Concise Communication

Estimating severe acute respiratory coronavirus virus 2 (SARS-CoV-2) seroprevalence from residual clinical blood samples, January–March 2021

Daniel S. Gracia MD, MPH1, Hans P. Verkerke BS2, Jeannette Guarner MD2, Ana Maria Moldoveanu MPH1, Narayanaiah Cheedarla PhD2, Connie M. Arthur PhD3, Cheryl L. Maier MD, PhD2, Andrew Neish MD2, Sara C. Auld MD, MSc4, Angie Campbell MA5, Neel R. Gandhi MD1,5, John D. Roback MD, PhD2 and N. Sarita Shah MD, MPH1,5

1Division of Infectious Diseases, Department of Medicine, Emory University School of Medicine, Atlanta, Georgia, 2Department of Pathology & Laboratory Medicine, Emory University School of Medicine, Atlanta, Georgia, 3Department of Pathology, Brigham and Women’s Hospital, Harvard Medical School, Boston, Massachusetts, 4Division of Pulmonary, Allergy, Critical Care, and Sleep Medicine, Department of Medicine, Emory University School of Medicine, Atlanta, Georgia and 5Departments of Epidemiology and Global Health, Rollins School of Public Health, Emory University, Atlanta, Georgia

Abstract

We describe severe acute respiratory coronavirus virus 2 (SARS-CoV-2) IgG seroprevalence and antigenemia among patients at a medical center in January–March 2021 using residual clinical blood samples. The overall seroprevalences were 17% by infection and 16% by vaccination. Spent or residual samples are a feasible alternative for rapidly estimating seroprevalence or monitoring trends in infection and vaccination.

(Received 5 July 2022; accepted 23 August 2022)

Traditional serosurveys are time- and resource-intensive, making them challenging to conduct repeatedly in short periods to evaluate trends in seroprevalence.1 Spent or residual clinical blood samples, which are collected for clinical testing and then routinely discarded, provide an alternative method for conducting serosurveys and have been conducted on a large scale, particularly early in the coronavirus disease 2019 (COVID-19) pandemic.2 To understand population immunity to severe acute respiratory coronavirus virus 2 (SARS-CoV-2), however, serosurveys must differentiate individuals with infection and vaccine-induced immunity.3 After deployment of SARS-CoV-2 vaccines, individuals in a population may have detectable antibodies to the SARS-CoV-2 receptor binding domain (RBD) from either infection or vaccination. Spent samples offer a readily available source of specimens for testing of multiple targets such as antibodies to the RBD or nucleocapsid or, alternatively, SARS-CoV-2 antigens to identify prior infection, active infection, or vaccination. The objective of this study was to determine SARS-CoV-2 antibody prevalence and antigenemia in spent samples from an urban medical center during the initial stages of vaccine implementation.

Methods

Spent samples were collected weekly from January 22 to March 12, 2021, from the clinical laboratory of a medical center in Atlanta composed of a 500-bed hospital and multispecialty outpatient clinics. The clinical laboratory processed all blood specimens from inpatient and outpatient laboratory collection, including from medical-surgical wards, intensive care units, obstetrics units, the emergency department, and infusion centers. After processing, blood chemistry specimens were stored up to 5 days prior to being discarded. The same day weekly, a convenience sample of discarded specimens representing ~400 unique patients from that day was transported to the research laboratory for SARS-CoV-2 testing. Patient samples were matched to clinical data from the electronic medical record and assessed for both SARS-CoV-2 antigen and antibody. Antigenemia was assessed on the Quanterix platform by ultrasensitive quantitative immunoassay for SARS-CoV-2 nucleocapsid protein.4 SARS-CoV-2 RBD and nucleocapsid antibodies were detected by single-dilution serological assays that were developed and validated using pre-pandemic and polymerase chain reaction (PCR)-confirmed COVID-19 patient serum and plasma samples.5 ELISA optical density cutoffs for seroconversion were chosen using receiver

Author for correspondence: Daniel S. Gracia, MD, Woodruff Memorial Research Building, 101 Woodruff Circle, Suite 2101, Atlanta, GA 30322. E-mail: dsgracia@emory.edu

© The Author(s), 2022. Published by Cambridge University Press on behalf of The Society for Healthcare Epidemiology of America. This is an Open Access article, distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike licence (http://creativecommons.org/licenses/by-nc-sa/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the same Creative Commons licence is used to distribute the re-used or adapted article and the original article is properly cited. The written permission of Cambridge University Press must be obtained prior to any commercial use.
Among 2,406 samples collected, 1,186 (49%) originated from inpatient units, 586 (24%) originated from outpatient labs, 403 (17%) originated from the emergency department, and 231 (10%) originated from infusion centers. Matching with the medical record identified 2,132 unique patients: 55% were female; the median age was 58 years (IQR, 40–70); and 36% were aged >65 years. Also, 63% self-reported as Black or African American, 27% as white, and 3% as Hispanic or Latino. For this cohort overall, the median body mass index was 25 kg/m² and the median Elixhauser comorbidity index was 6. Clinical data indicated that 210 (9.9%) ever had SARS-CoV-2 detected by PCR and that 191 (9.9%) had received a COVID-19 vaccine within the health system.

Among 2,406 samples, 409 (17%, 95% confidence interval [CI], 15.5%–18.6%) had serologic evidence of natural infection and 390 (16%; 95% CI, 14.7%–17.7%) had evidence of vaccination without infection. These estimates were consistent when excluding resampled patients. Inpatients (21%) were more likely than patients from other settings to have evidence of infection (14% for outpatients, 11% for infusion center, 15% for emergency department, \( \chi^2 P < 0.001 \)). Outpatients (20%) and those in the infusion center (20%) were more likely to have evidence of vaccination (15% for inpatients, 12% for emergency department; \( P = 0.001 \)).

Seroprevalence and antigenemia were reported by week from January 22 to March 12 (Table 1 and Fig. 1). Over the sampling period, estimates of serologic evidence of vaccination varied but generally increased from 7.6% in January to 16% in March. Estimates of serologic evidence of infection ranged from 9.7% to 24%, and the prevalence of antigenemia, suggestive of current infection, gradually decreased from 18% to 4%.

### Results

Among 2,406 samples collected, 1,186 (49%) originated from inpatient units, 586 (24%) originated from outpatient labs, 403 (17%) originated from the emergency department, and 231 (10%) originated from infusion centers. Matching with the medical record identified 2,132 unique patients: 55% were female; the median age was 58 years (IQR, 40–70); and 36% were aged >65 years. Also, 63% self-reported as Black or African American, 27% as white, and 3% as Hispanic or Latino. For this cohort overall, the median body mass index was 25 kg/m² and the median Elixhauser comorbidity index was 6. Clinical data indicated that 210 (9.9%) ever had SARS-CoV-2 detected by PCR and that 191 (9.9%) had received a COVID-19 vaccine within the health system.

Among 2,406 samples, 409 (17%, 95% confidence interval [CI], 15.5%–18.6%) had serologic evidence of natural infection and 390 (16%; 95% CI, 14.7%–17.7%) had evidence of vaccination without infection. These estimates were consistent when excluding resampled patients. Inpatients (21%) were more likely than patients from other settings to have evidence of infection (14% for outpatients, 11% for infusion center, 15% for emergency department, \( \chi^2 P < 0.001 \)). Outpatients (20%) and those in the infusion center (20%) were more likely to have evidence of vaccination (15% for inpatients, 12% for emergency department; \( P = 0.001 \)).

Seroprevalence and antigenemia were reported by week from January 22 to March 12 (Table 1 and Fig. 1). Over the sampling period, estimates of serologic evidence of vaccination varied but generally increased from 7.6% in January to 16% in March. Estimates of serologic evidence of infection ranged from 9.7% to 24%, and the prevalence of antigenemia, suggestive of current infection, gradually decreased from 18% to 4%.

### Discussion

In this serosurvey, spent samples were used to estimate SARS-CoV-2 IgG seroprevalence from infection and vaccination as well as antigenemia among patients at a medical center early in the COVID-19 pandemic. Our study demonstrates that spent samples are a feasible alternative for obtaining a rapid estimate of seroprevalence or for monitoring trends in a population during periods of disease spread or vaccine implementation. As might be expected, the estimated IgG seroprevalence due to infection was more common in inpatients, whereas vaccination was more common in patients presenting to outpatient settings. The increasing prevalence of the vaccination signature likely reflects vaccine uptake early in the implementation of SARS-CoV-2 vaccines in the first months of 2021 as community vaccine coverage increased from ~5% to 20%. In contrast, the infection seroprevalence is fairly stable over the sampling period, consistent with IgG antibody remaining detectable for months after infection. This estimate of infection prevalence is comparable to CDC-reported laboratory surveillance estimates for Georgia during the study period (Table 1). A household-based survey from August to December 2020 estimated a seroprevalence of 7.8% (95% CI, 5.1–11.7) in the core Atlanta counties of Fulton and DeKalb. The higher estimate in our study likely reflects incident infections during the winter 2020–2021 surge.

Spent or residual samples represent a feasible alternative serosurvey sample method, particularly for obtaining repeated estimates over time in a defined population. As demonstrated by the analysis of antigenemia, the same samples can be used for multitarget surveillance, improving detection of acute infections. This rapidly available information could inform infection control practices at the healthcare facility or system level by capturing data from

### Table 1. Estimated Seroprevalence of SARS-CoV-2 IgG in Spent Samples From a Clinical Laboratory by Sampling Week and Comparison With CDC Laboratory Surveillance Estimates for the Preceding Week for the State of Georgia in January–March 2021

<table>
<thead>
<tr>
<th>Sampling Weeka</th>
<th>1 Jan 22 (N = 301)</th>
<th>2 Jan 29 (N = 338)</th>
<th>3 Feb 5 (N = 243)</th>
<th>4 Feb 12 (N = 336)</th>
<th>5 Feb 19 (N = 371)</th>
<th>6 Feb 26 (N = 291)</th>
<th>7 Mar 5 (N = 426)</th>
<th>8 Mar 12 (N = 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IgG RBD+ N+ (infected), no. (%)</td>
<td>57 (18.9)</td>
<td>81 (24.0)</td>
<td>34 (14.0)</td>
<td>61 (18.2)</td>
<td>36 (9.7)</td>
<td>39 (13.4)</td>
<td>84 (29.7)</td>
<td>17 (17.0)</td>
</tr>
<tr>
<td>CDC lab surveillance estimate, % (95% CI)</td>
<td>21.0 (18.0–24.1)</td>
<td>26.3 (23.0–29.8)</td>
<td>17.1 (14.9–19.6)</td>
<td>17.3 (14.9–19.9)</td>
<td>17.8 (15.4–20.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IgG RBD+, N-(vaccinated), no. (%)</td>
<td>23 (7.6)</td>
<td>15 (4.4)</td>
<td>20 (8.2)</td>
<td>32 (9.5)</td>
<td>110 (29.7)</td>
<td>93 (32.0)</td>
<td>81 (19.0)</td>
<td>16 (16.0)</td>
</tr>
</tbody>
</table>

Note. RBD, receptor binding domain; N, nucleocapsid; CDC, Centers for Disease Control and Prevention.

*aAverage of 4-day lag from date of blood sample draw from patient to date of collection for study.*
patients seeking care in both inpatient and outpatient settings without additional sample collection. This would be useful as a surveillance method both during periods of presumed low SARS-CoV-2 transmission, to potentially identify an increase in infections in the patient population, and during periods of influenza-like illness activity to target patient testing, care, and isolation resources. The spent sample approach could also be applied to public-health case-finding and vaccination activities, including monitoring for waning vaccine-induced antibody response in a vaccinated population. The limitations of this study include the convenience sampling method that yielded a varying number of unique patients per week, a study period before breakthrough infections were common, and a care setting distribution that may not reflect the actual distribution of patients seeking care at the medical center.

In conclusion, spent samples provide a feasible alternative for a rapid estimate of seroprevalence or for monitoring trends in infection and vaccination over time in a defined population. This approach has potential impactful applications for patient care, infection control, and public health to monitor epidemiologic changes as the COVID-19 pandemic persists.

Acknowledgments.

Financial support. This study was supported by an Emory University Woodruff Health Sciences Center CURE Award and by the National Institutes of Health (NIH) National Cancer Institute (grant no. 1U54CA260563-01). S.C.A. was supported by the National Institute of Allergy and Infectious Diseases (NIAID) grant no. K23AI134182. N.R.G. was supported in part by the NIAID (grant nos. K24AI114444 and P30AI168386).

Conflicts of interest. All authors report no conflicts of interest relevant to this article.

References