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Major Article

Prevalence of SARS-CoV-2 IgG antibodies in health care workers at a tertiary care academic medical center – An assessment of occupational infection risk

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Background: The purpose of this study was to assess the occupational SARS-CoV-2 infection risk among health care workers (HCW) at University of Kentucky HealthCare (UKHC) by evaluating the prevalence of SARS-CoV-2 antibodies.

Methods: This is a prospective cohort study of HCW at UKHC. SARS-CoV-2 IgG antibody seropositivity was measured in a CLIA-certified laboratory utilizing the Abbott Architect SARS-CoV-2 IgG antibody assay. Demographics and work type were self-reported by study participants via an emailed survey.

Results: The overall antibody positivity rate of HCW was 1.55% (5/322; 95% confidence interval: 0.65%-3.71%) at cohort entry. There were no differences in antibody positivity between those that worked directly with SARS-CoV-2 infected patients and those that did not. The antibody rate of positivity of patients during the same time period was similar, 1.8% (9/499; 95% confidence interval 0.94%-3.45%).

Conclusions: Antibody positivity was low and similar between HCW and patients tested during a similar time period. HCW positivity rates did not appear to be impacted by caring for known SARS-CoV-2 infected patients suggesting that appropriate use of personal protective equipment is effective in protecting individuals from transmission.

INTRODUCTION

As of April 12, 2021, there have been over 136 million confirmed cases of COVID-19 worldwide and 2,938,804 deaths.[1] The United States alone has suffered over 562,080 of those deaths. Kentucky has had a total of 434,878 cases and 6,204 deaths although case counts are currently declining. This has put significant stress on health care facilities to not only provide care to patients but also to protect the most valuable resource in the pandemic, its health care workers (HCW).

SARS-CoV-2 is transmitted primarily via respiratory droplets, although fomite and airborne spread have also been reported.[2-5] Infected individuals are contagious whether asymptomatic, presymptomatic, or symptomatic. Since 18%-81% of infected individuals are asymptomatic,[6,7] unprotected occupational exposure of HCW is especially important. To limit this infection risk, additional infection prevention measures that are more broadly applied not to just those patients with possible COVID-19 symptoms is critical. These more universal measures include the wearing of masks by all HCW, patients and visitors when they enter the health care facility, the screening of HCW, patients and visitors daily for symptoms of COVID-19 with work restriction and rapid testing if symptomatic, and testing of all patients being admitted to the hospital or undergoing a procedure or surgery requiring sedation.[8] Still, there remains little data assessing the effectiveness of personal protective equipment (PPE) in preventing SARS-CoV-2 transmission or exploring the comparative risk of exposure between HCW and the general

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population. One study of HCW in England suggested that rates of infection were no different than those in the general community, a finding that supports the effectiveness of appropriate PPE in preventing transmission.[9] However, another study found that 19.4% (19/98) of asymptomatic HCW at a hospital in New York City were positive for SARS-COV-2 via PCR and/or IgG antibody testing despite routinely wearing PPE.[10] The toll of the pandemic on HCW is evident from an international survey demonstrating the median deaths due to COVID-19 among HCW is 0.05 per 100,000 of general population the country. The US was higher than the median at 0.17 per 100,000.[11] In addition, HCW have exhibited clinically significant mental health symptoms during the pandemic.[12]

The purpose of this study is to determine the prevalence of SARS-CoV-2 IgG antibodies among HCW as a measure of SARS-CoV-2 infection risk in the health care setting which can inform the effectiveness of PPE in preventing transmission of SARS-CoV-2 and the occupational infection risk borne by medical staff treating patients during the COVID-19 pandemic.

METHODS

Study population

Participants are HCW at University of Kentucky HealthCare (UKHC) who were ≥18 years of age and elected to undergo SARS-CoV-2 serology testing at UKHC. Notably, these individuals were not known to have an active SARS-COV-2 infection at time of inclusion; instead, they were assessed for antibodies as evidence of a prior SARS-COV-2 infection. Participants were excluded from the study population if they were prisoners, if they had a psychiatric illness or social situation that would limit compliance with study requirements. HCW participants were offered testing from June 22, 2020 to June 26, 2020. Per the IRB-approved protocol (NCT04573634), each staff member who made an appointment to receive antibody testing was invited to participate in the study. Symptomatic individuals were required to stay home from work, so no individual exhibiting symptoms was included in testing group. Individuals who elected to participate in the study were consented by study personnel upon arrival for their appointment. Results of testing were only provided to tested HCW and the study team. For comparison, the non-HCW population was comprised of patients who had SARS-CoV-2 serology testing ordered by their provider and performed at UKHC between April 24, 2020 and September 17, 2020. Providers could order Ab testing without restriction or documenting the rationale for testing. The results of these tests were obtained retrospectively through a waiver of consent.

SARS-CoV-2 IgG antibody seropositivity

SARS-CoV-2 IgG antibody seropositivity was measured in a CLIA-certified laboratory utilizing the Abbott Architect SARS-CoV-2 IgG antibody assay (Abbott Park, IL). In validation studies, the Abbott Architect assay demonstrated a sensitivity of 100% (95% confidence interval [CI]: 95.8%-100.0%) and a specificity of 99.6% (95% CI: 99.0%-99.9%).[13] To perform the assay, one 6-mL tube of blood was obtained for each participant.

Surveys

Participants were emailed a survey for collecting demographic factors, including age, race, ethnicity, household income, educational attainment, history of bacille Calmette-Guerin (BCG) vaccination, prior COVID infection, chronic medical conditions and occupational exposures. Surveys were initially administered the week after testing was conducted and non-responsive individuals received up to three additional attempts spaced 2 weeks apart.

Statistical analysis

Descriptive analysis of demographic variables including age, sex, race, ethnicity, household income, education, height and weight, and clinical variables including BCG vaccination, diabetes, hypertension, chronic obstructive pulmonary disease and other lung disease, and heart failure were conducted. Analysis between demographic or clinical variable and COVID-19 status were conducted. Categorical and continuous variables were compared by χ^2 test or Fisher's exact test and Student t test, respectively. All statistical analyses were performed using R 3.63.[14]

RESULTS

Participants

Staff at UKHC were offered SARS-CoV-2 antibody testing between June 22, 2020 and June 26, 2020, with 445 undergoing testing and 322 HCW enrolling in the study. All 322 had antibody testing successfully performed and 84% (270/322) at least partially completed the survey. The mean age of participants was 36.1 ± 10.3 years, with 216 female and 54 male participants (**Table 1**). The majority of participants were white (251), consistent with the demographics of our population, with 10 Black or African-Americans, and 8 Asians also participating. The majority were college graduates, with household incomes between $45,000 and $139,990. Two individuals reported a prior SARS-COV-2 infection. Chronic diseases were infrequent, with no participants reporting heart failure, one with chronic obstructive pulmonary disease, nine with diabetes, 21 with a lung disease other than chronic obstructive pulmonary disease and 38 with hypertension.

Between April 24, 2020 and September 17, 2020, 2772 patients receiving health care at UKHC were tested as part of their routine care, with 499 patients tested between June 22 and June 26.

SARS-COV-2 positivity

The overall antibody positivity rate of HCW was 1.55% (5/322; 95% CI: 0.65%-3.71%). The antibody rate of positivity of patients over the same time period (June 22 to June 26) was similar, 1.8% (9/499; 95% CI: 0.94%-3.45%). The antibody positivity rate for patients between April 24, 2020, which was the initiation of testing and September 17, 2020, the date of data cut-off was 3.9% (104/2666; 95% CI: 3.23%-4.71%) (Tables 2 and 3).

The majority of HCW was directly patient facing and had cared for patients with COVID-19 (187 versus 78), however, there were no significant differences in SARS-CoV-2 antibody positivity between different occupational exposure risks. There were also no differences in antibody positivity by income, educational attainment, or comorbid diseases. However, Black or African-Americans were significantly more likely to be antibody positive, with 20% (2/10) having SARS-CoV-2 antibodies as compared to less than 1% (2/251) of White HCW (P= .01068). In addition, of the 2 individuals reporting a prior COVID-19 infection, only one was antibody positive.

DISCUSSION

The antibody positivity rate of HCW at UKHC was low (1.55%) and is similar to other studies, with a German study reporting an antibody positivity rate of 1.6% in a population of 316 HCW between March and April 2020,[15] and a study performed in Denmark over the same time period reporting a positivity rate of 4.04% (1163/28792).[16] These

Table 1
Characteristics of participants at inclusion

Variable	HCW (n = 322)
Age (yr)	36.1 ± 10.31
Sex	
Female	216
Male	54
No data	52
Race	
White	251
African American	12
Native Hawaiian or Other Pacific Islander	0
Asian	8
American Indian of Alaska Native	3
No Data	54
Ethnicity	
Hispanic	8
Non-Hispanic	229
No Data	85
Household Income	
Less than $20,000	7
$20,000-$44,999	19
$45,000 - $139,999	172
$140,000 - $149,999	16
$150,000 - $199,999	34
$200,000+	19
No data	55
Education	
Some college	13
Associate degree	44
Bachelor's degree	80
Bachelor's degree or more	34
Master's degree	47
Professional degree	5
Doctoral degree	46
No data	53
Bacille Calmette-Guerin vaccination	
Yes	8
No	219
No data	95
Diagnosed SARS/COVID-19	
Yes	2
No	268
No data	52
Diabetes	
Yes	9
No	254
No data	59
Hypertension	
Yes	38
No	229
No data	55
Chronic obstructive pulmonary disease (COPD)	
Yes	1
No	261
No data	60
Other lung disease	
Yes	21
No	244
No data	57
Heart failure	
Yes	0
No	263
No data	59

studies, and subsequent editorials suggest being a HCW is a significant occupational risk for SARS-COV-2 infection.[17-19] Since the majority of HCW who elected to undergo testing provided direct patient facing care to patients with a known SARS-COV-2 infection, this group can be viewed as the highest risk in our health system. The low positivity rate among these individuals directly caring for patients with COVID-19 2/187 (1.1%) suggests that the PPE measures employed were effective in preventing SARS-COV-2 infection.

Table 2
Antibody positivity among HCW

Variable	Total	Antibody positive	Antibody negative	*P* value
Directly patient-facing and cared for known COVID-19 positive patients				1
Yes	187	2	185	
No	78	1	77	
No data	57	2	55	
Non-patient facing but potentially at higher risk of exposure				.2588
Yes	29	1	28	
No	180	1	179	
No Data	113	3	110	
Nonclinical (outside of work) exposure				.1304
Yes	14	1	13	
No	194	1	193	
No data	114	3	111	

The antibody positivity rate of patients receiving care at UKHC over the same time period was also low, at 1.8%. In addition, patients had testing as part of routine clinical care and since serology is not recommended for diagnosis, we anticipate the majority of the testing was performed at the request of patients who suspected they had already had an infection. Taken together, the low rates of antibody positivity among the highest risk HCW and the comparability to the general population suggest the efficacy of PPE measures employed at UKHC.

PPE measures included the use of airborne infection isolation (AII) for patients known to be SARS-COV-2 positive and for those who were being tested for SARS-COV-2 and undergoing an aerosol generating procedure. The care for these patients is provided in a negative pressure room. PPE for all HCW includes gowns, gloves, eye protection, and N95 masks or powered air purifying respirators. Universal masking for all HCW, patients and visitors was initiated in April, 2020. We also began preprocedural testing and asymptomatic testing of all hospital admissions in late May with the intent of identifying and isolating potentially positive patients that may have otherwise led to an unprotected exposure.

Similar to other studies in the general population and among HCWs,[19-21] we identified African-American race as significantly associated with increased risk of SARS-COV-2 infection, although these results should be interpreted with caution due to small numbers.

This study has several strengths. It was a single institution study with consistent recommendations for PPE which were in accordance with national standards and study participation was offered to all individuals being tested. The use of SARS-CoV-2 Ab rate was beneficial for the purpose of the study as it provided information about past infections as opposed to the use of molecular or antigen-based methods which identify active infections. At the time of this study, SARS-COV-2 infection rates were low in Kentucky which may have reduced the positive predictive value of the antibody tests that were performed; however, this would have been true across all populations so we believe that comparisons among these groups are still appropriate. Limitations include a relatively small sample size, lack of clinical and demographic data related to patients, and a potential lack of generalizability. While patients represent a population sample drawn from UKHC, they may have had comorbid conditions or concurrent medications that may have impacted their antibody response or lived in higher risk locations, like long term care facilities. In addition to low infection rates, available resources such as ICU beds, trained staff and PPE were not significantly limited at UKHC. Therefore, our results, demonstrating efficacy of PPE in preventing SARS-COV-2 transmission to HCW may not translate to settings where cases counts are high and resources, especially access to PPE, are strained.

Table 3
HCW covariate analysis

Variable	Total	Antibody positive	Antibody negative	*P* value
Sex				.587
Female	216	4	212	
Male	54	0	54	
No data	52	1	51	
Race				.01068
White	251	2	249	
African American or Black	10	2	8	
Native Hawaiian or Other Pacific Islander	0	0	0	
Asian	7	0	7	
American Indian of Alaska Native	0	0	0	
No data	54	1	53	
Ethnicity				1
Hispanic	8	0	8	
Non-Hispanic	229	3	226	
No data	85	2	83	
Household Income				.4757
Less than $20,000	7	0	7	
$20,000-$44,999	19	1	18	
$45,000 - $139,999	172	2	170	
$140,000 - $149,999	16	0	16	
$150,000 - $199,999	34	1	33	
$200,000+	19	0	19	
No data	55	1	54	
Education				.1881
Some college	13	0	13	
Associate degree	44	2	42	
Bachelor's degree	80	0	80	
Bachelor's degree or more	34	0	34	
Master's degree	47	2	45	
Professional degree	5	0	5	
Doctoral degree	46	0	46	
No data	53	1	52	
BCG vaccination				.1345
Yes	8	1	7	
No	219	3	216	
No data	95	1	94	
Diabetes				1
Yes	9	0	9	
No	254	4	250	
No data	59	1	58	
Hypertension				.09833
Yes	38	2	36	
No	229	2	227	
No data	55	1	54	
Chronic obstructive pulmonary disease				1
Yes	1	0	1	
No	261	4	257	
NA	60	1	59	
Other lung disease				1
Yes	21	0	21	
No	244	4	240	
No data	57	1	56	
Heart failure				
Yes	0	0	0	
No	263	4	259	
No data	59	1	58	

This highlights the need for public health measures that limit SARS-COV-2 spread and prevent overwhelming health systems.

Conclusion

Antibody positivity was low, and similar between HCW and patients tested over the same time period. Furthermore, rates of antibody positivity among HCW caring for known SARS-COV-2 positive patients did not differ from HCW who did not, suggesting that appropriate use of PPE, which includes gowns, gloves, eye protection and N95 masks or powered air purifying respirators, is effective in protecting even high-risk HCW from SARS-CoV-2 transmission.

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