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Unbiased care, unequal outcomes: a nursing telehealth intervention reveals systematic inequities in COVID-19 care delivery

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Abstract

Background The Covid Connected Care Center (C4), a low-barrier telephone nurse hotline, was developed at an academic medical center to increase access to healthcare information and services across the state of Oregon, including to those without a usual source of care. Other studies have demonstrated that telephone triage services can positively influence health behaviors, but it is not known how this effect is maintained across racial/ethnic groups. The objective of this study was to show that the C4 reached throughout the state of Oregon, was valuable to callers, and that recommendations given affected callers' subsequent health-related behaviors.

Methods This mixed-methods study, informed by the RE-AIM (Reach, Effectiveness, Adoption, Implementation and Maintenance) framework, assessed caller demographics and clinical care from March 30 2020 until September 8, 2021. Descriptive statistics, multivariable risk models and Zou's modified Poisson modeling were applied to electronic health record and call system data; An inductive approach was used for patient and staff experience surveys and semi-structured interviews. Approval was obtained from the OHSU Institutional Review Board (Study 00021413).

Results 145,537 telephone calls and 92,100 text-based contacts (61% and 39%, respectively) were included. Callers tended to not have a usual source of primary care and utilized recommended services. Emergency department utilization was minimal (1.5%). Racial or ethnic disparities were not detected in the recommendations, but Black (RR 0.92, CI 0.86–0.98) and Multiracial (RR 0.90 CI 0.81–0.99) callers were less likely than non-Hispanic white callers to receive a COVID-19 test. Participants in the post-call survey ($n=50$) would recommend this service to friends or family. Interviews with callers ($n=9$) revealed this was because they valued assistance translating general recommendations into a personalized care plan. C4 staff interviewed ($n=9$) valued the opportunity to serve the public. The C4 was a trusted resource to the public and reached the intended audiences. However, disparities in access to COVID-19 testing persisted.

Conclusions Nursing triage hotlines can guide caller behavior and be an effective part of a robust public health information infrastructure.

Keywords Nurse triage, Telehealth, COVID-19, Health Equity

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Background

The Covid Connected Care Center (C4) [1], a low-barrier telephone nurse hotline, was developed in March 2020 at Oregon Health & Science University (OHSU) to increase access to healthcare information and services for systematically harmed groups who face significant obstacles to health information and care. This study evaluates the C4's success in providing both established patients and those disconnected from the health system access to COVID-related care, while reducing unnecessary utilization of primary care and the emergency department. The C4 was advertised to the public via the county public health department, social service agencies and the OHSU website. People called the C4 directly or were transferred from a clinic via an automated voice-messaging system. Callers could receive text-based messages regarding lab results through the OHSU patient portal.

Prior studies show that a telephone triage service can positively influence health behaviors [2, 3] and numerous studies document COVID-specific hotlines [1, 4–15] but none disaggregate data by race/ethnicity, leaving open the question of whether a nurse triage hotline can mitigate health disparities. This is important because the reliable health information provided by nurses could potentially combat dangerous misinformation [16], especially among racial and ethnic minorities who are targeted by those messages as well as the growing number of people without a usual source of care [17].

We know that misinformation has proliferated and can lead to maladaptive behaviors, [18, 19] increased psychological stress [19] and an erosion of trust in healthcare professionals [20]. During the pandemic, misinformation targeted Black people, [21] who were also more than twice as likely to die from COVID-19 in the United States [22]. Meanwhile, patients without a usual source of care have worse baseline chronic disease control, higher rates of ED and hospitalization use, and are more likely to be Hispanic or Non-Hispanic Black individuals [17].

Others have reported on healthcare organization efforts to rapidly implement technology-enabled tools and workflows [4, 5, 23–25] to deliver patient care, including care to patients with COVID-19 symptoms [26]. These generally focused on patients within a particular healthcare system and have been descriptive in nature. [1, 4–15, 27–29] The purpose of this study was to evaluate a hotline that was deployed with a state-wide reach and to directly measure the effectiveness of the hotline in terms of perceived value and the ability to influence health-related behaviors.

Our research questions were (1) To what extent does the hotline reach the intended target population? This was measured by number in the target population who called and spoke to someone relative to the number of OHSU patients and number of Oregonians without a

primary care doctor). (2) Does the telephone hotline impact key outcomes? Primary outcomes were patient and provider experience (were questions answered, did patients feel reassured, would patients/providers recommend this service, how much do patients value the service) and clinical outcomes and care utilization (was testing offered when indicated, what was the follow-up rate, was their appropriate alignment of care level with severity of illness). (3) What was the willingness and experiences of staff implementing the hotline? (4) How was the hotline implemented? What were the key elements of the intervention and what processes were put into place to ensure fidelity of the hotline. (5) Among key stakeholders, how would the hotline (if it is needed) be maintained, and what is needed to maintain it? Questions 4 and 5 were addressed in the prior manuscript [1].

Methods

We used a robust mixed methods approach to evaluate the reach, effectiveness and adoption of the C4 from patients and clinical team members perspectives through the lens of a natural experiment. Evaluation and planning was informed by the RE-AIM framework, which is an implementation science framework that was conceptualized more than two decades ago and has become widely used for planning and/or evaluation [30]. In this case, a priori definition of the research questions supported the hotline's implementation goals to provide a reliable, accessible, sustainable service to the state of Oregon. They were revisited routinely throughout the lifespan of the hotline. The implementation and maintenance of the program is described in a prior manuscript [1].

Ethical considerations

All activities were completed with ethical approval of the Oregon Health & Science University Institutional Review Board (study 00021413). Approval was granted as a minimal-risk protocol and a waiver of consent was granted for automated surveys and EHR data. For interviews, participants were given an information sheet and verbal consent was obtained.

Setting

OHSU is a 576 bed not-for-profit hospital in Oregon and the only academic medical center in the state with a stated mission to serve the 4.2 million people in the state, 35% of whom live in rural or frontier areas, [31]. It includes 21,300 employees, 4,130 students in OHSU degree or certificate programs, and 972 graduate medical education residents and fellows. It has 3,487 faculty in 5 professional schools including a School of Nursing, School of Medicine, School of Dentistry, School of Public Health and College of Pharmacy. The C4 was a telephone-based hotline staffed by nurses. Callers from

across the state were able to reach the hotline by phone 7 days a week, during the hours of 7 AM to 7 PM. They had the ability to perform nursing triage, to connect callers to testing services or medical appointments and to make referrals to social service agencies when needed [31, 32].

Sample

The sample for this study were people who made contact with the C4. A combination of call center analytics (Aceyus system) and EHR (Epic) data, including telephone contacts and text-based messages, was used to define our study sample. All callers received an invitation to complete a survey. Those who completed a survey were asked to opt-into an interview. C4 staff interviewees were purposively selected to vary in role (e.g., clinician leader, nurse).

Data collection and management

Data were collected between March 30, 2020 and September 8, 2021. We defined the Reach numerator as the number of patients who made contact with the C4. We were able to examine the trend in contact over time, and describe patient sex, age, race, preferred language, location and primary care source (active OHSU patients, inactive OHSU patients, non-OHSU patients with a primary care clinician in another health system and non-OHSU patients without established primary care). Patient primary care source was determined using EHR healthcare utilization data and nursing documentation. A three-year cut-point was used to differentiate active vs. inactive patients. The Reach denominator was the total number of unique callers.

Effectiveness of the C4 was defined by clinical outcomes (the ability of the nurses to guide patient health-related COVID-19 behavior as defined by testing or follow-ups being recommended and those recommendations being adhered to after their contact with the hotline), and patients' perceived value of the C4. We used nurses' documentation in the EHR to describe what recommendations were given to patients (e.g., home care). We tracked those encounters at a patient-level to determine what healthcare services were received after each C4 contact (e.g., emergency department visit) (see Fig. 1). The Effectiveness denominator was the total number of calls. To assess perceived value, we ask C4 patients to participate in a brief after call survey from April to May 26, 2020. Patients that agreed were asked:

- Did you get your questions answered during the call? (Yes / No)
- Would you recommend this service to a friend or family member? (Yes / No)
- Assume this C4 had no funding and the only way to keep it open would be to impose a fee on every

household in the state. Would you be willing to pay an annual fee of [randomly inserted the following values: \$5, \$25, \$50, \$75, \$100]? (Yes / No)

- Are you an OHSU patient? Yes / No.

As we did not have time to test the reliability and validity of survey items, our team chose commonly used, simple satisfaction questions. We consulted with a health economist about how to assess the perceived value of the hotline, and adapted items that have been used in other fields to assess willingness to pay for a service, as a way to assess value [33]. Survey data collection was intended to be descriptive, and our quantitative analysts determined that 50 completed surveys would provide a large enough sample to understand callers' experiences.

The caller survey included a final question about willingness to participate in an interview. Willing callers left a recording of their name and phone number. All willing callers were contacted by a qualitative researcher who then explained the interview process further, obtained informed consent from the interviewee, and scheduled a time to conduct the interview. During the scheduled interview time, an experienced qualitative researcher used a semi-structured interview guide to explore participants' experiences with the C4 (e.g., reason for calling, what advice they received, and what they found helpful (or not) about their experience). Caller interviews lasted approximately 30 min.

Adoption of the C4 was understood through the experiences and affective orientation towards implementing the C4. This was assessed through semi-structured interviews with clinical team members who were recruited through an email to all participating C4 clinical team members. Interested clinical team members were contacted by a qualitative researcher via email to schedule an interview time. Informed consent was obtained from interviewees before the start of the interview. The interviews followed a semi-structured guide that asked about their role with the C4, training and support received, and experience providing C4 support to patients. Interviews were conducted by an experienced qualitative interviewer and lasted approximately 60 min.

Data management

Quantitative data were obtained by writing SQL queries against OHSU's Epic database and exporting the results to flat text files, which were subsequently curated using R version 4.1.0. Interviews were conducted by phone or video, depending on what was available to the participant.

[34]Interviews were audio-recorded with permission, professionally transcribed, checked for accuracy, and uploaded into Atlas.ti (Version 9.0, Atlas.ti Scientific Software Development GmbH, Berlin, Germany) for

a. Recommendations



b. Services received by type of recommendation

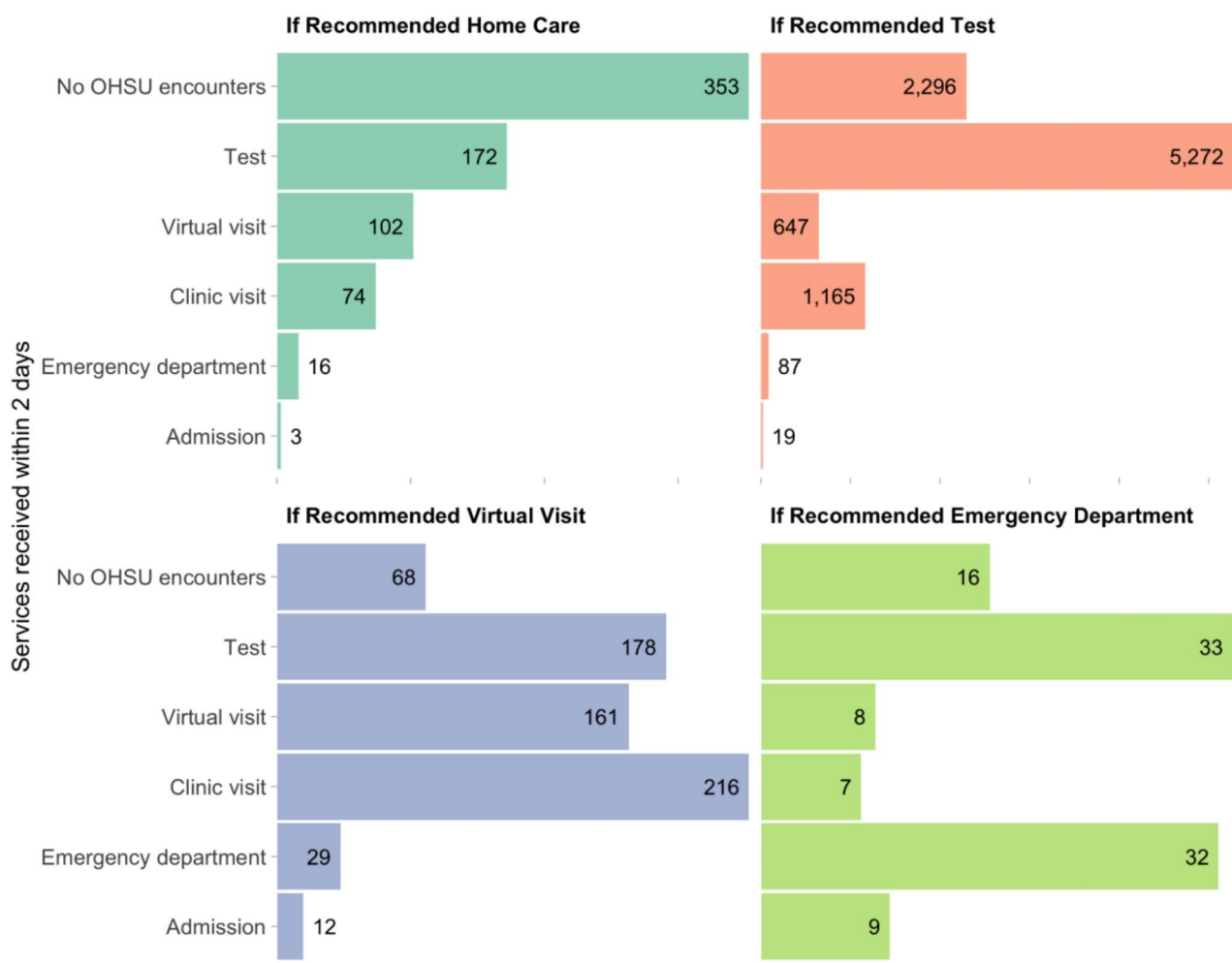


Fig. 1 Distribution of recommendations (a) and services received within 2 days of C4 contact among those who received each type of recommendation (b). These data include only encounters with OHSU providers; data on encounters outside the OHSU system were not available

data management and analysis. We continued interviewing participants until saturation was reached, the point at which no new information emerged from subsequent interviews [34]. For patients, this was achieved after nine interviews, with variation in age and gender. For C4 staff, saturation was achieved after 9 interviews, with variation by C4 role.

Data analysis

Descriptive statistics were used to summarize incoming and outgoing telephone contacts (C4 volume, demographics of patients, recommendations made, and services received) and callers' responses to the survey. Multivariable risk models were created to estimate relative risks of patients receiving recommendations and follow-up services by race and ethnicity using Zou's modified Poisson modeling approach [35]. All models were adjusted for type of caller (active or inactive OHSU patient, patient without a primary care provider, or patient from another health system), age, location, and caller-reported symptom severity. Adjustments were selected based on available demographics and clinical judgment. We performed subgroup analysis on recommendations given (home care/nothing, testing, virtual visit), services received within two days and concordance between the two. There was insufficient power to perform this analysis on emergency department visits and office appointments. We conducted all analysis using R version 4.1.0.

Qualitative data were analyzed by two experienced qualitative researchers (DC and AB) and a medical resident (ED) using an immersion-crystallization approach [36]. We analyzed patient and clinician interviews separately, using a similar process: We listened to one or two interviews together, while reviewing the transcript. We discussed the interview and how to tag sections of the interview relevant to understanding the impact and utility of the C4 (for callers) and the experience of implementing the C4 (for clinical team members). Through this process the team deductively developed a codebook that two researchers (AB and ED) applied to the remaining interviews. Next, data were pulled by code to conduct comparative analysis, and findings were grouped within the RE-AIM constructs. We found that most findings

aligned with Effectiveness (the patient interviews) and Adoption (the clinical staff interviews). AB, ED and DC met regularly to discuss these data, and identify emerging findings through a cyclical and iterative process. Preliminary findings were shared with the larger team and further refined the themes Strategies to ensure rigor in this process are the group analytic process to minimize researcher bias and sampling to saturation [37]. Additionally, the qualitative researchers found the data to be reliable given the consistency among the interviews for each group.

Results

Our data set included 112,582 incoming telephone contacts, 32,952 outbound telephone contacts, 1,387 incoming and 90,713 outgoing text-based messages through the portal (Table 1). Callers included residents of each of Oregon's counties, all 50 states, the District of Columbia, 3 US territories, and 3 Canadian provinces. Demographic data were available for 27,508 contacts and this group was representative of the region in terms of race/ethnicity, but were more often adults 18 to 64 years old and were less likely to speak a language other than English at home (Table 2). Of the incoming telephone contacts, 85,074 involved sharing information such as hours and location of testing sites, and 27,508 involved screening, triage, or clinical decision-making. 0.41% of incoming calls or messages resulted in a referral to the emergency department and 1.5% of all calls resulted in an ED visit. Outgoing follow-up telephone contacts were conducted to share test results or follow-up contacts from previous C4 interactions. Incoming messages through the patient portal included questions about COVID-19 symptoms; outgoing messages were primarily about negative results.

Reach of the C4

145,537 telephone calls and 92,100 text-based contacts (61% and 39%, respectively) were included in our sample. Among the 27,508 contacts documented in the EHR (contacts that were non-clinical were logged only in the call system data), most (89%) of the callers were from the Portland metropolitan area (comprising of Clackamas, Columbia, Multnomah, and Washington counties in Oregon and Clark County in Washington). Non-Portland

Table 1 C4 contacts

Type of Contact	Number
Incoming telephone contacts	112,582
Documented, with questions with clinical decision making	27,508
Undocumented	85,074
Outbound telephone contacts for follow-up	32,952
Incoming text-based questions through the patient portal	1,387
Outbound text-based questions through the patient portal	90,713
Total C4 Contacts	237,634

Table 2 Demographics of individuals from the Portland metropolitan area who contacted the C4 and had clinical documentation, compared to census demographics

	Census	C4
Age group		
< 5	5%	3%
< 6–18	21%	8%
< 19–64	58%	78%
>= 65	15%	11%
Female	51%	54%
Race		
White	83%	69%
Black	3%	4%
American Indian/Alaska Native	1%	1%
Asian	8%	6%
Native Hawaiian/Pacific Islander	1%	1%
Multiracial	4%	3%
Declined/Unknown		16%
Ethnicity		
Hispanic	12%	21%
Non-Hispanic	72%	71%
Declined/unknown		8%
Language other than English at home	18%	11%

metropolitan area callers (11%) were located in nearly every state of the country, with 1,953 (approximately 65%) residing outside of Washington or Oregon. While most of the incoming phone calls documented in the EHR were from active OHSU patients (57%, $n=15,675$), the C4 reached people inactive OHSU patients (17%, $n=4,543$) and people without a primary care clinician (20%, $n=5,434$).

Incoming call volume overtime correlated with daily COVID-19 case counts (Fig. 2) and pandemic waves in the Portland metropolitan area; call volume increased during the spring, summer and winter surges in 2020 and with delta variant in late summer 2021. Weekly call volume peaked at 978 clinical and 3,521 non-clinical contacts on November 22, 2020.

Effectiveness of the C4

Nurses were able to guide patients' COVID-19 related behavior. Figure 1 shows that the most common nurse recommendation was a COVID-19 test ($n=8,056$); the least common was an emergency department visit ($n=63$). We found concordance between the most common nurse recommendations and the healthcare services received after a C4 call, as seen in Fig. 1. If home care, COVID-19 testing, or a clinician visit was recommended, this was the most common subsequent care received. There was insufficient power to determine concordance between ED utilization and a nurse's recommendation.

We found no evidence of racial or ethnic disparities in the types of advice provided at the C4 in our subgroup analysis (Table 3, "Recommendations"). However, there

were disparities in services received (Table 3, "Services received within 2 days"): Black (RR 0.92, CI 0.86–0.98) and Multiracial (RR 0.90 CI 0.81–0.99) patients were less likely than non-Hispanic white patients to receive a COVID-19 test. Furthermore, Black (RR 0.92, CI 0.87–0.98) and Asian (RR 0.95, CI 0.90–1.00) patients were less likely to be able to receive the services recommended within two days (Table 3).

Patients' experiences of the C4 were overwhelmingly positive. Survey data showed that 90% would recommend this service to a friend or family member; 86% got their questions answered during the call; and patients were willing to pay to support this service, with the majority willing to pay \$100 a year. Interviews explained these survey findings—patient feedback about the hotline was overwhelmingly positive; they liked that it was accessible, reduced their stress, and gave them tailored guidance.

Patients appreciated the accessibility of the C4, speaking with a real person rather than an automated message system, and short hold times.

The fact that I got somebody right away, live voice, answering questions, was great... I could see other people hanging up midstream if it was a series of connections or they couldn't understand what was being said or they were on hold. "You are 10th in line. We'll answer you in 45 minutes." I got none of that. – Patient 1.

C4 patients reported the assistance from the nurse reduced their stress. They recognized that information

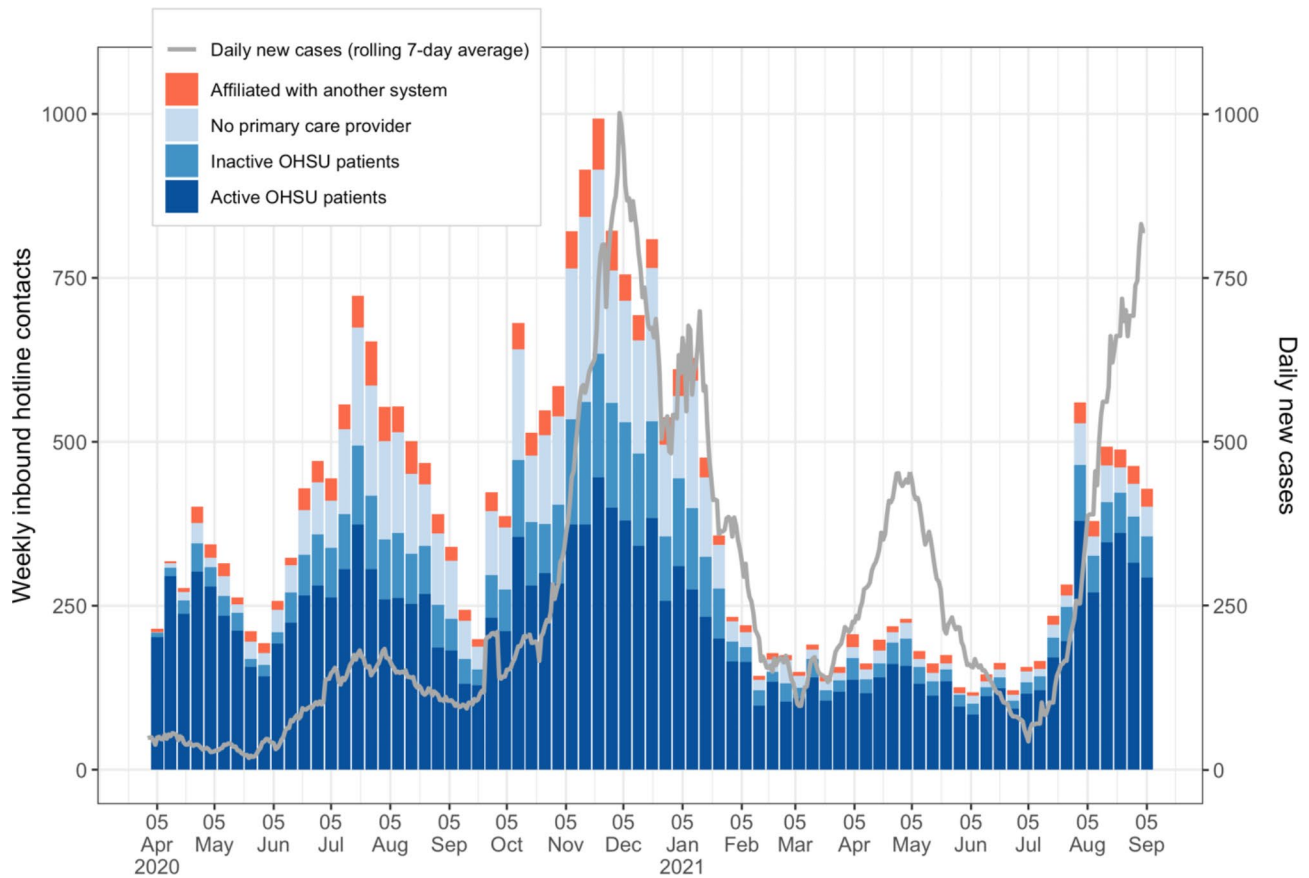


Fig. 2 Inbound telephone and MyChart C4 volume and rolling 7-day average of daily new cases in the Portland metropolitan area

Table 3 Relative risks and 95% confidence intervals* of C4 recommendations and services received within 2 days of contacting the C4. Results in boldface indicate statistically significant results, adjusted for age, geographic location, severity of reported symptoms, and the caller’s relationship to OHSU

Outcome	White (n = 10,048)	Hispanic (n = 2,047)	Black (n = 597)	Asian (n = 772)	Multiracial (n = 228)
Recommendations					
Home care/nothing	1.00	0.84 (0.65–1.08)	1.10 (0.79–1.54)	0.61 (0.39–0.93)	1.03 (0.57–1.89)
Testing	1.00	1.01 (1.00–1.02)	0.99 (0.97–1.02)	1.01 (0.99–1.03)	0.99 (0.95–1.03)
Virtual visit	1.00	0.97 (0.86–1.11)	1.10 (0.91–1.33)	0.93 (0.75–1.13)	1.08 (0.78–1.48)
Services received within 2 days					
Home care/nothing	1.00	0.87 (0.80–0.94)	1.15 (1.02–1.29)	1.04 (0.93–1.16)	1.30 (1.10–1.54)
Testing	1.00	1.06 (1.03–1.09)	0.92 (0.86–0.98)	0.96 (0.91–1.02)	0.90 (0.81–0.99)
Virtual visit	1.00	0.83 (0.68–1.01)	1.06 (0.81–1.40)	1.04 (0.81–1.33)	1.12 (0.73–1.74)
Services received within 2 days among those who received the corresponding recommendation					
Home care/nothing	1.00	0.75 (0.55–1.01)	0.94 (0.68–1.29)	0.72 (0.43–1.19)	1.53 (1.33–1.76)
Testing	1.00	1.05 (1.02–1.08)	0.92 (0.87–0.98)	0.95 (0.90–1.00)	0.92 (0.83–1.01)
Virtual visit	1.00	0.90 (0.69–1.17)	0.69 (0.44–1.08)	0.90 (0.60–1.37)	1.29 (0.79–2.10)

* Relative risks calculated by multivariable modified Poisson regression [cite Zou 2004]

related to the virus was imperfect and evolving; nevertheless, talking with the C4 nurse reduced COVID-related anxiety even when nurses were unable to answer every question.

We have our daughters and our grandsons over on occasion to our house. I would just die a thousand deaths if I got the virus and passed it to my family. It’s important to me that everyone be tested. It really relieved a lot of stress for me... it just relieved my

mind to know that I wasn't going to give anybody the virus. –Patient 8.

C4 patients also appreciated receiving COVID-related guidance tailored to their particular circumstances: “*They [C4 nurse] helped me form a plan. I don't want to go out if I don't have to. Knowing that I could call and get the test if I felt like I needed to, it gives me a lot of confidence. I feel that I could do that and get it done quickly*” (Patient 4). This included recommendations about testing, quarantine, and safe interaction. Both patients and C4 nurses recognized the wide range of sources for general COVID-19 information (e.g., CDC website, local news, personal acquaintances). C4 nurses recognized the important role they played in helping patients translate general recommendations into an individualized plan.

...we play a really important role in helping people individualize their care. Anybody can go to a CDC website. Anybody can go to the OHSU [website]. Where we play an important role, I feel, is in helping people apply what we know to their specific situation. It's very complex. –RN 9.

Patients appreciated how nurses assessed their situation, and helped them translate general guidance into concrete, personalized steps.

Adoption of the C4

Adoption of the C4 was a positive experience for the clinical team; they appreciated the opportunity to support patients and work in a new capacity. The clinical team described being grateful for the opportunity to provide support to patients at a time when their normal clinical roles were suspended due to the virus.

It is nice to feel like—even if it's minimal but at least feeling you're doing something to assist with the COVID-19 pandemic. As a specialized surgeon or a specialized physician in a small domain of medicine, your applicability is so little when it comes to that... It feels nice to be at least plugged into something where you can help out. –MD 3.

They also appreciated the opportunity to work in a new capacity and with colleagues across departments and disciplines with whom they had not previously worked (“*... working with my peers is really important because our system doesn't work unless everyone works together... I've met people I never would have met otherwise... I learned things about the system that I wouldn't otherwise know.*” (MD 5). This enriched their professional work and fostered unanticipated learning about their healthcare system.

Discussion

COVID hotlines were created across the globe, typically building upon existing telephone systems [4–15]. Published information regarding these hotlines is largely descriptive in nature and does not include a combined assessment of efficacy, patient experience and differential impact on racial/ethnic groups. This mixed-methods study suggests that nurse hotlines similar to the C4 can be an effective component of the public health information infrastructure. Further efforts are needed to include people with limited English proficiency, Black, Multi-racial and Asian people. There are several implications from the study results relevant to building a more robust public health information [38] and communication infrastructure [39].

Nursing triage can guide caller behavior but there are limitations

The COVID-19 pandemic revealed that neither the public health nor the medical establishment was prepared to provide trusted individualized clinical advice at a population level. In a March 2020 survey, 52% of primary care clinics nationwide reported being under severe strain, with patient questions and contacts being the most commonly cited driver [40]. This study shows that a centralized nurse call center can serve as an effective source of triage care throughout a region, even reaching those without a pre-existing relationship with the hospital through telephone and text-based contacts. Such a service could absorb increased demand during pandemics, regulating utilization of emergency departments and primary care clinics, thus serving as an important part of the public health infrastructure, which needs greater investment. Call centers may be more successful as local rather than state-wide or national interventions: the intended audience was statewide but 89% of callers were from the 6 counties surrounding the hospital.

Prioritize equity and community engagement throughout the design of clinical programs

Pre-existing disaster response models prioritize coordination and speed [41]. On the other hand, a contemporary focus on justice emphasizes collaborative, deliberate and sustained activities [42]. Our findings mirror the disproportionate impact of COVID-19 on communities of color, [43–46] and the relative ease of access to testing in white and primarily English-speaking communities [47–49]. These findings suggest that individual actions are not sufficient to mitigate healthcare inequities that arise from a multitude of systemic factors [50]. Thoughtful engagement with communities to develop culturally responsive services is needed.

Data infrastructure should provide patient-level data across health systems, be disaggregated and democratized

Our country needs data infrastructure inclusive of public, medical and mental healthcare systems while being detailed enough that it can be disaggregated by race/ethnicity, age, language and disability to allow early detection of disparities [51]. Analytic capabilities should be democratized so that health systems and communities without research infrastructure can detect and mitigate disparities in real time.

Academic medical centers (AMCs) serve a crucial role but should act collaboratively with other agencies

Given the public's lack of trust in governmental and media outlets combined with the proliferation of misinformation on social media, AMCs have a crucial role to play in a pandemic. Nonetheless, a robust response also requires the engagement of social services and public health agencies. Developing and maintaining multi-sector partnerships for coordinated care is crucial for success.

This study's limitations include the lack of integrated health system data. Care received after hotline encounters did not account for services at another health system and this missing data could alter the results. Missing race data (8%) also limited our ability to interpret demographic data. Nurses often made several recommendations complicating the analysis of subsequent care. Recommendations documented outside of the discrete data fields in our documentation templates was not accounted for. Office visits and emergency department visits were infrequent both as recommendations and services received during the study period. As a result there was insufficient power to perform an analysis on concordance between these recommendations and services received and any demographic disparities in recommendations given. We estimate that this is unlikely to alter our conclusion that nursing recommendations were generally followed and that they were given equally irrespective of race/ethnicity. Finally, our findings from the patient survey and interviews may be influenced by self-selection bias.

Conclusions

Key findings are that C4 was effective in reaching those with no usual source of care, as 20% of callers had no primary care provider. While disparities were not evident in recommendations provided, callers identifying as Black and Multiracial were less likely to gain access to a COVID-19 test (RR 0.92, CI 0.86–0.98 for Black and RR 0.90, CI 0.81–0.99 for Multiracial callers). We found that nurses were able to guide patients' COVID-19 related behavior: there was concordance between nurse recommendations and healthcare services received after a C4

contact, and only 1.5% of calls resulted in an Emergency Room visit. The C4 service was valued by callers and clinical teams. Callers particularly appreciated the individualized advice they received and would have been willing to pay for the service, which was provided free of charge. Staff found meaning in the experience, even when it was outside of their normal duties.

Abbreviations

C4 The Covid Connected Care Center
OHSU Oregon Health & Science University

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12912-024-02270-8>.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Acknowledgements

First, and foremost, thank you to the nurses who have served the community since March 2020. The "Covengers" are healthcare heroes. The implementation team included Anthony Cheng, MD; Eric Herman, MD; Emily Barclay, MS; Kellen Strickland, BSN; Debbie Lamberger, MPA; Kevin O'Boyle, MHA; Janice Flier; Shilpa Kasukurthi; Ali Bruni; Jessica Hoyt; and the administrative staff of the School of Medicine. The Steering Committee included: Jen DeVoe, MD, DPhil; Darren Malinoski, MD; Janice Flier; Jewell Sutton; T Timbreza; Sarah Present, MD, MPH; Cat Livingston, MD, MPH; Steve Kassakian, MD; Banning Hendriks, MBA; Johanna Warren, MD; Betsy Boyd-Flynn; and Kelsey Huwaldt, MBA. OHSU's Vaccine Equity Committee was co-led by Donn Spight, MD, FACS, FASMBS, and Derick Du Vivier, MD, MBA. More than 20 OHSU members with high levels of expertise in the areas of operations (led by Kat Phillips, MHA), community relations (led by Jenny Lee Berry), culture (led by Leslie Garcia, MPA, Ed D), communications (led by Mariana Phipps, MS) and various medical specialties joined the committee to devise and support a strategy for improving vaccine equity. Thanks to Faiza Khan for support with data collection and interpretation. Many thanks to the Andrew and Corey Morris-Singer Foundation for their generous grant to fund the COVID-19 Connected Care Center.

Author contributions

AC made substantial contributions to the conception, design, analysis, interpretation and drafting of the work. KH conducted the acquisition, analysis and interpretation of the call center and EHR data. AB contributed to the acquisition, analysis and interpretation of the qualitative data as well as drafting and revising the manuscript. ED contributed to the acquisition and analysis of the qualitative data. BP contributed to substantial revisions of the manuscript. JJ, JD and EH made substantial contributions to the conception of the work. DC made substantial contributions to the conception, design, analysis and interpretation of data as well as substantial revisions. All authors read and approved the final manuscript.

Funding

This evaluation was funded by the Andrew and Corey Morris-Singer Foundation.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All activities were completed with oversight of the Oregon Health & Science University Institutional Review Board (study 00021413). Informed consent was obtained from all study participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 22 February 2024 / Accepted: 16 August 2024

Published online: 05 September 2024

References

- Cheng A, Angier H, Huguet N, Cohen DJ, Strickland K, Barclay E, Herman E, McDougall C, Biagioli FE, Pierce K. Launching a statewide COVID-19 primary care hotline and telemedicine service. *J Am Board Family Med.* 2021;34(Supplement):S170–8.
- Sexton V, Dale J, Bryce C, Barry J, Sellers E, Atherton H. Service use, clinical outcomes and user experience associated with urgent care services that use telephone-based digital triage: a systematic review. *BMJ open.* 2022;12(1):e051569.
- Rushton S, Boggan JC, Lewinski AA, Gordon AM, Shoup JP, Van Voorhees E, Whited JD, Tabriz AA, Adam S, Fulton J. Effectiveness of remote triage: a systematic review. 2020.
- Sinha S, Kern LM, Gingras LF, Reshetnyak E, Tung J, Pelzman F, McGrath TA, Sterling MR. Implementation of video visits during COVID-19: lessons learned from a primary care practice in New York City. *Front Public Health.* 2020;8:514.
- Lin S, Sattler A, Smith M. Retooling primary care in the COVID-19 era. In: *Mayo Clinic Proceedings: 2020*. Elsevier; 2020: 1831–1834.
- Jang B, Facchini D, Staib L, Fernandez A, Pye S, Goodman RT, Granucci C, Nardecchia N, Pahade JK. Creating a Radiology Call Center Hotline and HOT sites: centralizing Radiology questions and cohorting out-patient care during the COVID-19 pandemic. *Curr Probl Diagn Radiol.* 2021;50(5):665–8.
- Navarrete-Reyes AP, Avila-Funes JA. Staying in a Burning House: perks and perils of a hotline in the Times of COVID-19. *J Am Geriatr Soc.* 2020;68(5):E10.
- Santos JJ, Chang DD, Robbins KK, Le Cam E, Garbuzov A, Miyakawa-Liu M, Goodwin B, Malik I, Tholen C, Green M. Answering the call: medical students reinforce health system frontlines through Ochsner COVID-19 hotline. *Ochsner J.* 2020;20(2):144.
- Matthewson J, Tiplady A, Gerakios F, Foley A, Murphy E. Implementation and analysis of a telephone support service during COVID-19. *Occup Med.* 2020;70(5):375–81.
- Wang J, Wei H, Zhou L. Hotline services in China during COVID-19 pandemic. *J Affect Disord.* 2020;275:125.
- Machado MBDSD. On the frontlines, behind the computer screen. *Acad Med.* 2020;95(11):e10–1.
- Lai L, Wittbold KA, Dadabhojy FZ, Sato R, Landman AB, Schwamm LH, He S, Patel R, Wei N, Zuccotti G. Digital triage: novel strategies for population health management in response to the COVID-19 pandemic. *Healthcare.* 2020. Elsevier; 2020. p. 100493.
- Choi YS, Ko JY. Operating a national hotline in Korea during the COVID-19 pandemic. *Osong Public Health Res Perspect.* 2020;11(6):380.
- Margolius D, Hennekes M, Yao J, Einstadter D, Gunzler D, Chehade N, Sehgal AR, Tarabichi Y, Perzynski AT. On the front (phone) lines: results of a COVID-19 hotline. *J Am Board Family Med.* 2021;34(Supplement):S95–102.
- Meaden CW, Ramdin C, Ruck B, Nelson LS, Soukas C, Hirsch M, Alsharif P, Beckford D, Calello DP. The Poison Center as a pandemic response: establishment and characteristics of a COVID-19 hotline through the New Jersey poison Center. *Clin Toxicol.* 2021;59(12):1228–33.
- Nelson T, Kagan N, Critchlow C, Hillard A, Hsu A. The danger of misinformation in the COVID-19 crisis. *Mo Med.* 2020;117(6):510.
- Yalda Jabbarpour AG, Jetty A, Kempinski A, Kamerow D, Grace Walter, Jamie Sibel: relationships Matter. How usual is usual source of (primary) care? In: *Primary Care Collaborative*; 2022.
- Kim HK, Tandoc EC Jr. Consequences of online misinformation on COVID-19: two potential pathways and disparity by eHealth literacy. *Front Psychol.* 2022;13:783909.
- Lee JJ, Kang K-A, Wang MP, Zhao SZ, Wong JYH, O'Connor S, Yang SC, Shin S. Associations between COVID-19 misinformation exposure and belief with COVID-19 knowledge and preventive behaviors: cross-sectional online study. *J Med Internet Res.* 2020;22(11):e22205.
- Baker DW. Trust in health care in the time of COVID-19. *JAMA.* 2020;324(23):2373–5.
- Kemei J, Alaazi DA, Tulli M, Kennedy M, Tunde-Biyass M, Bailey P, Sekyi-Otu A, Murdoch S, Mohamud H, Lehman J. A scoping review of COVID-19 online mis/disinformation in black communities. *J Global Health* 2022, 12.
- Reyes MV. The disproportional impact of COVID-19 on African americans. *Health Hum Rights.* 2020;22(2):299.
- Lim J, Broughan J, Crowley D, O'Kelly B, Fawsitt R, Burke MC, McCombe G, Lambert JS, Cullen W. COVID-19's impact on primary care and related mitigation strategies: a scoping review. *Eur J Gen Pract.* 2021;27(1):166–75.
- De Vera K, Challa P, Liu RH, Fuller K, Feroz AS, Gamble A, Leung E, Seto E. Virtual primary care implementation during COVID-19 in high-income countries: a scoping review. *Telemedicine e-Health.* 2022;28(7):920–31.
- Mohammed HT, Hyseni L, Bui V, Gerritsen B, Fuller K, Sung J, Alarakhia M. Exploring the use and challenges of implementing virtual visits during COVID-19 in primary care and lessons for sustained use. *PLoS ONE.* 2021;16(6):e0253665.
- Hollander JE, Carr BG. Virtually perfect? Telemedicine for COVID-19. *N Engl J Med.* 2020;382(18):1679–81.
- Hegde SKB, Sharma M, Alam I, Bambram HS, Deshmukh A, Varma D. Leveraging Health helplines to combat COVID-19 pandemic: a descriptive study of Helpline utilization for COVID-19 in eight States of India. *Asia Pac J Public Health.* 2021;33(4):441–4.
- Jaffe TA, Hayden E, Uscher-Pines L, Sousa J, Schwamm LH, Mehrotra A, Zachrisson KS. Telehealth use in emergency care during coronavirus disease 2019: a systematic review. *J Am Coll Emerg Physicians Open.* 2021;2(3):e12443.
- Ho K, Lauscher HN, Stewart K, Abu-Laban RB, Scheuermeyer F, Grafstein E, Christenson J, Sundhu S. Integration of virtual physician visits into a provincial 8-1-1 health information telephone service during the COVID-19 pandemic: a descriptive study of HealthLink BC Emergency Idoctor-in-assistance (HEiDi). *CMAJ Open.* 2021;9(2):E635–41.
- Holtrop JS, Estabrooks PA, Gaglio B, Harden SM, Kessler RS, King DK, Kwan BM, Ory MG, Rabin BA, Shelton RC. Understanding and applying the RE-AIM framework: clarifications and resources. *J Clin Translational Sci.* 2021;5(1):e126.
- Oregon Office of Rural Health. About rural and Frontier Data. In.: Oregon Health & Science University.
- Rural Health Information Hub. Health Professional shortage areas: primary care, by County, 2022 - oregon. In.: Rural Health Information Hub.
- Haab TC, McConnell KE. Valuing environmental and natural resources: the econometrics of non-market valuation. Edward Elgar Publishing; 2002.
- Strauss A, Corbin J. Grounded theory methodology: An overview. 1994.
- Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol.* 2004;159(7):702–6.
- Borkan JM. Immersion–Crystallization: a valuable analytic tool for healthcare research. *Fam Pract.* 2022;39(4):785–9.
- Cohen DJ, Crabtree BF. Evaluative criteria for qualitative research in health care: controversies and recommendations. *Annals Family Med.* 2008;6(4):331–9.
- Dixon BE, Staes C, Acharya J, Allen KS, Hartsell J, Cullen T, Lenert L, Rucker DW, Lehmann H. Enhancing the nation's public health information infrastructure: a report from the ACMI symposium. *Journal of the American Medical Informatics Association* 2023, 30(5):1000–1005.
- Goulbourne T, Yanovitzky I. The communication infrastructure as a social determinant of health: implications for health policymaking and practice. *Millbank Q* 2021, 99(1).
- Clinician, Survey. Quick Covid-19 survey. In: *Series 1 March 13–16, 2020*. Larry A. Green Center.
- Gibson PJ, Theadore F, Jellison JB. The common ground preparedness framework: a comprehensive description of public health emergency preparedness. *Am J Public Health.* 2012;102(4):633–42.
- Johnson-Agbakwu CE, Ali NS, Oxford CM, Wingo S, Manin E, Coonrod DV. Racism, COVID-19, and Health Inequity in the USA: a call to action. *J Racial Ethnic Health Disparities* 2020:1–7.

43. Rossen LM, Ahmad FB, Anderson RN, Branum AM, Du C, Krumholz HM, Li S-X, Lin Z, Marshall A, Sutton PD. Disparities in excess mortality associated with COVID-19—United States, 2020. *Morb Mortal Wkly Rep*. 2021;70(33):1114.
44. Cronin CJ. WN Evans 2021 Excess mortality from COVID and non-COVID causes in minority populations. *Proc Natl Acad Sci* 118 39 e2101386118.
45. Stokes AC, Lundberg DJ, Elo IT, Hempstead K, Bor J, Preston SH. COVID-19 and excess mortality in the United States: a county-level analysis. *PLoS Med*. 2021;18(5):e1003571.
46. Chen R, Aschmann HE, Chen Y-H, Glymour MM, Bibbins-Domingo K, Stokes AC, Kiang MV. Racial and ethnic disparities in estimated excess mortality from external causes in the US, march to December 2020. *JAMA Intern Med* 2022.
47. Lieberman-Cribbin W, Alpert N, Flores R, Taioli E. Analyzing disparities in COVID-19 testing trends according to risk for COVID-19 severity across New York City. *BMC Public Health*. 2021;21(1):1–8.
48. Jacobson M, Chang TY, Shah M, Pramanik R, Shah SB. Racial and ethnic disparities in SARS-CoV-2 testing and COVID-19 outcomes in a Medicaid managed care cohort. *Am J Prev Med*. 2021;61(5):644–51.
49. Kim HN, Lan KF, Nkyekyer E, Neme S, Pierre-Louis M, Chew L, Duber HC. Assessment of disparities in COVID-19 testing and infection across language groups in Seattle, Washington. *JAMA Netw open*. 2020;3(9):e2021213–2021213.
50. Anderson LM, Scrimshaw SC, Fullilove MT, Fielding JE, Normand J, Services TFCP. Culturally competent healthcare systems: a systematic review. *Am J Prev Med*. 2003;24(3):68–79.
51. Cohen DJ, Dorr DA, Knierim K, DuBard CA, Hemler JR, Hall JD, Marino M, Solberg LI, McConnell KJ, Nichols LM. Primary care practices' abilities and challenges in using electronic health record data for quality improvement. *Health Aff*. 2018;37(4):635–43.

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