Seroprevalence of SARS-CoV-2 among Internal Medicine Residents at a Major Academic Medicine Residency Program

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ABSTRACT

BACKGROUND: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its associated disease (COVID-19) are a significant cause of morbidity and mortality across the United States. Internal medicine (IM) residents are a critical component of the healthcare workforce yet their seroprevalence of SARS-CoV-2 antibodies is largely unknown. The aim of this research was to ascertain the seroprevalences of SARS-CoV-2 among internal medicine residents during the first peak of COVID-19.

METHODS: IM residents were enrolled in a surveillance program that included PCR and antibody testing for SARS-CoV-2 in June 2020. Residents also completed a short questionnaire to obtain sociodemographic information and characterize potential workplace exposure to COVID-19.

RESULTS: A total of 101 IM residents participated in the study (out of N=162). Of the 101 samples, three (2.9%) tested positive for SARS-CoV-2 antibodies. No residents tested PCR positive for SARS-CoV-2.

DISCUSSION: The implementation of COVID-19 patient cohorting and the incorporation of telemedicine to communicate with hospitalized patients into clinical practice early in the pandemic may have prevented the spread of the virus among the surveyed clinical trainees.

CONCLUSION: Despite significant engagement with COVID-19 patients, IM residents demonstrated a low rate of SARS-CoV-2 seroprevalence.

KEYWORDS: seroprevalence, SARS-CoV-2, internal medicine residents

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is the novel infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). First identified at the end of 2019, it has quickly spread internationally and was declared a global health emergency of international concern on January 30th, 2020[1] and subsequently a pandemic on March 11th, 2020 by the World Health Organization.[2] The United States has been significantly impacted by the virus with the greatest number of diagnosed cases and deaths globally.[3] Certain populations are at greater risk for exposure and infection with the virus. Healthcare workers (HCWs) represent a particularly vulnerable population for infection with SARS-CoV-2 due to significant exposure and close contact with COVID-19 patients.[4] Incidence and prevalence data of COVID-19 among HCWs is limited but initial population surveys have estimated prevalence to be as high as 11%.[5] While there is likely to be variability based on the type of setting and health care position evaluated,[6] one study of HCWs in a tertiary care center in the United States found a prevalence of nearly 10% without significant differences in prevalence across job title and work area.[7]

In many healthcare systems, residents are heavily relied upon as essential frontline caregivers during the COVID-19 pandemic.[8] With significant inpatient, outpatient, and critical care responsibilities, Internal Medicine (IM) residents represent an important subset of the frontline healthcare workforce caring for adult patients in a number of settings where there is treatment of known individuals with COVID-19 as well as individuals who may be pre-symptomatic or asymptomatic. Understanding the prevalence of COVID-19 among this group of HCWs would provide key information on exposure risk for this uniquely vulnerable subset of clinicians. This study presents the results of antibody and PCR-based testing for SARS-CoV-2 among IM residents in a single large, academic training program in the United States during the first peak of the COVID-19 pandemic in the spring of 2020. Participants were also asked to complete a survey that included sociodemographic information as well as information on exposure to COVID-19 in the clinical setting. This is the first study to describe the prevalence of anti-SARS-CoV-2 prevalence among resident trainees working in an IM training program while exploring potential risk factors for COVID-19 exposure and infection.

METHODS

All active resident trainees in a major academic IM residency program in Providence, Rhode Island were offered voluntary SARS-CoV-2 testing at a single site over the course of two weeks (June 8, 2020 through June 23, 2020). All residents were aged 18 years or older at time of testing.

Verbal consent was obtained at the time of testing. Trained clinical staff performed a nasopharyngeal (NP) swab for PCR-based SARS-CoV-2 swab and a venipuncture for antibody-based SARS-CoV-2 testing during the same encounter. SARS-CoV-2-specfic antibodies were measured using SARS-CoV-2 IgG test (Abbott, Lake Forest, IL). SARS-CoV-2 PCR tests were performed using one of the seven platforms: ePlex® SARS-CoV-2 Test(GenMark, Carlsbad CA), cobas SARS-CoV-2 Test (Roche, Indianapolis, IN), Xpert® Xpress SARS-CoV-2 (Cepheid, Sunnyvale, CA), BD SARS-CoV-2 (Becton, Dickinson and Company, Sparks, MD), SARS-CoV-2 Assay (Hologic, San Diego, CA), TaqPath COVID-19 Combo Kit (Thermo Fisher, Waltham, MA) and ARIES® SARS-CoV-2 Assay (Luminex, Austin, TX). On presentation for SARS-CoV-2 testing, individuals were asked to complete a one-page questionnaire via REDCap. This standardized form included baseline demographics such as age, sex, race and ethnicity as well as exposures and self-reported symptoms consistent with COVID-19 infection and information related to potential COVID-19 exposure in the workplace. Residents were asked to report on COVID-19 symptoms from January 1st through May 31st of 2020. Residents were asked to respond to questions about workplace COVID-19 exposure beginning on March 1st which was the approximate date of the first diagnosed case of COVID-19 in Rhode Island. This study was conducted for surveillance purposes and reviewed by the Rhode Island Department of Public Health Institutional Review Board.

RESULTS

Of 162 active 2019-2020 IM residents in this academic residency program, 101 (62.3%) provided consent, were tested for SARS-CoV-2 and completed the survey. Sociodemographic characteristics of the participants are outlined in **Table 1**. Based on surveyed workplace activities related to potential COVID-19 exposure (**Table 2**), nearly all of the residents reported working on an inpatient medical unit (N=100) and a significant majority reported working in an intensive care unit setting (N=75). There were a number of residents who worked in an emergency department (N=22) and nearly half (N=48) responded that they had worked in an outpatient clinical setting. The vast majority (N=95) of residents cared for at least one patient with COVID-19 and almost half (N=45) cared for at least 20 COVID-19 patients with 11 residents having cared for 50 or more patients infected with the virus. Residents also reported the incorporation of changes in clinical service provision to mitigate the spread of COVID-19 with 79 noting they had provided clinical care in a setting where COVID-19 patients were cohorted and 91 documenting the use of telemedicine for patient care encounters, including the hospital setting. Despite the relatively low prevalence of COVID-19, a notable number of residents (N=30) reported prior symptoms consistent with

Table 1. Study Participant Characteristics

Overall Participants	101
Gender	**% (N)**
Male	54.5 (55)
Female	44.6 (45)
Decline to Answer	0.9 (1)
Race	**% (N)**
White	55.4 (56)
Black or African American	5.9 (6)
American Indian or Alaska Native	1.0 (1)
Asian	35.6 (36)
Native Hawaiian or Pacific Islander	0.0 (0)
Other	3.0 (3)
Decline to Answer	1.0 (1)
Ethnicity	**% (N)**
Hispanic/Latino	5.0 (5)
Non-Hispanic/Latino	94.0 (95)
Decline to Answer	0.9 (1)

Table 2. Exposures through clinical work

Settings where patient care was conducted (Participants may have chosen more than one)	**% (N)**
Inpatient Medical Floor	99.0 (100)
Intensive Care Unit	74.3 (75)
Emergency Department	21.8 (22)
Outpatient Clinic	47.5 (48)
Other	4.0 (4)
None	0.0 (0)
Used telemedicine (either phone or video) to provide patient care	**% (N)**
Yes	90.1 (91)
No	9.9 (10)
Served in a clinical setting where COVID+ patients were cohorted	**% (N)**
Yes	78.2 (79)
No	21.8 (22)
Estimated total number of COVID+ patients cared for	**% (N)**
0	5.9 (6)
1 to 9	32.7 (33)
10 to 19	16.8 (17)
20 to 29	17.8 (18)
30 to 39	13.9 (14)
40 to 49	1.0 (2)
50+	10.7 (11)

COVID-19 infection (**Table 3**). Relatively few had received testing for COVID-19 (N=19) before this surveillance study and three individuals had previously documented COVID-19 infection.

Of the 101 serum samples collected, three (2.9%) were positive for SARS-CoV2 antibodies. None who participated had a positive PCR test.

Table 3. Self-report of symptoms and prior COVID testing

Experienced symptoms of COVID since January 1, 2020?	% (N)
Yes	29.7 (30)
No	70.3 (71)
Previously tested for COVID	**% (N)**
Yes	18.8 (19)
No	81.1 (82)
Previously documented COVID infection	**% (N)**
Yes	2.97 (3)
No	97.0 (98)

DISCUSSION

This is the first study examining IM resident exposure to COVID-19 during clinical activities as well as seroprevalence for the disease. Despite working with a significant number of COVID-19 patients, few of the surveyed trainees were infected with SARS-CoV-2. Of note, the current study was performed after the first peak of COVID-19 in the state (March-June 2020). The low seroprevalence rate is reassuring given the relatively frequent care provided by residents to individuals with COVID-19. It is also reassuring that the same number of individuals who had documented COVID-19 infection were found to be seropositive for SARS-CoV-2 antibodies suggesting that previous testing strategies had successfully diagnosed cases of the disease. It is not surprising, given the clinical training requirements for residents, that virtually all residents reported working in an inpatient medical unit and that the vast majority reported working in an intensive care unit. The academic medical centers where surveyed residents had participated in clinical activities were responsible for the inpatient and intensive medical care of the vast majority of COVID-19 cases in the state of Rhode Island. It is also not surprising then that nearly all of the residents (N=95) reported caring for a patient with COVID-19.

The clinical care of patients with COVID-19 was provided during the initial months of the pandemic when there were still many aspects of care related to COVID-19 that were unknown, in addition to shortages of personal protective equipment (PPE) and COVID-19 testing supplies. The residents followed hospital-wide guidelines regarding re-use and sterilization of PPE as these protocols changed. Hospital-wide protocols were developed based on CDC or RI Department of Health guidelines as available at the time.

Several specific strategies were used to prevent the spread of the virus among the surveyed clinical trainees. Residents were encouraged, but not mandated, to use telehealth technologies including audio and/or video interviews in both inpatient and outpatient settings. The vast majority of residents (N=91) participated in this risk mitigation technique in order to reduce face-to-face exposure of individuals infected with or potentially infected with COVID-19. In addition to changes in clinical care delivery, the residency administration made program-wide changes in educational activities including the transition of formal didactics to socially distanced and virtual sessions. Efforts were made to reduce congregating including spacing out computer work stations and designating specific socially distanced work areas per resident team. Resident lunches were transitioned to individually packaged meals. All residency sanctioned social activities were postponed unless made virtual. Although many of these protocols were developed early in the pandemic when many aspects of SARS-CoV2 were still unknown, these risk mitigation strategies may have also prevented the spread of the virus among the surveyed clinical trainees.

The vast majority of residents cared for at least one patient with COVID-19 and a significant number of residents reported working cohorted COVID-19 patient units (N=79). Despite the relatively high exposure to COVID-19 in the workplace, however, relatively few of the surveyed residents reported having previously been tested for COVID-19. Alarmingly, fewer individuals who reported symptoms consistent with COVID-19 had been previously tested for the disease. There are several potential explanations for this including testing supply shortages, a lack of easily accessible testing sites for clinical trainees who have demanding clinical work schedules, underreporting of symptoms to residency leadership or employee health, and a lack of clear guidance on who needed testing in the early months of the pandemic. From March through June 2020, residents were asked to call hospital Employee and Occupational Health Services to determine need for testing if symptomatic. The administered survey requested self-reported COVID-19 related symptoms during a time period that included the two months prior to the first diagnosed case of COVID-19 in Rhode Island. This same time period overlapped with seasonal influenza which shares a similar symptomatology with COVID-19. Residents may have experienced COVID-19-like symptoms prior to the known arrival of COVID-19 to Rhode Island making exposure to the virus less likely during that time. Additionally, the responses of residents may be impacted by recall bias, a phenomenon which has not been fully explored in the context of self-reported COVID-19 symptoms and serum antibody testing. Ultimately the low SARS-CoV-2 antibody seroprevalence compared to the more frequent self-report of COVID-19-like symptoms may

indicate a poor correlation between self-reported COVID-19 symptoms and seropositivity.

While there are many strengths to this study including some of the first detailed seroprevalence data among this important subset of HCWs, there are some inherent weaknesses of the methodological approach and results that limit the conclusions that can be drawn from the study. The first limitation is the response rate from active residents as 61 out of 162 active residency trainees did not participate in the study. While participation in the study was actively advertised throughout the residency program and there were multiple sessions for sample collection held across a greater than two-week period, participation may have been limited by a number of factors that could impact the study findings and interpretability of the results. Anecdotally, residents cited scheduling as the primary reason limiting their ability to participate. Additionally, there were likely a number of other interventions implemented to mitigate the spread of COVID-19 among HCWs in this academic center that were not surveyed in the questionnaire. As a result, it is difficult to determine causality between the low seroprevalence results and the queried mitigation interventions included in the questionnaire. Finally, given the low number of seropositive cases of COVID-19 in this study sample, it is not possible to identify meaningful associations between seropositivity and sociodemographic characteristics or reported workplace exposure. This study may not be generalizable to other settings.

CONCLUSION

With the sustained COVID-19 pandemic, HCWs continue to experience a high level of potential exposure to SARS-CoV-2 as they care for patients who are often severely ill. IM residents at a major academic medical center responsible for the clinical care of many severely ill COVID-19 patients report significant workplace exposure. However, they also report the incorporation of interventions to mitigate the spread of COVID-19 in the workplace including cohorting of COVID-19 and the use of telemedicine to communicate with hospitalized patients. Despite caring for a significant number of COVID-19 patients in a potentially challenging workplace environment, this study demonstrated a low seroprevalence of SARS-CoV-2 antibodies among surveyed residents indicating that efforts to limit infections among this group of HCWs have been successful. Administrators of residency programs and the health systems in which residents work should ensure access to COVID-19 testing, particularly for those reporting symptoms consistent with COVID-19 infection.

References

1. COVID-19 Public Health Emergency of International Concern (PHEIC) Global research and innovation forum. WHO. https://www.who.int/publications/m/item/covid-19-public-health-emergency-of-international-concern-(pheic)-global-research-and-innovation-forum. Published 2020. Accessed November 23, 2020.
2. Archived: WHO Timeline–COVID-19. WHO. https://www.who.int/news/item/27-04-2020-who-timeline---covid-19. Published 2020. Accessed November 23, 2020.
3. WHO Coronavirus Disease (COVID-19) Dashboard. Covid19.who.int. https://covid19.who.int/. Published 2020. Accessed November 23, 2020.
4. Korth J, Wilde B, Dolff S, et al. SARS-CoV-2-specific antibody detection in healthcare workers in Germany with direct contact to COVID-19 patients. *J Clin Virol*. 2020;128:104437. doi:10.1016/j.jcv.2020.104437
5. Sergio Alejandro Gómez-Ochoa, Oscar H Franco, Lyda Z Rojas, et al. COVID-19 in Health-Care Workers: A Living Systematic Review and Meta-Analysis of Prevalence, Risk Factors, Clinical Characteristics, and Outcomes, American Journal of Epidemiology, kwaa191, https://doi.org/10.1093/aje/kwaa191
6. Fusco FM, Pisaturo M, Iodice V, et al. COVID-19 among healthcare workers in a specialist infectious diseases setting in Naples, Southern Italy: results of a cross-sectional surveillance study. *J Hosp Infect*. 2020;105(4):596-600. doi:10.1016/j.jhin.2020.06.021
7. Jeremias A, Nguyen J, Levine J, et al. Prevalence of SARS-CoV-2 Infection Among Health Care Workers in a Tertiary Community Hospital. JAMA Intern Med. Published online August 11, 2020. doi:10.1001/jamainternmed.2020.421
8. Guiding principles to protect resident & fellow physicians responding to COVID-19. American Medical Association. https://www.ama-assn.org/delivering-care/public-health/guiding-principles-protect-resident-fellow-physicians-responding. Published 2020. Accessed November 23, 2020.

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