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BRIEF REPORT

Seroprevalence of SARS-CoV-2 Among Frontline Healthcare Personnel During the First Month of Caring for Patients With COVID-19—Nashville, Tennessee

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Among 249 healthcare personnel who worked in hospital units with COVID-19 patients for 1 month, 19 (7.6%) tested positive for SARS-CoV-2 antibodies. Only 11 (57.9%) of the 19 personnel with positive serology reported symptoms of a prior illness, suggesting asymptomatic healthcare personnel could be an important source of SARS-CoV-2 transmission.

Keywords. COVID-19; SARS-CoV-2; healthcare personnel; coronavirus; serology.

Healthcare personnel caring for patients infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19), may be at increased risk for infection due to frequent exposure to the virus [1, 2]. Understanding the risk for SARS-CoV-2 infection among these frontline healthcare personnel is essential for planning and executing the national response to the COVID-19 pandemic [3, 4]. Most people infected with the virus develop antibodies specific to SARS-CoV-2 proteins approximately 1–2 weeks after the onset of illness [5–7]. Unlike nucleic acid tests designed to detect SARS-CoV-2 genetic material during acute infection, serological assays measure antibodies that remain detectable after acute infection, thus providing a useful method to detect cases that were not identified during the acute infectious phase [8]. In this exploratory study, we describe the first cohort of healthcare personnel tested with a new SARS-CoV-2 serology assay developed by the Centers for Disease Control and Prevention (CDC) [9]. Our goals were to estimate the seroprevalence of SARS-CoV-2 antibodies among frontline healthcare personnel in the first month of the COVID-19 pandemic in Tennessee and explore potential risk factors for positive serology results.

METHODS

Design and Setting

We conducted a cross-sectional seroprevalence study for antibodies to SARS-CoV-2 among a convenience sample of frontline healthcare personnel at Vanderbilt University Medical Center, an academic medical center in Nashville, Tennessee. Participants were enrolled between 3 and 13 April 2020. The first confirmed case of COVID-19 at the study hospital was identified on 11 March 2020. In the 23 days between this first identified case and initiation of enrollment in this study, 133 patients with laboratory-confirmed SARS-CoV-2 infection were managed in the emergency department (ED), and 63 were admitted to the hospital. During this time, Tennessee ranked 32nd in COVID-19–associated mortality among 50 US states and the incidence of COVID-19 hospitalizations in the Nashville region was 20.7 per 100 000 [10, 11]. At this time, the medical center was performing SARS-CoV-2 nucleic acid testing only on symptomatic individuals (patients and healthcare personnel). The project was reviewed by the Institutional Review Board at Vanderbilt and was determined to be nonresearch public health surveillance.

Population

Healthcare personnel at the study hospital were eligible if they regularly had direct patient contact in units that cared for adult patients with COVID-19, including the ED, medical intensive care unit (ICU), and medical step-down unit (converted into an inpatient COVID-19 unit on 18 March 2020). We did not enroll healthcare personnel who were not working due to illness, quarantine, or isolation.

Universal surgical mask use for healthcare personnel was instituted in the ED on 19 March 2020 and in the medical ICU and medical step-down unit on 2 April 2020. On the same dates, enhanced use of personal protective equipment (PPE; face shield, gown, and gloves in addition to a surgical mask) was instituted when interacting with patients known or suspected to have SARS-CoV-2. An N-95 respirator or powered, air-purified respirator (PAPR) was recommended when interacting with a patient with known or suspected SARS-CoV-2 undergoing an

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aerosol-generating procedure. Before institution of these new policies, use of PPE was at the discretion of each healthcare provider. The study hospital did not experience PPE shortages. Nucleic acid SARS-CoV-2 testing on nasal specimens was performed by occupational health services for symptomatic healthcare personnel.

Data Collection

We set up temporary research stations to collect data and blood samples in the ED, medical ICU, and medical step-down unit on 3 April, 8 April, 10 April, and 13 April 2020. Participants were informed about the study through staff e-mails and meetings. Healthcare personnel volunteered to participate by presenting to the research station, where they were screened for inclusion, completed a brief survey, and underwent phlebotomy. Survey data included demographics, medical history, symptoms, dates and results of prior nucleic acid testing for SARS-CoV-2, and PPE use practices. Participants were classified as having symptoms consistent with a prior acute viral illness if they reported any of the following since 1 February 2020: fever, cough, shortness of breath, myalgias, sore throat, vomiting, diarrhea, dysgeusia, or anosmia. All participants were also asked if they believed or suspected they had previously had COVID-19 [12]. Self-reported responses on PPE use were summarized by classifying participants based on whether they universally used PPE (a surgical mask, N-95 respirator, or PAPR) during all clinical encounters in the prior month. Serum samples were collected, frozen, and shipped to the CDC on dry ice.

Serology Testing

The CDC personnel completed serology testing using a recently developed and validated enzyme-linked immunosorbent assay against the extracellular domain of the SARS-CoV-2 spike protein. This assay uses anti–pan-immunoglobulin (-Ig) secondary antibodies to maximize sensitivity and specificity, which are approximately 96% and 99%, respectively [9]. Pan-Ig secondary antibody assays detect any isotype, including IgM, IgG, and IgA. Of note, in many patients with SARS-CoV-2, IgG is detectable before or at the same time as IgM, and some patients never develop IgM responses [7]. Hence, measuring pan-Ig was the selected approach to optimize sensitivity.

Analysis

We characterized the enrolled cohort using descriptive statistics, stratified by SARS-CoV-2 antibody results. We compared groups using Fisher's exact test for categorical variables and Wilcoxon rank-sum test for continuous variables to identify potential factors associated with positive serology. Data were collected in REDCap [13] and analyzed with STATA version 16 (StataCorp, College Station, TX).

RESULTS

We enrolled 249 healthcare personnel, including 105 (42.2%) nurses, 86 (34.5%) providers (physicians and advanced practice providers), 17 (6.8%) radiology technicians, and 41 (16.5%) other healthcare personnel (Table 1). Most were young adults (median age, 33 years; range, 21–70 years) without chronic medical illnesses (79.9% reported no comorbidities). Among enrolled personnel, 147 (59.0%) worked primarily in the ED, 55 (22.1%) in the medical ICU, and 47 (18.9%) in other locations.

Among 249 participants, 19 (7.6%) had SARS-CoV-2 antibodies detected. Demographics and chronic medical conditions were similar among those with positive serology and negative serology (Table 1). Seropositivity appeared to be more common among those who reported not universally wearing PPE for all encounters versus those who reported always wearing PPE (15.8% vs 4.3%) ($P = .07$).

Of the 19 participants with SARS-CoV-2 antibodies detected, 7 (36.8%) reported at the time of specimen collection that they believed they previously had COVID-19, and 11 (57.9%) reported prior symptoms consistent with a viral illness (Table 1). The most common symptoms among those with positive serology were as follows: cough, 9 (47.4%); sore throat, 6 (31.6%); and myalgias, 4 (21.1%).

Thirty-five participants (14.1%) reported a prior SARS-CoV-2 nucleic acid test. All participants who had a prior nucleic acid SARS-CoV-2 test were symptomatic at the time of testing, consistent with the local practice of only testing symptomatic workers. Of the 35 participants with prior nucleic acid testing, 3 were positive; all 3 of these participants also tested positive for SARS-CoV-2 antibodies (Table 1). Of the 32 participants who reported a negative prior nucleic acid test, 4 (12.5%) tested positive for SARS-CoV-2 antibodies; in these participants, nucleic acid testing was performed 7, 9, 24, and 27 days before specimen collection for serology testing.

DISCUSSION

Among a convenience sample of 249 US frontline healthcare personnel in a region with moderate local SARS-CoV-2 activity, 19 (7.6%) tested positive for SARS-CoV-2 antibodies within 1 month of the first local COVID-19 hospitalization. Only about half of the healthcare personnel who had antibodies detected reported any symptoms consistent with a prior viral illness, and only about one-third believed they previously had COVID-19. Only 7 of 19 healthcare personnel with detectable antibodies had prior nucleic acid testing for SARS-CoV-2, and only 3 of those 7 had positive nucleic acid tests. This suggests that testing only symptomatic personnel misses a substantial number of SARS-CoV-2 cases among practicing healthcare personnel. Widespread surveillance testing of asymptomatic healthcare personnel could be considered as a strategy to help curtail SARS-CoV-2 transmission.

Table 1. Comparison of Characteristics of Enrolled Healthcare Personnel by SARS-CoV-2 Serology Result

Characteristic[a]	Serology Positive for SARS-CoV-2 (n = 19)	Serology Negative for SARS-CoV-2 (n = 230)	*P*
Median age (interquartile range), years	30 (26, 36)	34 (28, 42)	.05
Female, n (%)	11 (57.9)	152 (66.1)	.46
Race, n (%)			.10
White	17 (89.5)	211 (91.7)	
Black	0	14 (6.1)	
Other	2 (10.5)	5 (2.2)	
Hispanic ethnicity, n (%)	1 (5.3)	9 (3.9)	.56
Chronic medical conditions n (%)			
Any comorbidity	3 (15.8)	47 (20.4)	.77
Asthma	2 (10.5)	20 (8.7)	.68
Diabetes mellitus	0	1 (0.4)	1.00
Hypertension	0	22 (9.6)	.39
Autoimmune disease	0	8 (3.5)	1.00
Current smoker, n (%)	1 (5.3)	7 (3.0)	.48
Primary location of clinical work, n (%)			.85
Emergency department	12 (63.2)	135 (58.7)	
Medical ICU	3 (15.8)	52 (22.6)	
Other[b]	4 (21.1)	43 (18.7)	
Clinical role, n (%)			.01
Nurse	5 (26.3)	100 (43.5)	
Provider	8 (42.1)	78 (33.9)	
Radiology technician	5 (26.3)	12 (5.2)	
Other[c]	1 (5.3)	40 (17.4)	
Typical number of clinical workdays per week since 1 February 2020, median (interquartile range), days	3 (3, 4)	3 (3, 4)	.72
Did not universally use a surgical mask, N-95 respirator, or PAPR during all clinical encounters, n (%)	3 (15.8)	10 (4.3)	.07
Participant reported belief he/she had COVID-19 since 1 February 2020, n (%)	7 (36.8)	34 (14.8)	.02
Specific symptoms reported since 1 February 2020, n (%)			
Cough	9 (47.4)	61 (26.5)	.06
Sore throat	6 (31.6)	39 (17.0)	.12
Myalgias	4 (21.1)	24 (10.4)	.25
Fever	3 (15.8)	34 (14.8)	1.00
Shortness of breath	2 (10.5)	24 (10.4)	1.00
Vomiting	0	8 (3.5)	1.00
Diarrhea	0	20 (8.7)	.38
Dysgeusia	2 (10.5)	4 (1.7)	.07
Anosmia	2 (10.5)	5 (2.2)	.09
Cough or fever or shortness of breath	9 (47.4)	73 (31.7)	.20
Any of the above symptoms reported, n (%)	11 (57.9)	93 (40.4)	.15
If any symptoms reported, time interval between symptom onset and serology specimen collection, median (minimum, maximum), days	22 (7, 60)	28 (1, 63)	.54
SARS-CoV-2 nucleic acid testing completed clinically prior to serology testing,[d] n (%)			<.01
Test positive	3 (15.8)	0	
Test negative	4 (21.1)	28 (12.2)	
Test not done	12 (63.2)	202 (87.8)	

Abbreviations: COVID-19, coronavirus disease 2019; ICU, intensive care unit; PAPR, powered, air-purified respirator; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

[a]Categorical variables with mutually exclusive categories: race, primary location of clinical work, clinical role. Variables with multiple answer options that are not mutually exclusive: chronic medical conditions, specific symptoms reported since 1 February 2020.

[b]Other primary location of clinical work included: COVID-19 testing center (8); outpatient clinic (5); procedural suite (3); emergency medical services (1); hospital-wide positions such as radiology technician, respiratory therapist, consultants, rapid response team member (11); and not specified (19).

[c]Other clinical roles included: care partner, athletic trainer working at COVID-19 testing center, critical care transport, medical assistant, clinical technician, clinical pharmacist, guest services, advanced EMT (emergency medical technician), mental health specialist, registration and admitting, medical receptionist, and transporter.

[d]Of the 7 healthcare personnel who were positive by serology and had previously been tested for SARS-CoV-2 by nucleic acid testing, all experienced symptoms: 7 reported cough; 4, myalgias; 2, fever; 2, sore throat; 2, dysgeusia; 2, anosmia; and 1, shortness of breath.

Limitations of this study include its single-center setting, convenience sampling, and modest sample size. A convenience sampling strategy could introduce bias if personnel at higher or lower risk for infection were more likely to volunteer. Excluding personnel who were not working because they were ill or quarantined during the enrollment window may have led to an

underestimation of SARS-CoV-2 seroprevalence. The study had low power to detect differences between seropositive and seronegative groups in participant characteristics, such as clinical role. Although participating healthcare personnel worked in units that cared for patients with COVID-19, the level of direct contact with patients with COVID-19 was not quantified. We did not ask participants about potential community exposures to SARS-CoV-2; some seropositive healthcare personnel may have been infected outside of healthcare settings [14]. Important unanswered questions include whether SARS-CoV-2 is transmitted from asymptomatic healthcare personnel who carry the virus and how the use of PPE mitigates that risk.

In conclusion, new serology testing from CDC identified that 7.6% of frontline healthcare personnel had SARS-CoV-2 antibodies within 1 month of the first local hospitalization for COVID-19. The majority of healthcare personnel with positive serology tests did not suspect that they had been infected nor had they undergone prior SARS-CoV-2 nucleic acid testing. Enhanced surveillance for SARS-CoV-2 infection, such as routine point-of-care nucleic acid testing of healthcare personnel, could be an important strategy to reduce SARS-CoV-2 transmission from asymptomatic and minimally symptomatic healthcare personnel.

Notes

Disclaimer. The findings and conclusions of this report are those of the authors and do not necessarily reflect the official position of the Centers for Disease Control and Prevention (CDC).

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Potential conflicts of Interest. H. K. T. has served on a data safety and monitoring board (DSMB) for Seqirus. All other authors report no potential conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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