RESEARCH ARTICLE

Prevalence of Health Care and Hospital Worker SARS-CoV-2 IgG Antibody in a Pediatric Hospital

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ABSTRACT

OBJECTIVES: Asymptomatic transmission of coronavirus disease 2019 (COVID-19) in health care settings is not well understood. In this study, we aimed to determine the prevalence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) immunoglobulin G (IgG) antibodies in health care and hospital workers (HCHWs) and assess how antibody levels change over time.

METHODS: Cross-sectional study of employed HCHWs at a freestanding, urban pediatric tertiary care hospital. Employed HCHWs ≥18 years old who were asymptomatic and worked in clinical hospital locations were eligible to participate. Participants completed blood draws and surveys at baseline (between May 4, 2020, and June 2, 2020) and 2 months later (between July 6, 2020, and August 7, 2020). Surveys collected demographic information, SARS-CoV-2 exposures, and previous COVID-19 diagnosis.

RESULTS: In total, 530 participants enrolled in and completed baseline study activities. The median age was 37 years (range 19–67 years); 86% identified as female, and 80% identified as white. Two months later, 481 (91%) HCHWs completed another survey and blood draw. Four of 5 (0.9%) seropositive subjects at baseline remained seropositive at 2 months, although 3 had decreasing IgG indices. Five (1.0%) seropositive individuals, including 4 who were previously seropositive and 1 newly seropositive, were detected 2 months later. History of positive SARS-CoV-2 polymerase chain reaction testing results ($P < .001$) and history of COVID-19 exposure ($P < .001$) were associated with presence of SARS-CoV-2 antibodies.

CONCLUSIONS: SARS-CoV-2 antibodies were detected in 1% of HCHWs in an urban pediatric hospital in a city with moderate SARS-CoV-2 prevalence. Participants with a known previous COVID-19 diagnosis showed a decline or loss of IgG antibodies over 2 months. These results have implications for identifying those with previous exposure and for ongoing public health recommendations for ensuring workplace safety.

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Coronavirus disease 2019 (COVID-19) is caused by the novel viral pathogen severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). More than 63 million infections have been diagnosed worldwide, with >13 million cases in the United States alone.[1] Individuals infected with COVID-19 have disease severity ranging from asymptomatic infection to fatal illness. Those working in the hospital setting may be at increased risk for contracting COVID-19 compared with the general population.[2] Children infected with COVID-19 are suspected to be underrepresented in total COVID-19 case counts.[3] Health care and hospital workers (HCHWs) in a pediatric setting may have unrecognized exposure to SARS-CoV-2 because children typically experience a milder course of illness or asymptomatic infection.[4,5]

Workplace safety is contingent on an adequate supply of appropriate personal protective equipment (PPE), increased testing capacity, contact tracing, and potential development of new therapeutics and vaccines.[6] Previous studies suggest that SARS-CoV-2 specific immunoglobulin G (IgG) and immunoglobulin M antibodies reach peak levels 17 to 19 and 20 to 22 days after symptom onset, respectively.[7] However, the duration and magnitude of antibody response for those with symptomatic and asymptomatic COVID-19 infection is unknown. In this study, we tested pediatric HCHWs at two time points to further understand infection rates, seroconversion, and the potential durability of SARS-CoV-2 IgG antibodies as a measure of past infection.

METHODS

Employed HCHWs at a 400-bed freestanding, urban pediatric tertiary care hospital were recruited to enroll in a SARS-CoV-2 IgG serology study beginning May 4, 2020. All staff members (including physicians, nurses, allied health professionals, pharmacists, social workers, mental health evaluators, security team members, child-life specialists, and environmental services staff) were eligible to participate if they were >18 years of age and worked in a clinical environment. Participants must have worked at least one shift in a clinical setting in the 14 days before enrollment and could not be experiencing any COVID-19–related symptoms (including cough, fever, sore throat, runny nose, body aches, chills, wheezing, shortness of breath, diarrhea, or vomiting) at the time of their blood draw. During this study, HCHWs were also screened daily before entering the hospital and denied entry if they were experiencing any COVID-19–related symptoms. Through targeted e-mails and word-of-mouth recruitment, ~1000 physicians and staff working in clinical areas were invited to participate, with emphasis placed on the emergency department (ED), ICUs, operating rooms, and inpatient units.

Serology specimens were obtained at two time points. Baseline blood draws took place at the hospital from May 4, 2020, to June 2, 2020, and 2-month follow-up blood draws took place from July 6, 2020, to August 7, 2020. A vascular access nurse, or qualified study team member, obtained ~6 mL of blood in a deidentified serum tube from each participant. Blood was allowed to clot at room temperature for ~1 hour and was refrigerated and centrifuged within 24 hours. Sera were tested for SARS-CoV-2 antibodies by using the Abbott Architect SARS-CoV-2 IgG assay, a qualitative test for IgG against the SARS-CoV-2 nucleoprotein. An antibody index >1.4 was considered positive per the manufacturer's instructions. The expected imprecision for this test is <5% coefficient of variation; thus, a 1.4 index could be between 1.33 and 1.47 in this qualitative assay. Furthermore, in a study by Bryan et al,[8] the sensitivity of Abbott Architect SARS-CoV-2 IgG assay 10 days after positive polymerase chain reaction (PCR) testing results was 97.2% (90.4%–99.5%), and the sensitivity 17 days after positive PCR testing results was 100% (95.5%–100%).

Participants completed a short survey at the time of each blood draw (Supplemental Information). The survey was used to collect participant demographic information, current and recent symptoms, hospital role, typical work location, known exposures, previous COVID-19 diagnosis, and medical history, including immunosuppressant medication use or chronic underlying conditions. Participants were informed of their individual serology results from both tests 1 month after the second blood draw.

Demographic characteristics were described by using means, ranges, and percentages. χ^2 testing was performed for evaluation of factors associated with positive SARS-CoV-2 IgG serology testing results. This study was approved by the hospital institutional review board.

RESULTS

A total of 530 HCHWs enrolled in the study and completed their baseline blood draw. The participant pool included 446 health care providers: 67 attending physicians, 8 fellows, 17 resident physicians, 95 advanced practice providers, 218 nurses, 15 clinical technicians, 26 respiratory therapists, and 84 other hospital workers, including social workers, mental health evaluators, security officers, pharmacists, and child-life specialists (Table 1).

Overall, 5 (0.9%) of the 530 participants were seropositive for SARS-CoV-2 IgG at baseline. Three participants reported previous positive SARS-CoV-2 PCR testing results, and 2 of these participants were IgG-seropositive. Four participants with no previous history of positive SARS-CoV-2 testing results reported living with someone who had been diagnosed with COVID-19, and 1 of these participants was IgG-seropositive. Two participants with no household exposures and no previous positive SARS-CoV-2 PCR test results were IgG-seropositive at baseline. History of positive SARS-CoV-2 PCR testing results was associated with presence of SARS-CoV-2 antibodies ($P < .001$), as was history of exposure to a household contact who was previously diagnosed with COVID-19 ($P < .001$).

A total of 481 (91%) HCHWs participated in the 2-month blood draw. Five (1.0%) tested seropositive for SARS-CoV-2 IgG, including 4 of the 5 previously positive and 1 newly positive (Table 2). The 3 participants with previous positive SARS-CoV-2 PCR testing results showed decreased antibody indices at the second blood draw compared with

TABLE 1 Participant Demographics at Baseline Enrollment

	Work Location				Health Care Role		Total Enrolled
	ED	ICU	Urgent Care	Other[a]	Provider[b]	Other[c]	
Mean age, y (range)	37.1 (22–64)	36.4 (22–67)	38.4 (24–65)	37.3 (19–65)	37.5 (21–67)	35.0 (19–62)	37.1 (19–67)
Sex,[d] *n* (%)							
Female	143 (80.8)	111 (83.5)	34 (91.9)	166 (90.7)	386 (86.5)	68 (81.0)	454 (85.7)
Male	33 (18.7)	22 (16.5)	3 (8.1)	17 (9.3)	60 (13.5)	15 (17.9)	75 (14.2)
Race							
Total, *n*	177	133	37	183	446	84	530
American Indian or Alaskan native, *n* (%)	1 (0.6)	0 (0.0)	0 (0.0)	3 (1.6)	2 (0.4)	2 (2.4)	4 (0.8)
Asian American, *n* (%)	31 (17.5)	14 (10.5)	3 (8.1)	11 (6.0)	47 (10.5)	12 (14.3)	59 (11.1)
Native Hawaiian or other Pacific Islander, *n* (%)	1 (0.6)	0 (0.0)	0 (0.0)	1 (0.5)	2 (0.4)	0 (0.0)	2 (0.4)
Black or African American, *n* (%)	3 (1.7)	0 (0.0)	1 (2.7)	5 (2.7)	5 (1.1)	4 (4.8)	9 (1.7)
White, *n* (%)	132 (74.6)	109 (82.0)	29 (78.4)	153 (83.6)	366 (82.1)	57 (67.9)	423 (79.8)
Other, *n* (%)	6 (3.4)	3 (2.3)	0 (0.0)	2 (1.1)	6 (1.3)	5 (6.0)	11 (2.1)
>1 race, *n* (%)	2 (1.1)	6 (4.5)	2 (5.4)	8 (4.4)	17 (3.8)	1 (1.2)	18 (3.4)
Prefer not to say, *n* (%)	1 (0.6)	1 (0.8)	2 (5.4)	0 (0.0)	1 (0.2)	3 (3.6)	4 (0.8)
Ethnicity, *n* (%)							
Hispanic	17 (9.6)	5 (3.8)	4 (10.8)	15 (8.2)	26 (5.8)	15 (17.9)	41 (7.7)
Not Hispanic	159 (89.8)	128 (96.2)	32 (86.5)	168 (91.8)	419 (93.9)	68 (81.0)	487 (91.9)
Prefer not to say	1 (0.6)	0 (0.0)	1 (2.7)	0 (0)	1 (0.2)	1 (1.2)	2 (0.4)

[a] Includes Post anesthesia care unit and operating room, inpatient wards, outpatient clinics, critical care transport, and other locations.
[b] Includes physicians (attendings, fellows, residents), nurses, advanced practice providers, respiratory therapists, and clinical technicians.
[c] Includes social workers, mental health evaluators, security officers, pharmacists, child-life specialists, and others.
[d] One participant declined to answer.

the first. Antibody indices for the 3 participants with previously positive SARS-CoV-2 PCR testing results at baseline and 2 months decreased from 2.4 to 1.48, from 1.91 to 1.28, and from 1.32 to 0.32, respectively. Two of these 3 participants had IgG antibody titers greater than the seropositive threshold of 1.4 at baseline, and only 1 remained seropositive at 2 months. The 3 participants without previous positive SARS-CoV-2 PCR testing results who were IgG-seropositive at baseline remained IgG-seropositive. One had an increased antibody index, whereas 2 others had decreased antibody indices, which changed from 1.57 to 1.86, from 3.05 to 2.4, and from 1.5 to 1.43 at baseline and 2 months, respectively. Only 1 participant was newly seropositive for SARS-CoV-2 IgG at the second blood draw and had no reported household exposures, with antibody indices of 1.35 at baseline and 1.43 at 2 months (Table 2).

SARS-CoV-2 IgG seropositivity in HCHWs was similar to the rate of SARS-CoV-2 IgG seropositivity in the hospital pediatric population. At baseline in May 2020, 0.9% of HCHWs were IgG-seropositive compared with 1.0% of a convenience sample of 1076 children evaluated in March and April 2020.[3] To provide further context for these results, 0.7% of hospitalized pediatric patients undergoing diagnostic real-time reverse transcription PCR testing were positive for SARS-CoV-2 in May 2020 (internal testing data), compared with detection rates of 1.3% in hospital employees (internal testing data) and 5% in residents of the surrounding county (public data). In July 2020, 1.1% of hospitalized pediatric patients were positive for SARS-CoV-2 by PCR, compared with 2.0% of hospital employees and 3.8% of nearby county residents (Fig 1).[9]

DISCUSSION

One percent of HCHWs employed in the pediatric hospital clinical setting who were tested for SARS-CoV-2 IgG antibodies showed evidence of IgG seroconversion in the summer of 2020. Of the 5 HCHWs who had antibodies detected at baseline, all but 1 had waning IgG indices 2 months later. In addition, 2.3% of participants working in the ED tested positive, whereas 0.01% of non-ED personnel tested positive, identifying the ED as a likely higher-risk clinical location. Our findings have implications for rates of viral transmission to HCHWs in the pediatric health care setting as well as for ongoing identification of past infection and for public health recommendations.

This study was conducted in a pediatric hospital with moderate rates of COVID-19 disease and in the presence of adequate PPE, including gowns, gloves, masks, face shields, and controlled air-purifying respirators, throughout the hospital. Additionally, each room in the ED is negative pressure, which allows for rapid clearance of aerosolized viral particles when the doors remain closed. These factors may have influenced the low SARS-CoV-2 seroprevalence rate. In comparison, the authors of a study of 40 329 health care

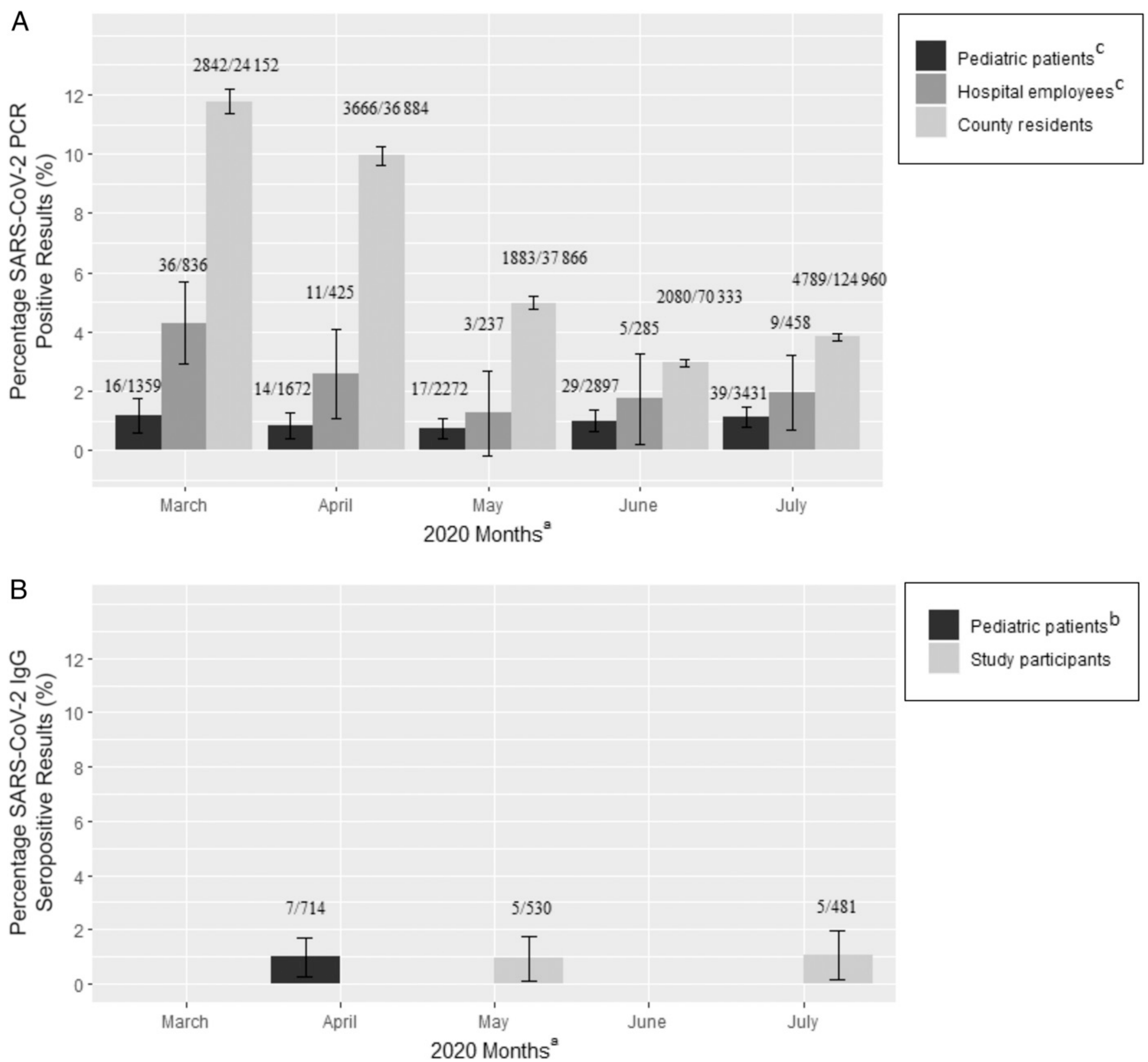

FIGURE 1 A and B, Comparison of SARS-CoV-2 PCR positivity (A) and IgG antibody seropositivity (B) within an urban pediatric hospital and the surrounding county. [a] February data: 0 of 2 pediatric patients tested positive, no hospital employees tested, 6 of 8 (75%) surrounding county residents tested positive. Data not included because of strict testing criteria and few tests done. [b] Internal testing data. [c] A subset of pediatric patients tested by PCR were also tested retrospectively in April for IgG antibodies. Approximately 1.0% of pediatric patients had at least 1 seropositive sample.

workers in New York City found an overall seropositivity of 13.7%. Performed during a time of high rates of SARS-CoV-2 circulation and by using 7 different antibody assays with varying sensitivity and specificity, this study revealed a 93.5% seropositivity in those with previous positive PCR testing results and a 9% seropositivity in those without known previous exposure.[10] Additionally, in a point-prevalence serology study within the largest hospital system in the United Kingdom, sera from 515 health care workers obtained in a 24-hour period revealed a seropositivity rate of 24.4% with a laboratory-developed enzyme-linked immunosorbent assay, with a rate of 37.5% in those with previous symptoms and 17.1% in those with no previous symptoms.[11]

Our results are similar to those of several studies of health care workers caring for hospitalized and older patients. In a study of health care workers in China, 77 health care workers with no exposure history all tested negative for SARS-CoV-2 IgG antibodies.[12]

TABLE 2 SARS-CoV-2 PCR and IgG-Seropositive Test Results

Case No.	Age, y	Sex	Hospital Role	Area of Work	Previous COVID-19 PCR Diagnosis (Baseline Draw)	Household Exposure at Baseline	Baseline Result (Index)[a]	Household Exposure at 2 mo	2-mo Result (Index)
1	30	Female	Nurse	ED	No	No	Positive (1.57)	No	Positive (1.86)
2	40	Female	Respiratory therapist	ICU	No	Yes	Positive (3.05)	Yes	Positive (2.4)
3	30	Female	Advanced practice provider	Other	No	No	Positive (1.50)	No	Positive (1.43)
4	43	Female	Nurse	ED	No	No	Negative (1.35)	No	Positive (1.43)
5	39	Female	Attending physician	ED	Yes (47 d before)	No	Positive (2.40)	No	Positive (1.48)
6	45	Female	Nurse	ED	Yes (58 d before)	No	Positive (1.91)	No	Negative (1.28)
7[b]	31	Female	Advanced practice provider	Other	Yes (71 d before)	No	Negative (1.32)	Yes	Negative (0.32)

[a] Lowest detected index = 1.40.
[b] Although seronegative, this case is included in the table because of a previous COVID-19 PCR diagnosis.

Another study of seroprevalence in health care workers in a New Jersey ICU documented 1 case (0.83%) of asymptomatic seroconversion in the 121 health care workers who were exposed to critically ill patients with COVID-19.[13] In our study, 4 of the 5 participants with detectable IgG levels at baseline had decreased IgG indices at the 2-month draw. Waning of IgG indices in this study is consistent with the findings of a study of 37 individuals with positive SARS-CoV-2 PCR testing results in China, in whom IgG levels waned as the patients moved into the convalescent phase of illness.[14] Similar results were found in a study at the University of Washington of 34 individuals who had recovered from asymptomatic COVID-19 infections. In that group, neutralizing antibody titers declined fourfold on average from 1 to 4 months after symptom onset.[15] In a recent *Morbidity and Mortality Weekly Report* publication, it was found that among 156 health care workers at 13 hospitals in 12 states with positive SARS-CoV-2 testing results and baseline antibody testing results, 94% had a decline of antibody levels at repeat testing 60 days later and 28% seroconverted to below the level of positivity.[16]

The use of PPE may play an important role in seroconversion of health care workers. The association between universal masking and SARS-CoV-2 positivity was evaluated among health care workers at the Massachusetts General Brigham Hospital, where workers were tested by using real-time reverse transcription PCR if they reported any COVID-19–related symptoms. The rate of positive test results decreased from 14.7% to 11.5% after universal masking was used.[17] In a study of community health workers counseling contacts with COVID-19 in Chennai, India, 19% of 62 community health workers wearing masks, gloves, and shoe covers and using hand sanitizer were infected after visiting >5800 homes. After the addition of face shields, none of the remaining 50 workers were infected after visiting >18 000 homes.[18] These studies reveal low rates of SARS-CoV-2 infection with appropriate PPE use. At the pediatric hospital where this study was conducted, masks were initially in critically short supply, and guidance evolved over time. Beginning March 27, 2020, masks and eye protection were required for evaluation of all patients unless a respirator was indicated (for patients considered to be at high risk for COVID-19 or if an aerosol-generating procedure was being performed on a patient with unknown infection status). Universal masking throughout the hospital was instituted for staff, patients, and families beginning May 6, 2020, just before the start of enrollment for this study.

This study is limited because it was completed at a single pediatric hospital with infrastructure, PPE availability, and local guidance regarding PPE and safety practices that may not be generalizable to other types of hospitals or geographic locations. Furthermore, our understanding of changes in antibody concentrations over time is limited by the small number of participants who were IgG-seropositive. Lastly, it is important to note that HCHWs may have different risk-associated behaviors in the community compared with the community population at large, which may contribute toward the relatively low seropositivity observed in HCHWs.

In a well-resourced freestanding pediatric hospital in a city with moderate community levels of COVID-19 infection, SARS-CoV-2 IgG seroconversion of frontline health care workers was low, and antibody levels waned over time. These results have implications for identifying those with previous exposure as well as for ongoing public health recommendations for ensuring workplace safety. Despite evidence of waning antibodies over time, IgG testing may be advantageous to repeated PCR testing for epidemiological purposes because it is more practical logistically, is less costly, would require fewer tests, and would decrease selection bias if personnel are only testing with PCR when symptomatic.

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