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Diversification of COVID-19 Testing Resources to Decrease Racial/Ethnic Disparities: Comparative Use of Adaptive Approaches to Community Testing Across an Integrated Healthcare System

Jennifer S. Priem [a,*], Lisa M. Krinner [a], S. Tyler Constantine [b], Lewis McCurdy [c]

[a] Center for Outcomes Research and Evaluation (CORE), Atrium Health, Charlotte, NC, USA
[b] Department of Emergency Medicine, Atrium Health's Carolinas Medical Center, Charlotte, NC, USA
[c] Department of Medicine, Division of Infectious Diseases, Atrium Health, Charlotte, NC, USA

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ABSTRACT

Background: Access to SARS-CoV-2 testing is a crucial component of early identification and disease containment. Racial and ethnic health disparities exist related to testing utilization. To optimize testing with limited resources, Atrium Health developed free-standing and roving testing centers outside of the traditional clinical settings in hopes of meeting the needs of a diverse urban community. The objective of this study is to evaluate differences in testing site utilization based on demographic factors, particularly race/ethnicity.
Methods:A cohort study of patients tested for COVID-19 between March 10 and October 26, 2020, within the Atrium Health system.
Results: 128,258 persons under investigation (PUIs) were tested across our health system, including 25,434 patients at our Mobile Integrated Health (previously called Community Paramedicine) drive-thru testing sites and community roving testing units. PUIs were on average 47 years old (SD = 17.7); approximately half were female and White/Caucasian. Drive-thru testing sites were utilized proportionally more by non-Hispanic Whites and African Americans, and less by Hispanic PUIs. Roving testing units were used significantly more by younger PUIs, Hispanics, and PUIs of other races/ethnicities.
Conclusions: Diversification in testing site locations optimized testing resources, allowed for significant reduction in the burden of patient volumes, and avoided alteration of workflow in our urgent care facilities and Emergency Departments. Additionally, roving testing units may help to decrease racial/ethnic disparities in access to COVID-19 testing. Our results highlight the importance of offering a variety of testing modalities to reach different populations.

COVID-19, the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) poses a major global public health threat.[1,2] Limited testing availability has been identified as a barrier to early identification and containment of the COVID-19 pandemic worldwide and within the United States. As the pandemic continues, the lack of COVID-19 testing access inhibits the ability to contain outbreaks, identify new variants, and monitor vaccine effectiveness, especially in vulnerable communities where baseline testing rates are low.[3] The ability to direct testing for high risk, symptomatic individuals in an efficient, safe manner is critical to optimize the testing that is available given the limited resources. Multiple strategies have been developed to address the need for testing, including targeted testing at Emergency Departments (EDs), screening centers, drive-up testing sites, and mobile community units.[4-10]

At the same time, various cities and states have observed racial/ethnic disparities in COVID-19 testing.[4-10] For example, African Americans are six times less likely to be tested than White individuals, due to a confluence of barriers including access to testing resources and mistrust in healthcare.[11] Accordingly, equity experts have stressed the importance of developing strategies to decrease racial/ethnic health disparities related to COVID-19 testing, treatment, and mortality.[12] In addition to increasing equitable deployment of resources, strategies need to address how to continue to meet the needs of non-COVID-19 patients and address a large influx of patients in EDs related to COVID-19, while augmenting containment strategies to reduce the likelihood of disease transmission.

In response to the increased need for improved hospital resource utilization and safety of both healthcare workers and patients who access care, Atrium Health (AH) established a process for virtual COVID-19 community screening, combined with drive-thru testing centers outside of the traditional clinical settings supported by our Mobile Integrated Health Program (MIH, previous called Community Paramedicine), and roving testing units

* Corresponding author at: 1300 Scott Avenue Charlotte, NC 28209.
E-mail address: Jennifer.Priem@atriumhealth.org (J.S. Priem).

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deployed to community-based sites located in COVID-19 hotspots and vulnerable communities.

In this paper, we evaluate the utilization of diversified testing sites comparing COVID-19 specific testing sites to traditional care facilities for individuals with COVID-related symptoms (henceforth labeled as persons under investigation (PUIs)). Our primary objective was to determine if there are testing site selection differences based on patient demographics, specifically evaluating age, sex, and race/ethnicity. Understanding differences in testing site utilization may inform strategies for improved implementation and access to virtual screening and free-standing testing sites. Insights gained will be useful for decision-making about offering testing modalities in areas with different racial/ethnic distributions to decrease racial/ethnic disparities in COVID-19 testing. Understanding testing site utilization is crucial in detecting disease early and reducing utilization of traditional medical care sites, such as EDs, for testing.

Methods

Setting

Atrium Health is the largest integrated health system in the Carolinas with 11 acute care hospitals, two behavioral health centers, four acute rehabilitation facilities, five skilled nursing facilities, and more than 500 outpatient clinics in the Charlotte, NC metropolitan area. Across the health system, approximately 57% of patients identify as female, 19% African American, and 70% non-Hispanic White. The payor mix is 16% Medicare, 15% Medicaid, 49% commercial, and 20% self-pay.

External Drive-Thru Testing Sites

Even though ED visits declined overall in the early stages of the pandemic, infectious disease-related visits were four times higher than other reasons for ED visits.[13] To diffuse the high proportion of COVID-19 related ED visits, AH established a system of ambulatory COVID-19 testing sited in March 2020. As part of this effort, AH established a dedicated COVID-19 hotline to support community members by linking callers to a virtual care platform to screen them for COVID-19 and schedule testing. All ambulatory patients across the healthcare system with concerns for COVID-19 symptoms were directed to the hotline. Daily systemwide PUI criteria were based on CDC guidelines set by the Infectious Diseases team. The hotline nursing staff reviewed each patient's symptoms and directed them to testing if they met the PUI criteria for the day. If patients did not meet the daily criteria, PUIs received consultation with the Infectious Diseases team for testing approval when appropriate.

All patients approved for testing were referred to a drive-thru testing site. Starting on March 11, AH opened the first free-standing drive-thru pop-up testing site.[14] The testing site was intentionally established to be geographically separate from any existing AH facility and was set up by MIH program staff. The site was supported by a team of three nurses, 1 virtual provider, and 1 registration employee, and was open for about 6 hours per day, 7 days a week (with hours increasing to meet testing demand). This initial site was established central to the footprint in Charlotte, NC. Over the following three weeks, additional clinics were set up at five other geographically distinct areas (see Fig. 1 for locations). COVID-19 testing was conducted using in-house testing with a WHO assay specific for the RdRP gene of SARS-CoV-2 (starting on March 9th), and subsequently, on March 17. Additional testing with a Roche Cobas® nasopharyngeal PCR for SARS-CoV-2 began (Roche Diagnostics, Indianapolis, IN) (See Fig. 2).

Roving Testing Units

AH system data indicated that residents in the most vulnerable areas were suffering disproportionate COVID-19 disease burdens while having lower testing rates. Starting in May 2020, AH deployed roving testing units in addition to drive-thru testing sites. The roving COVID-19 testing units began with two buses that drove to target communities and provided walk-up testing, and later vaccination. Locations were strategically chosen based on the ongoing evaluation of COVID-19 hotspots. Testing schedules for the communities were posted online. The program was designed to overcome as many of the barriers to access and uptake as possible. Community members did not need to make an appointment or show identification. In addition, insurance was not required, and testing/vaccination services

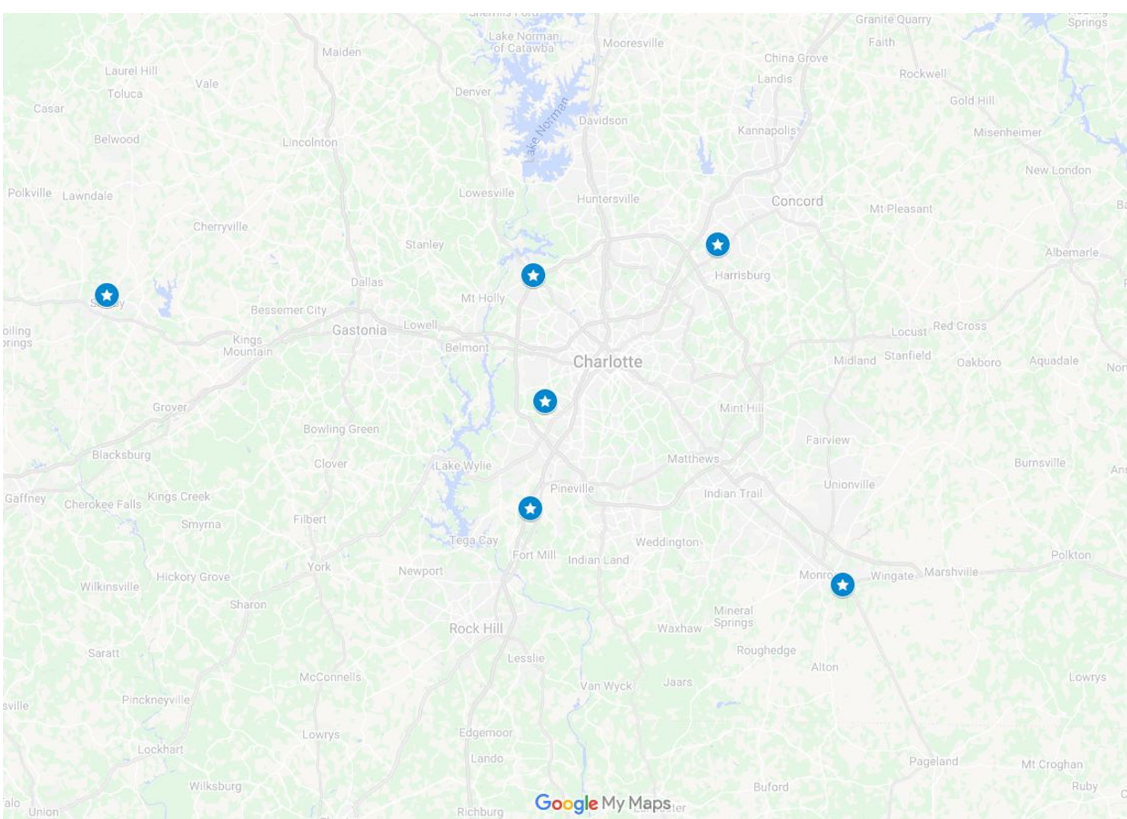

Fig. 1. Location of Drive-Through Testing Sites.

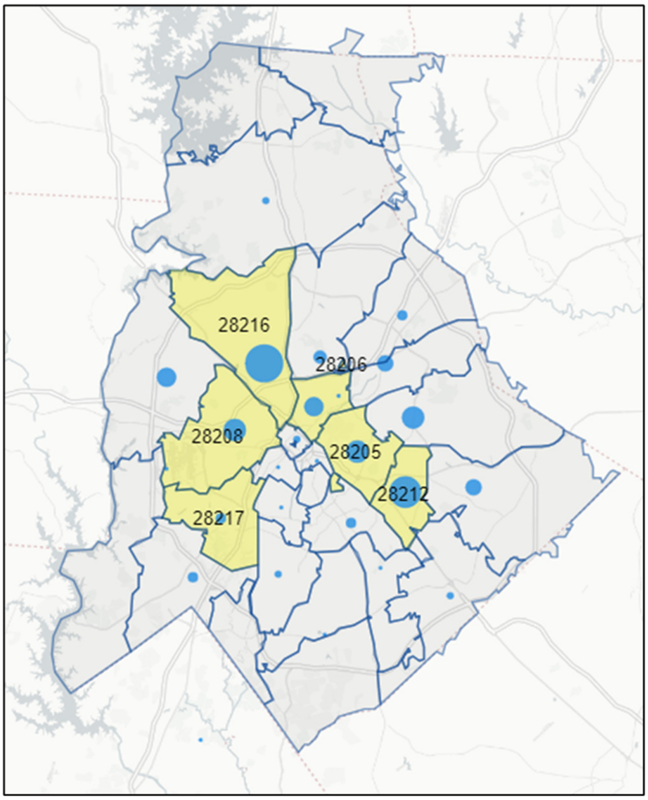

Fig. 2. Distribution of Mobile Testing Events within and outside High Health Priority Areas in Mecklenburg County, N.C. legend. Areas identified through hot-spot mapping of high vulnerability within the greater Charlotte Mecklenburg North Carolina area.

were free for uninsured residents. These measures helped increase utilization in hesitant residents who did not have health insurance or a primary care provider. The roving unit team included Spanish speaking staff to facilitate communication and connection. As part of the marketing for the program, community members were told that immigration status will never be shared, and undocumented patients will not be reported. Upon arrival, community members were screened for COVID-19 symptoms and those who screened positive were tested on the spot. Test results were delivered via text or phone call with follow-up instructions for care when needed.

Sample

The study cohort includes PUIs tested for COVID-19 at EDs, urgent care facilities, drive-thru testing sites, and roving testing units within the AH system between March 10 and October 26, 2020. All patients tested for SARS-CoV-2 were tracked in a prospective registry linked with the health system's electronic medical record (EMR), which was IRB approved for research use and included a waiver of informed consent. Because the focus of the study was on utilization of testing sites, patients who did not have a choice in testing location, including those tested in rehabilitation or skilled nursing facilities, patients who were tested after being admitted for an inpatient stay, and AH employees were excluded from analyses.

Data Analysis

All COVID-19 test orders, date and time of test order and admission, and patient demographics were collected from the EMR. Patient comorbidities were identified in a 3-year EMR look-back for diagnosis codes related to the target comorbidities; conditions were chosen based on their relevance to COVID-19 risk. We compared testing site utilization for the drive-thru testing sites and roving testing units to utilization of urgent care facilities and EDs within the AH system. To compare average age among testing sites, we used One-way Analysis of Variance with Games-Howell post-hoc tests. Distributions of sex, race/ethnicity, and SARS-CoV-2 test results by testing site were analyzed using separate Chi-Square Fishers Exact tests; the *p*-values reported are for the overall Fishers test. Proportional differences within each testing site were tested using *z*-tests with Bonferroni *p*-value adjustments. Data were analyzed using IBM SPSS Statistics for Windows, version 27 (IBM Corp., Armonk, N.Y., USA).

Results

A total of 128,258 COVID-19 tests were conducted at all four testing sites between March 10 and October 26, 2020.

Testing Site Utilization

To assess the potential of drive-thru and roving testing sites in reducing the number of COVID-19 related ED visits, we examined the proportion of SARS-CoV-2 tests at each testing location using Chi-squared Fisher's Exact tests. Comparing the different testing sites, 46% of tests were conducted at the free-standing drive-thru testing sites and 20% at roving testing units. Of the remaining tests, 14% were conducted at an ED and 20% were at urgent care facilities (see Table 1). Of the 128,258 tests conducted, 10.3% were positive. The proportion of positive tests was highest when PUIs were tested in the ED, and lowest when PUIs were tested at drive-thru testing sites compared to other testing sites (see Table 1).

Differences in Testing Site Utilization based on Demographic Factors

PUIs demographic characteristics by testing site are shown in Table 2. PUIs were on average 47 years old (SD = 17.6). Approximately half of the PUIs were female (55.5%). Most PUIs were White/Caucasian (55%) or Black/African American (23%). The age of PUIs differed significantly by testing site with older PUIs presenting to drive-thru testing sites (average 51 years), and younger individuals using mobile testing sites (average 42 years). Females did not preferentially use drive-thru testing sites compared to EDs (56% vs. 55%) or roving testing units (56% vs. 53%), while significantly more males used roving testing units compared to all other testing sites ($p < .001$; Table 2).

Race and ethnicity played a distinct role in testing site utilization. Non-Hispanic Whites chose urgent care facilities most frequently (69%) and roving testing units least frequently (24%). African American PUIs had significantly higher utilization of EDs (37%), and lowest utilization for urgent care facilities (19%; $p<.001$). Hispanics differed from both groups in the proportion of testing site utilization, with a significantly higher proportion of tests being conducted in roving testing units (44.1%) compared to all other testing sites. PUIs of other race/ethnicity also used roving testing units significantly more than all other testing sites, with lowest utilization for EDs.

Table 2 also presents common comorbidities among the PUIs. Almost one-third of the PUIs had hypertension and 15% had diabetes. PUIs with asthma and pregnant PUIs were more likely to be tested at the ED, whereas PUIs with cancer, chronic heart failure, chronic kidney disease, diabetes, and hypertension were significantly more likely to use drive-thru testing sites. PUIs with comorbidities were generally less likely to use roving units for testing.

Discussion

Since the early identification of the SARS-CoV-2 virus, testing has been emphasized as paramount to the identification of infected persons and the control of viral spread. One of the challenges has been the ability to test large populations with increased disease prevalence, and secondly, to assure safe and easy accessibility to rapid testing. At our institution, we were successful in deploying free-standing drive-thru testing sites supported by MIH. These sites are physically distinct from any existing medical facility and allow for direct scheduling of PUIs to these sites instead of to traditional care sites. In addition, roving testing units provided a similar external option, but without the need to schedule an appointment or provide proof of insurance. Whereas the drive-thru testing sites were identified early in the pandemic in a fixed location, the roving testing units moved throughout the community based on COVID-19 hotspots and social vulnerability of communities.[10] These efforts helped to reduce exposure of our

Table 1
Proportion of Positive COVID-19 Test Results by Testing Site.

	All Testing Sites (n = 128,258)	Emergency Department (n = 18,062)	Drive-thru Testing Sites (n = 58,682)	Urgent Care (n = 26,107)	Roving Testing Units (n = 25,434)	*p*-value
		n (%)				
Positive COVID-19 Test Results	13,212 (10.3)	2,016 (15.3)$_a$	1,121 (2.6)$_b$	860 (4.4)$_c$	2,000 (10.4)$_d$	< .001

Percentages that do not share a subscript differ by $p < .05$.

Table 2
Patient Demographics and Health Characteristics by Testing Site.

	All Testing Sites (n = 128,258)	Emergency Department (n = 18,062)	Drive-thru Testing Sites (n = 58,682)	Urgent Care (n = 26,107)	Roving Testing Units (n = 25,434)	*p*-value
	n (%)					
Age in Years– Mean (SD)	46.9 (17.7)	43.6 (17.6)	50.9 (17.6)	45.0 (17.8)	41.9 (16.0)	<.001
Median (IQR)	48.6 (16.2)	45.3 (16.4)	53.7 (17.2)	47.8 (17.2)	42.3 (15.5)	
Sex						
Male	57,035 (44.5)	8,115 (44.9)$_a$	25,468 (43.4)$_b$	11,416 (43.7)$_{a,b}$	12,036 (47.3)$_c$	<.001
Female	71,223 (55.5)	9,944 (55.1)$_a$	33,200 (56.6)$_b$	14.687 (56.3)$_{a,b}$	13,392 (52.7)$_c$	
Race/Ethnicity*						
White/Caucasian	70,060 (55.4)	8,658 (47.9)$_a$	38,342 (65.3)$_b$	18,002 (69.0)$_c$	6,058 (23.8)$_d$	<.001
Black/African American	29,679 (23.1)	6,617 (36.6)$_a$	12,350 (21.0)$_b$	4858 (18.6)$_c$	5,854 (23.0)$_d$	
Hispanic/Latinx	18,396 (14.3)	2,000 (11.1)$_a$	3,400 (5.8)$_b$	1,770 (6.8)$_c$	11,226 (44.1)$_d$	
Other Race/Ethnicity	9,150 (7.1)	787 (4.4)$_a$	4,590 (7.8)$_b$	1,477 (5.7)$_c$	2,296 (9.0)$_d$	
Comorbidities*						
Asthma	10,551 (8.2)	2,294 (217)$_a$	5,554 (52.6)$_b$	1,747 (16.6)$_c$	956 (9.1)$_d$	<.001
Cancer	10,380 (8.1)	748 (7.2)$_a$	7,757 (74.7)$_b$	1,347 (13.0)$_c$	528 (5.1)$_d$	<.001
Chronic Heart Failure	6,857 (5.3)	1,240 (18.1)$_a$	4,448 (64.9)$_b$	801 (11.7)$_c$	368 (5.4)$_d$	<.001
Chronic Kidney Disease	5,283 (4.1)	886 (16.8)$_a$	3,360 (63.6)$_b$	631 (11.9)$_c$	406 (7.7)$_d$	<.001
Diabetes	19,873 (15.5)	3,276 (16.5)$_a$	11,509 (57.9)$_b$	3,108 (15.6)$_c$	1,980 (10.0)$_d$	<.001
Hypertension	38,074 (29.7)	5,789 (15.2)$_a$	22,287 (58.5)$_b$	6,272 (16.5)$_c$	3,726 (9.8)$_d$	<.001
Pregnancy	3,374 (2.6)	624 (18.5)$_a$	1,459 (43.2)$_{b,c}$	607 (18.0)$_c$	684 (20.3)$_b$	<.001

Notes: To compare average age among testing sites, we used One-way Analysis of Variance and Games-Howell post hoc tests. Distributions of sex, race/ethnicity, and SARS-CoV-2 test results by testing site were analyzed using separate Chi-Square Fishers Exact tests; the *p*-values reported are for the overall Fishers test. Proportional differences within each column were tested using *z*-tests with Bonferroni *p*-value adjustments. Percentages that do not share a subscript differ by $p < .05$.

* Race/ethnicity proportions are presented as column proportions, comorbidities are presented as row proportions.

staff and other patients, and to preserve PPE resources through consolidated testing. Patient comorbidity information provides preliminary evidence that diversification of testing options for COVID-19 may have protected at-risk patients from unnecessary exposure and transmission in the ED, as well as ED staff. Future research should further examine the impact of pandemic care diversity on transmission and outcomes.

We were able to test 128,258 patients across our health system including 25,682 patients at our drive-thru sites and 25,434 patients at roving testing units. This amounts to 51,116 patients who might have otherwise used traditional care locations where transmission risks were high, or might have avoided testing altogether due to concerns and barriers limiting healthcare utilization. Redirecting these patients allowed for a significant reduction in the burden of patient volumes and avoided alteration of workflow in our urgent care facilities and EDs. Our study is the first to compare testing site utilization and demographic differences in testing site utilization from COVID-19 specific drive-thru and roving testing sites across a large integrated healthcare system with a large geographic footprint.

Understanding Outcomes

Our process to utilize directed testing via virtual screening at free-standing testing sites provided an effective testing mechanism for PUIs. The proportion of test positivity was lowest at our drive-thru testing sites (2.6%) compared to the EDs (15.3%). This suggests that the screening process for drive-thru testing sites was successful at identifying patients' COVID-19 symptoms and allowed optimization of testing resources in a safe and efficient process. Overall, by diversifying testing options, patients could be tested in the most appropriate place for their specific needs and without over-burdening urgent cares and EDs.

Understanding Utilization

Drive-thru testing sites were set up in areas distinct from established healthcare facilities to better facilitate testing and improve access; however, we identified that more minorities were tested in the ED and urgent care settings compared to drive-thru testing sites. The racial and ethnic makeup of drive-thru testing sites was 65% non-Hispanic White, 21% African American, and 6% Hispanic, while the racial composition of tests conducted in the ED was 48% non-Hispanic White, 37% African American, and 11% Hispanic. The racial/ethnic makeup of the Charlotte area (based on the 2019 U.S. Census)[15] was 45% non-Hispanic white, 35% African American, and 13% Hispanic. The racial/ethnic testing site distribution in our sample suggests that while drive-thru testing sites are a benefit to offload testing in traditional healthcare settings, utilization was disproportionate in the minority communities and underutilized by the population with reported higher disease burden (data not shown in a table).

There may be several factors that impact this observation including the ability to contact the COVID-19 hotline and navigate the scheduling process. The hotline was publicly distributed but not widely advertised, and most accessed through referral from primary care or other institutional portals. It is possible those who sought testing preferentially in the ED lacked access to primary care or had insufficient information about drive-thru and roving testing sites. Since testing in the urgent care or ED did not require prior screening, presenting directly to a traditional care site may be preferred for these identified groups. In addition, individuals who were screened via the hotline or a primary care physician were directed to a drive-thru testing site based on symptom severity; it is possible that symptoms at the time of screening were greatest in the older population, males, and minorities, and therefore they were directed directly to the ED for more immediate clinical evaluation. Lastly, the location of testing sites relative to demographic densities and transportation insecurity may have played a role in testing site utilization. Similar to the rest of the U.S.,[16] the majority of COVID-19 infections in our healthcare system are in the African American and other minority populations as well as the elderly, which were both underrepresented in our drive-thru testing sites. Consideration for optimal placement of free-standing drive-thru testing to better meet the demographics of the disease is necessary to optimize early access to testing and potentially improve overall outcomes.

In line with this, AH began deploying roving testing units to COVID-19 hotspots in areas of lower socioeconomic status to improve testing access. Consistent with previous research[9-10], results for our roving testing sites suggest that units deployed directly into areas with a higher proportion of minority populations can specifically address racial/ethnic disparities, especially for Hispanic/Latinx populations and patients of other races/ethnicities. Roving health units can help underserved communities overcome common barriers to accessing healthcare, including time, geography, and trust.[17] By providing community-based access for hard-to-reach populations, a mobile health strategy is integral to advancing health equity. This is especially relevant in the context of COVID-19 which has disproportionately impacted communities of color and lower socioeconomic status.[18] Taken together, our results further reinforce the need for a multi-faceted approach to testing equity, such as what was employed by AH, rather than a one-size-fits-all approach.

This study has a few caveats. We only had data for testing conducted within the AH system and can therefore not report on if other traditional testing sites were utilized by our patients. As research has shown, males and African Americans have been disproportionally impacted by COVID-19 with more detrimental outcomes including hospitalization, requiring an ICU stay or mechanical ventilation, and mortality.[19,20] It is possible that African Americans were tested in the ED more often because they also suffered from more severe illness or comorbidities.[21] Future research should assess the clinical factors that may influence testing site choices, further define barriers to testing for racial/ethnic minorities and elderly patients, and the evaluate clinical outcomes for those testing positive based on utilization of each testing site.

Conclusions

We used a community COVID hotline to provide standardized screening across our wide health system footprint to target testing and optimize our testing resources to suit the needs of patients. Overall, our results show that the creation of drive-thru and roving testing sites was an effective strategy for offsetting the demand on EDs for COVID-19 testing. These testing sites provide alternative testing options for high-risk patients who do not require immediate care, and help in decreasing racial/ethnic disparities in access to COVID-19 testing. Our results highlight the importance of offering a variety of testing modalities to reach different populations. Although the testing sites varied in the makeup of PUIs that utilized them, both similarities and differences uncovered in this study may inform strategies for future outbreaks and help to employ the flexible and agile use of non-traditional staffing models and sites for screening and testing.

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1All authors made a significant contribution to the manuscript, reviewed, and approved the manuscript prior to submission. LM, JP, and LK drafted and revised the introduction, methods, and discussion; JP and LK drafted the results and conducted all statistical analyses; TC performed critical revision of the manuscript for important intellectual content. The manuscript is not under review and has not been submitted to any other journal.

Declaration of Interest Statement

The authors have no conflicts of interest to report and are not funded by any external grants. The study was conducted under IRB approved protocol for COVID-19 research that included all persons who had test performed for COVID-19 PCR. The design of the study allowed for retrospective analysis of testing outcomes, conformed to standards set out by IRB, and included a waiver of informed consent.

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