

# Large-Scale Implementation of a Daily Rapid Antigen Testing Program in California for Detecting SARS-CoV-2

Maria I. Ventura, PhD, Darci Delgado, PsyD, Susan Velasquez, PhD, Eric Foote, MD, Kathleen Jacobson, MD, Juan Carlos Arguello, DO, and Katherine Warburton, DO

**Objectives.** To evaluate a daily antigen testing program for health care personnel.

**Methods.** We examined antigen testing results between December 13, 2020, and April 30, 2021, from 5 forensic psychiatric inpatient hospitals throughout California.

**Results.** Among 471 023 antigen tests administered, 449 positives (0.0036% false positives) were detected.

**Conclusions.** Antigen tests had low false-positive rates, high positive predictive value, and high levels of acceptability, important characteristics when considering their application in the community.

**Public Health Implications.** Daily antigen testing was feasible and should be considered to reduce COVID-19 transmission. (*Am J Public Health.* 2022;112(3):467–471. <https://doi.org/10.2105/AJPH.2021.306588>)

The COVID-19 pandemic caused by severe acute respiratory syndrome coronavirus (SARS-CoV-2) has to date infected more than 171 million individuals worldwide, including 33 million in the United States.<sup>1</sup> Although vaccine efficacy is commended, those who cannot or choose not to be vaccinated remain at greatest risk for COVID-19. In this current pandemic phase, congregate settings such as nursing homes and schools rely on testing to reduce risk of infection in combination with masking, hand washing, physical distancing, and increased ventilation.<sup>2</sup>

Viral antigen tests, although less sensitive for detecting COVID-19 than polymerase chain reaction (PCR) tests, have a turnaround time of 15 to 30 minutes and can be conducted on site at low cost, providing significant implementation advantages. A single negative antigen test cannot conclusively rule out

SARS-CoV-2 infection<sup>3</sup>; however, use of repeated antigen testing has served as a response to practical and financial imperatives. PCR testing often has a turnaround time of 1 to 4 or more days, cannot be performed at the point of entry, and costs approximately 10 times more than antigen tests.<sup>2</sup>

Symptom screening at the point of entry has been used in an attempt to reduce transmission of SARS-CoV-2 within patient care settings by preventing infected workers from entering the building.<sup>4</sup> However, symptom screening has been relatively ineffective in preventing workplace transmission. There is some evidence that asymptomatic or presymptomatic individuals account for at least 50% of transmission events.<sup>5</sup> If health care professionals (HCPs) or teachers, for example, could be tested daily with results available before they interacted with patients or students,

they could be prevented from unintentionally infecting others.<sup>6,7</sup>

The California Department of State Hospitals has faced multiple outbreaks of COVID-19 since the beginning of the pandemic. The main goals of this study were to (1) describe our experience in implementing a daily rapid antigen testing program for all HCPs, (2) evaluate false-positive rates and the positive predictive value of antigen tests relative to PCR tests, and (3) assess the impact of daily testing on staff morale.

## METHODS

The Department of State Hospitals maintains 5 forensic psychiatric inpatient hospitals throughout California employing approximately 10 000 HCPs, with the majority providing direct patient care. In consultation with the

California Department of Public Health, the Department of State Hospitals implemented daily testing of all HCPs upon their arrival at the hospital with BinaxNOW rapid antigen tests<sup>8</sup> to reduce new COVID-19 infections and outbreaks. A train-the-trainer framework was used in which an initial small group of staff members completed an in-depth 2-hour training session on the BinaxNOW test kit, including didactics, video tutorials, and hands-on training. These trainers then served as subject matter experts and provided training to other HCPs to quickly allow for widespread, rapid implementation.

Broadly, 2 testing station layouts emerged: front entrance testing stations and on-unit testing stations. Front entrance stations were operated by 1 to 4 rapid antigen test screeners depending on timing of HCP arrivals throughout the day. Daily rapid antigen testing was mandatory for all direct-care HCPs, and refusals, although rare,

resulted in progressive discipline with the employee being sent home. Each HCP self-collected the anterior nares sample and followed the BinaxNOW package insert directions. On-unit stations were set up for hospitals that did not have grounds layouts or staffing resources conducive to large testing stations. In these facilities, 40 to 50 unit supervisors were responsible for conducting rapid antigen testing for their units at the beginnings of shifts at small screening stations. During the 15-minute test processing time, HCPs were instructed to begin shift duties but not engage with patients until their results were available.

If HCPs had a positive rapid antigen test result, they were instructed to complete a confirmatory PCR test within 48 hours of their positive antigen test. Positive predictive value was calculated by dividing the number of positive antigen tests confirmed as positive via PCR by the total number of positive

antigen tests with either a positive or a negative PCR.<sup>9</sup> We conducted  $\chi^2$  analyses to compare the number of observed versus expected positive antigen results within specific job classifications. Three months into the daily rapid antigen testing program, all participating HCPs were invited to complete a voluntary, anonymous electronic survey that asked about their level of satisfaction with the program.

## RESULTS

From December 13, 2020, through April 30, 2021, a total of 471 023 rapid antigen tests were administered to HCPs (Table 1). Approximately 24 000 rapid antigen tests were conducted per week, averaging 500 to 800 tests per day with fluctuations dependent on several factors including, but not limited to, size of facility, day of the week, and holidays.

There were 486 positive rapid antigen tests, and 96% (n = 466) of

**TABLE 1— Results of Rapid Antigen Testing: California Department of State Hospitals Facilities, December 13, 2020, to April 30, 2021**

	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5	Total
Total tests administered	79 378	94 756	79 498	105 665	111 726	471 023
Total negative antigen results	79 328	94 656	79 372	105 602	111 579	470 537
Total positive antigen results	50	100	126	63	147	486
Confirmatory PCR result						
Detected	47	93	119	56	134	449
Not detected	3	5	1	5	3	17
Missing	0	2	6	2	10	20
Positive predictive value, %	94.0	94.9	99.2	91.8	97.8	96.4
Average number of tests administered per day (range)	584 (103–845)	697 (55–1046)	585 (230–930)	777 (297–1171)	822 (316–1322)	3 463 (1 473–5 225)
Test reader job classification	Any shift supervisor or manager	Any supervisor	Psychiatric technician or registered nurse	Psychiatric technician or registered nurse	Registered nurse	

Note. PCR = polymerase chain reaction.

**TABLE 2— Job Classifications of Health Care Personnel Who Tested Positive for COVID-19 via Antigen Testing: California Department of State Hospitals Facilities, December 13, 2020, to April 30, 2021**

Job Classification	Frequency of Positive Rapid Antigen Test, No. (%)	Expected Frequency Based on Percentage in Workforce, No. (%)	$\chi^2$	Ratio Observed vs Expected
Psychiatric technician or senior psychiatric technician	258 (53)	146 (30)	86.34	1.77
Registered nurse or licensed vocational nurse	67 (14)	73 (15)	0.48	0.92
Hospital police officer	44 (9)	29 (6)	7.55	1.51
Janitorial/custodial staff	29 (6)	15 (3)	14.26	1.93
Mental health clinician <sup>a</sup>	25 (5)	34 (7)	2.39	0.74
Food service/cook	22 (5)	24 (5)	0.22	0.92
Other <sup>b</sup>	41 (8)	165 (34)	93.41	0.25
Total	486 (100)	486 (100)	204.66	

Note. Data reflect observed versus expected frequency of a positive rapid antigen test ( $n = 486$ ;  $df = 6$ ;  $P < .001$ ).

<sup>a</sup>Psychiatrist, psychologist, social worker, or rehabilitation therapist.

<sup>b</sup>Clerical staff member, groundskeeper, or manager.

individuals with a positive result completed a confirmatory PCR test within 48 hours. Of the 466 individuals with a confirmatory PCR, 449 were confirmed as being positive, representing 0.095% of all tests administered; only 17 false positives (0.0036%) were identified. Rapid antigen tests had an overall PCR positive predictive value of 96.4%.

Data on the presence of COVID-19 symptoms were captured for a subset of HCPs who tested positive ( $n = 404$ ), among whom 77% reported being asymptomatic at the time of antigen testing. Vaccination of HCPs began on December 26, 2020. Antigen testing identified 4 instances of vaccine breakthrough. These individuals were confirmed as positive via PCR after being fully vaccinated or 14 days or more after the second dose of an mRNA vaccine.<sup>10</sup>

The distribution of observed COVID-19 positive antigen tests among job classifications was found to be significantly different than what would be expected given the workforce

compilation ( $\chi^2 = 204.66$ ,  $df = 6$ ;  $P < .001$ ; Table 2). Janitorial and custodial staff, psychiatric technicians, and hospital police officers were 1.93, 1.77, and 1.51 times more likely, respectively, to contract COVID-19 on the basis of their workforce prevalence.

When surveyed about their experience, 78% of HCP respondents reported feeling satisfied with daily antigen testing, 65% felt safer overall with daily testing, 57% appreciated not having to wait for days to receive their PCR results, and 51% felt more comfortable working in close proximity to hospital coworkers. Daily antigen testing also appeared to affect employees' broader quality of life, as 71% reported feeling safer at home with daily testing. There were some drawbacks: 20% of respondents indicated that daily rapid antigen testing required too much time each day, 14% worried about privacy related to their test result, and 10% indicated that they would be embarrassed if they tested positive.

## DISCUSSION

To our knowledge, our study represents the largest implementation of a daily antigen testing program in the United States to date, with 471 023 rapid antigen tests administered in a 4-month period. The antigen testing program identified 449 individuals with COVID-19 who would have otherwise interacted with other people in the workplace, potentially infecting patients and coworkers.

Approximately 77% of those who tested positive via antigen testing were asymptomatic, and 4 asymptomatic vaccine breakthroughs were detected. Although we did not collect presymptom and postsymptom data on all HCPs with positive antigen test results, this high percentage still highlights the crucial role of asymptomatic testing in reducing the spread of COVID-19 within high-risk congregate settings. Self-reported symptom screening would have been insufficient to prevent these infected HCPs from going to work. Our

findings add to a body of work demonstrating the utility of regular rapid antigen testing<sup>11–13</sup> in augmenting existing infection control practices to prevent infected individuals (in this case, the majority of whom were asymptomatic) from attending work and spreading COVID-19 to patients and other staff.

The low false-positive rate and high positive predictive value of antigen tests was invaluable because hospitals did not have to send home staff who were otherwise healthy. A higher false-positive rate could have presented problems in maintaining staffing during the surge. For symptomatic individuals, the BinaxNOW antigen test has been shown to have 64.2% sensitivity, 100% specificity, 100% positive predictive value, and 91.2% negative predictive value; among asymptomatic individuals, the corresponding percentages are 35.8%, 99.8%, 91.7%, and 96.9%.<sup>14</sup>

We identified some pros and cons in terms of the different testing strategies implemented. With on-unit testing stations, test administrators became experts owing to the large quantities of rapid antigen tests they performed on a daily basis. However, because staff were tested on units, there was still potential unit exposure. Front entrance stations, by contrast, prevented staff from entering hospital grounds in the first place because they were tested at the point of entry. However, this testing set-up required staff to be pulled from their regular duties to operate the testing stations. In addition, the cost of daily rapid antigen tests is a consideration. Regardless of the testing station set-up, quick removal of HCPs from the workplace avoided extensive costly quarantine protocols.

We found little variation in false positives despite different implementation protocols across sites, highlighting the

ease of use of rapid antigen tests with basic training. There was also evidence in our sample of a disproportionate prevalence of COVID-19 infections within certain job classifications, namely essential workers whose job duties precluded them from engaging in telework during the pandemic.

Our results show that widespread use of frequent testing can keep essential workers safe in the workplace. HCPs were overwhelmingly satisfied with the daily rapid antigen testing program, and the program improved feelings of safety for employees and their families. Our findings have significant implications for future interventions seeking to increase safety and boost morale among frontline HCPs during a pandemic.

## PUBLIC HEALTH SIGNIFICANCE

A large-scale daily rapid antigen testing program was successfully implemented in which almost half a million tests were administered with low false-positive rates and high positive predictive value. The results of our study can inform future rapid antigen testing in multiple settings. Our work contributes to the growing body of literature supporting the use of rapid antigen tests as a pre-entry screen to reduce the number of mostly asymptomatic infected individuals entering the workplace while not falsely identifying healthy individuals as infected.<sup>9–11</sup>

Many workplaces such as schools, prisons, jails, and hospital settings are currently struggling with a mixed group of vaccinated and unvaccinated staff. Although a stand-alone antigen test cannot be used to rule out a SARS-CoV-2 infection,<sup>3</sup> frequent rapid antigen testing has the potential to provide

another layer of COVID-19 safety for essential workers such as teachers, law enforcement personnel, janitorial and food service workers, and health care professionals. We encourage policy-makers and administrators in congregate settings to strongly consider using rapid antigen testing at the highest frequency possible (2–3 times per week or daily if resources allow) to screen large populations of individuals for SARS-CoV-2 as a means of preventing the introduction and spread of COVID-19, especially with increased transmission of the Delta and Omicron variants and rising case rates among unvaccinated and vaccinated individuals alike. **AJPH**

## ABOUT THE AUTHORS

Maria I. Ventura is with the Department of Psychiatry and Behavioral Sciences University of California, Davis. Darci Delgado, Susan Velasquez, Juan Carlos Arguello, and Katherine Warburton are with the Clinical Operations Division, California Department of State Hospitals, Sacramento. Eric Foote and Kathleen Jacobson are with the California Department of Public Health, Sacramento.

## CORRESPONDENCE

Correspondence should be sent to Maria I. Ventura, PhD, 1215 O St, Sacramento, CA 95814 (e-mail: maria.ventura@dsh.ca.gov). Reprints can be ordered at <http://www.ajph.org> by clicking the "Reprints" link.

## PUBLICATION INFORMATION

Full Citation: Ventura MI, Delgado D, Velasquez S, et al. Large-scale implementation of a daily rapid antigen testing program in California for detecting SARS-CoV-2. *Am J Public Health*. 2022;112(3):467–471.

Acceptance date: October 6, 2021.

DOI: <https://doi.org/10.2105/AJPH.2021.306588>

## CONTRIBUTORS

M. I. Ventura and D. Delgado made substantial contributions to conception and design, analysis and interpretation of data, and drafting and revision of content. S. Velasquez and J. C. Arguello made substantial contributions to conception and design. E. Foote made substantial contributions to analysis and interpretation of data and revision of content. K. Jacobson made substantial contributions to interpretation of data and revision of content. K. Warburton made substantial contributions to conception and review of content.

## ACKNOWLEDGMENTS

The findings and conclusions are those of the authors and do not necessarily represent the view or opinions of the California Department of State Hospitals or the California Health and Human Services Agency.

## CONFLICTS OF INTEREST

The authors report no conflicts of interest.

## HUMAN PARTICIPANT PROTECTION

This research was approved by the California Committee for the Protection of Human Subjects (project 2021-048). This project has an active institutional review board-approved waiver of informed consent. Obtaining informed consent was not possible. The project was initiated as part of an emergent public health response to the COVID-19 pandemic.

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ISBN: 978-0-87553-303-2  
2019, Softcover  
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