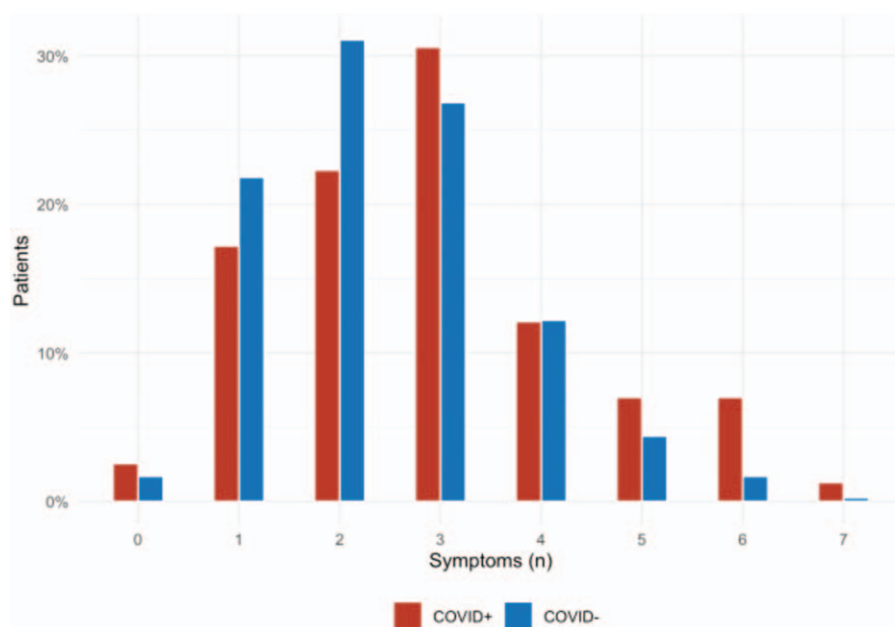


FIGURE 1. Number of unique symptoms reported by those who tested positive or negative for COVID-19. Symptoms include fevers, myalgias, cough, shortness of breath, runny nose, sore throat, nausea/vomiting/diarrhea, and anosmia.

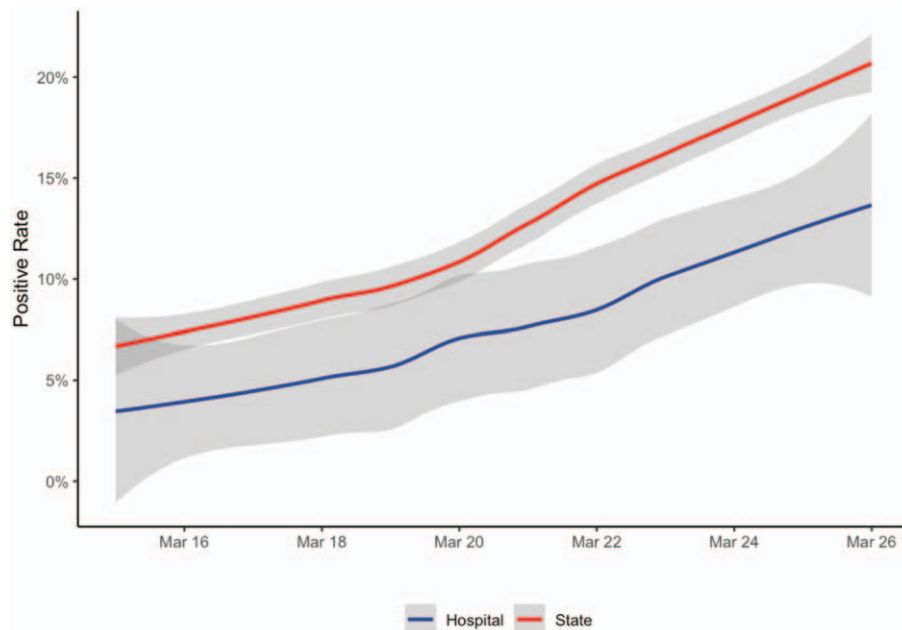


FIGURE 2. COVID-19 test positivity rates among healthcare workers tested at MGH compared with rates across Massachusetts between March 15 to March 26, 2020.

the infection to vulnerable populations and to each other, quickly identifying and isolating those who become infected is critical to maintaining the healthy work force needed to care for patients and to limit the spread of COVID-19. This is particularly important in the in-patient setting where healthcare workers often work in close proximity to each other. These results have important implications for establishing similar surveillance programs at other institutions, including large employers outside of healthcare. Such vast testing programs come with substantial cost, both directly through the workforce required to staff it and the material used in screening, and indirectly through lost productivity as workers are removed from the workforce while awaiting what will turn out to be negative test results. These data suggest no symptom, whether present or absent, is sufficiently sensitive that it can be used to exclude the possibility of a diagnosis of COVID-19. Therefore, broad surveillance programs will likely need to be the foundation of any infection control program – both in the hospital setting and in the community.

Although our data did not allow identification of specific locations where healthcare workers were employed (eg operating rooms, endoscopy suites, general medical floors, or elsewhere), we could identify whether their role was patient facing or not. Healthcare workers with direct patient contact were no more likely than healthcare workers whose jobs did not involve direct patient contact (such as environmental services or food workers) to be diagnosed with COVID-19. This may be due to several reasons. Appropriate personal protective equipment effectively prevents transmission from infected patients to care providers. Healthcare workers with direct patient contact may have heightened vigilance in clinical interactions with patients that is less stringent elsewhere inside and outside of the hospital. The trend toward increased risk of a positive COVID-19 test for healthcare workers without direct patient contact may also reflect disparities in community prevalence based on race and socioeconomic status as has been observed nationally.^{8,9} For example, at a different hospital in Boston, fewer than 1% of physicians lived in the parts of the city with the highest incidence of COVID-19, compared with 5% of nurses and 40% of environmental services and food workers.¹⁰ The similar trend, but lower overall test positivity rate,

observed for healthcare workers compared with those across the state may reflect both how healthcare workers' risk of contracting COVID is directly tied to community prevalence and that test positivity rates are likely to fall with lower barriers to testing. In addition, these data suggest that with adequate personal protective equipment and mandatory, strategic testing, hospitals have the ability to keep workers safe.

The striking association we observed for anosmia is consistent with early reports.^{11,12} Although specificity has yet to be fully determined, the possibility that negative testing in patients reporting anosmia may be a false negative should be considered. Media attention to anosmia could have influenced our results, as healthcare workers with this symptom may have presented for screening more often than those with other symptoms. However, a strength of this cohort is that screening was mandated across our hospital for healthcare workers reporting any symptom consistent with COVID-19, limiting potential selection bias.

These results have implications for surveillance programs at other institutions, including employers outside healthcare. Any surveillance program for COVID-19 will have to determine boundaries for recommending or enforcing testing. These data suggest no highly sensitive symptoms that can exclude a diagnosis of COVID-19, indicating that continued broad surveillance programs that include all people with symptoms potentially attributable to COVID-19 are critical for infection control.

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