


Effectiveness of a Population Health Intervention on Disparities in Hypertension Control: A Stepped Wedge Cluster Randomized Clinical Trial



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ABSTRACT

BACKGROUND: Disparities in hypertension control across race, ethnicity, and language have been a long-standing problem in the United States.

OBJECTIVE: To assess whether a multi-pronged intervention can improve hypertension control for a target population and reduce disparities.

DESIGN: This stepped wedge cluster randomized trial was conducted at 15 adult primary care clinics affiliated with Massachusetts General Hospital. PCPs were randomized to receive the intervention in twelve groups.

PARTICIPANTS: The target population was patients who met one of the following criteria based on self-identification: (1) Asian, Black, Indigenous, multi-racial, or other race; (2) Hispanic ethnicity; or (3) preferred language other than English. Reference population was White, English-speaking patients.

INTERVENTIONS: PCPs were given access to an online equity dashboard that displays disparities in chronic disease management and completed an equity huddle with population health coordinators (PHCs), which involved reviewing target patients whose hypertension was not well controlled. In addition, community health workers (CHWs) were available in some practices to offer additional support.

MAIN MEASURES: The primary outcome was change in the proportion of target patients meeting the hypertension control goal when comparing intervention and control periods.

KEY RESULTS: Of the 365 PCPs who were randomized, 311 PCPs and their 10,865 target patients were included in the analysis. The intervention led to an increase in hypertension control in the target population (RD 0.9%; 95% CI [0.3, 1.5]) and there was a higher intervention effect in the target population compared to the reference population (DiD 2.1%; 95% CI [1.1, 3.1]).

CONCLUSIONS: Utilizing data on disparities in quality outcome measures in routine clinical practice augmented by clinical support provided by PHCs and CHWs led to modest, but statistically significant, improvement in hypertension control among BIPOC, Hispanic, and LEP patients.

TRIAL REGISTRATION: ClinicalTrials.gov Identifier: NCT05278806.

KEY WORDS: disparities; hypertension; population health; community health

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BACKGROUND

Disparities in hypertension control across race, ethnicity, and language (REaL) is a long-standing problem in the United States.¹ We previously demonstrated that use of audit and feedback and population health coordinators (PHCs) can lead to improvement in ambulatory quality.^{2,3} Interventions involving community health workers (CHWs) have also been shown to be effective in improving blood pressure control.^{4,5}

OBJECTIVE

To address these disparities in a large academic primary care network, we developed a multi-pronged intervention that included an interactive online dashboard (“equity dashboard”) displaying disparities in chronic disease management to primary care physicians (PCPs) coupled with a clinical program to improve hypertension control among a target population experiencing disparities when compared to White, English-speaking patients. Clinical support was provided by pre-existing staff, which included PHCs in all practices and CHWs in some practices. Our primary hypothesis was that this intervention would lead to improved hypertension control among the target population. Our secondary hypothesis was that this intervention would help reduce disparities in hypertension control between the target population and White, English-speaking patients.

METHODS

Design

This stepped wedge cluster randomized trial, including waiver of consent, was approved by the Mass General Brigham Institutional Review Board. The study was conducted at Massachusetts General Hospital’s 15 primary care

practices (including 3 community health centers) caring for over 190,000 patients. PCPs were first divided into 12 groups based on their patients’ baseline hypertension control and number of their eligible patients to ensure that PHCs and CHWs would engage a similar number of patients per step. The groups were then randomized into one of 12 steps using a random number generator. Each step was one month (Fig. 1). Patients of PCPs randomized to Step 1 received the intervention in April 2022 while patients of PCPs randomized to Step 12 received the intervention in March 2023 but received usual care in Steps 1–11.

Participants

All PCPs were eligible to participate except 35 practice leaders, primary care equity steering committee members (1–2 PCPs from each practice), and study physicians who were given access to the equity dashboard prior to randomization and helped design and implement the intervention. Patients 18 years or older included in the Epic Systems hypertension registry in the step before or at the step their PCP was randomized to the intervention were included in the study. Patients were included in the hypertension registry if they met one of the following criteria: (1) hypertension on the problem list of the electronic medical record, (2) two billing diagnoses for hypertension in the last year, or (3) two encounter diagnoses for hypertension in the last year.

The target population met one of the following criteria based on self-identification: (1) Asian, Black, Indigenous, multi-racial, or other race; (2) Hispanic ethnicity; or (3) preferred language other than English. Information on REaL was obtained from the electronic medical record. Numerous steps have been taken to ensure that REaL data are accurate. In 2021, all primary care patients in the health system received outreach via multiple means to collect REaL data to reduce the number of unknown values. In addition, patients

are asked to review their REaL when checking in online for appointments. Patients in the target population were eligible for the intervention if they were not meeting their hypertension control goal immediately before their PCP was eligible for the intervention. White, English-speaking patients were included as the reference group for our secondary comparison. Patients who died or were deemed inappropriate for the intervention by their PCP due to terminal illness, advanced dementia, or competing co-morbidities were excluded from the analysis.

Interventions

During the intervention periods, PCPs were sent a link to the equity dashboard along with information about additional clinical resources for addressing hypertension control in the target population. Clinical support was provided by PHCs in all practices. PHCs are non-licensed professionals who manage disease registries and conduct quality improvement efforts addressing gaps in care. During this intervention, PHCs were responsible for completing one equity huddle with each intervention PCP to review their list of target patients who were not at their hypertension goal. The PCP formulated a follow-up plan for each patient based on a suggested list of potential actions (Table 1), which PHCs helped implement.

CHWs were available for additional support in 5 practices (PHC and CHW), selected by health system leadership for an institutional investment in health equity called United Against Racism.⁶ In these 5 practices, PCPs could refer patients to a CHW-led Healthy Blood Pressure Program. CHWs were trained in (1) patient education/coaching, (2) motivational interviewing to promote medication adherence, and (3) remote blood pressure monitoring.

The equity dashboard displayed practice-level data on ambulatory quality measures stratified by REaL, sex,

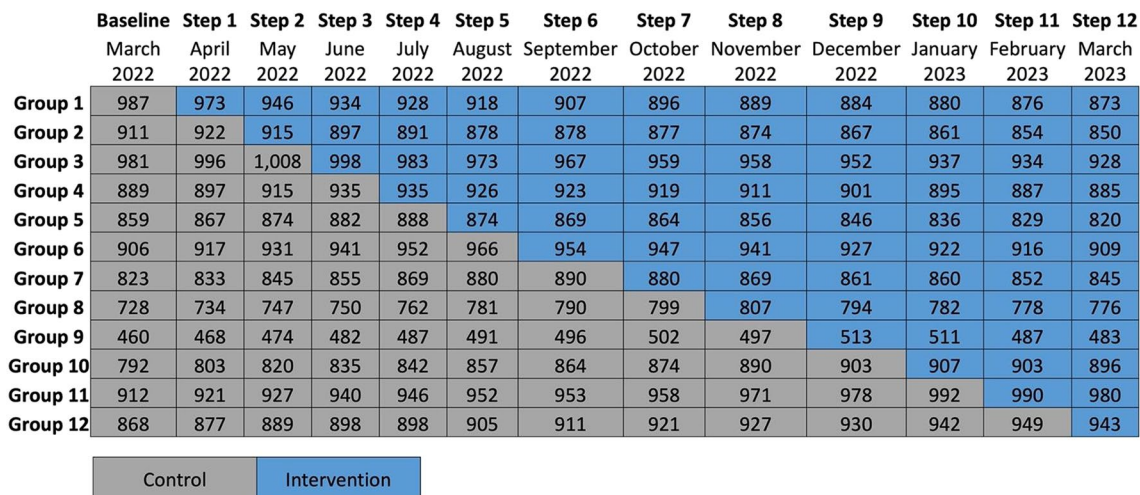


Figure 1 Study flow diagram. PCPs who left the institution during the study period and PCPs who did not have patients meeting the eligibility criteria were not included in the analysis.

Table 1 Menu of Intervention Options Presented to PCPs During Equity Huddles

Action items for PHCs	Action items for PCPs
Schedule visit with APP for co-management	Refer to resistant HTN clinic
Schedule visit with PCP	Refer to dietitian (for patients with HTN and DM)
Reach out to specialist (cardiology, endocrinology, or nephrology if already established) to request follow up visit	Refer to integrated care management program (program that connects patients to hospital/community resources and provides care coordination, patient education, and medication management)
Call and obtain home BPs	Refer to IMPACT program (program led by behavioral health coaches to address anxiety/depression)
Refer to HTN virtual group visit	Refer to CHW Healthy BP Program (<i>only available in select practices</i>)

insurance, disability, and PCP type (attending vs resident PCP); but did not identify individual patients not at goal. Ambulatory quality measures included preventive screening (e.g., cancer screening) and chronic disease control measures (e.g., blood pressure and hemoglobin A1c control). Reference group patients were not discussed during equity huddles and were not eligible for CHW assistance.

Main Measures

The primary outcome measure was change in the proportion of randomized target patients meeting the definition of hypertension control, comparing intervention and control periods. Being at goal for hypertension control was defined as (1) blood pressure (BP) measured in the last 12 months AND either the last BP or average of last three BP readings (in the last 18 months) < 130/80 or (2) BP measured within the past 6 months AND either the last or average of last three BP readings (in the last 18 months) met one of the following criteria: (a) age < 60, BP ≤ 140/90; (b) age ≥ 60 with diabetes, BP ≤ 140/90; without diabetes, BP ≤ 150/90; (c) age ≥ 60, diastolic BP < 70, regardless of systolic; (d) on three or more anti-hypertensive medications from three different classes.

Secondary outcome measures included difference in hypertension control rates between the target and reference populations and changes in the proportion of the target population meeting diabetes control and breast cancer screening goals, comparing intervention and control periods. PHCs and CHWs were not asked to focus on disparities in these measures as part of the equity intervention. Goals for these secondary measures are outlined in eTable 1. Process measures included the percentage of PCPs who viewed the equity dashboard and completed an equity huddle, and the number of patients reviewed during equity huddles and engaged in the CHW program.

Statistical Analysis

The primary analysis used an intention-to-treat approach comparing outcomes collected during the intervention and control periods regardless of whether the intervention was received. Our primary comparison was the difference

in the proportion of participants meeting control criteria between intervention and control periods in the target population. Our secondary analysis used a difference in differences (DiD) approach by comparing the difference between intervention and control periods in the target and reference populations.

To avoid pitfalls associated with mis-specifying mixed-effect models in stepped wedge trial analysis,⁷ we used a within-period cluster-level analysis:⁸ (1) We first estimated the period-specific intervention effect by calculating the rate difference between patients whose PCPs had received the intervention (intervention group) and patients whose PCPs had not yet received the intervention (control group); (2) We estimated the overall effect by combining the period-specific intervention effect estimates using an inverse-variance weighted average. We used the Generalized Estimating Equations (GEE) approach to account for clustering of patients within PCPs. We used a similar approach for our secondary comparison of difference in differences. We estimated the period-specific difference in differences in Step 1 adjusting for age, gender, and insurance. We conducted a sensitivity analysis excluding resident physicians. We used the same approach for our secondary outcome measures.

Sample Size

Sample size estimates and assumptions for our primary outcome of hypertension control were obtained using data from August 2021. We used the Hooper et al. approach⁹ to conduct the power analysis. We estimated 10,917 target patients from 365 PCPs would be eligible at each time point. With 13 time points (baseline plus 12 steps) and each PCP contributing an average of 29 patients per step, the design effect due to clustering is 2.4 assuming an intra-cluster correlation of 0.05, and the design effect due to repeated assessment is 0.135 assuming the cluster autocorrelation coefficient is 0.3 and the individual autocorrelation coefficient is 0.3. These estimates correspond to an effective sample size of 33,705. The study was predicted to have more than 90% power to detect an absolute difference of 3% in the proportion of patients meeting blood pressure control criteria (71% vs. 74%) with a two-sided significance level of 0.05.

RESULTS

Participants

Of the 365 PCPs randomized, 311 PCPs and their 10,865 eligible target patients and 28,889 reference patients were included in the analysis. Eight PCPs who left the institution during the study and 46 PCPs who did not have patients meeting the eligibility criteria at baseline were excluded. Out of the 311 PCPs, 155 (50%) were residents. The number of target patients available in each period, stratified by study group, is shown in Fig. 1.

Patient Characteristics

Compared to patients in the reference population, patients in the target population were younger (mean age 61.5 vs. 66.1 years) with a higher proportion of female (54.0 vs. 46.8%) and Medicaid-insured patients (19.3 vs. 3.9%) and a lower proportion of Medicare-insured patients (23.2 vs. 43.7%) (Table 2). Within the target population, 30.6% identified as Black, 22.7% as Asian, 30.6% as Hispanic, and 37.5% preferred a language other than English.

PHC and CHW practices had a higher percentage of Asian patients (27.3% vs. 19.3) and a lower percentage of Hispanic (23.9 vs. 35.5%) patients and patients whose race was categorized as “Other” (21.5 vs. 30.8%) compared to PHC-only

practices. In addition, baseline hypertension control was higher in PHC and CHW practices compared to PHC-only practices (75.3% vs. 72.2%) (eFigure 1). Baseline characteristics between patients in the intervention and control periods were comparable since most eligible patients (98%) contributed data to both periods (eTable 2).

Process Metrics

11.9% of PCPs included in the primary analysis visited the equity dashboard website at least once during the study. 76.3% of PCPs who were included in the primary analysis and had patients eligible for equity huddle at the time of the intervention step completed an “equity huddle” (Table 3). Huddle completion was significantly lower among residents compared to attending physicians (69.7% vs. 82.1%). On average, 49.8% of target patients who were eligible for intervention were reviewed during equity huddles across all 12 steps. The most frequently selected intervention options during equity huddles were scheduling PCP visits (41.9%), referring to CHW BP Program (19.5%), and obtaining home BPs (11.7%) (Table 3). In PHC-only practices, the most frequently chosen interventions were scheduling PCP visits (53.5%), obtaining home BPs (14.8%), and scheduling a visit with either an RN (4.0%) or APP (4.6%). A total of 252 patients were referred to the CHW program, but many

Table 2 Baseline Characteristics of Patients Included in Study

	Target population (BIPOC, Hispanic, or LEP)			Reference population (White and English-speaking)		
	All patients (N = 10,865)	PHC & CHW ¹ (N = 4594)	PHC only ² (N = 6271)	All patients (N = 28,889)	PHC & CHW (N = 15,605)	PHC only (N = 13,284)
Age, mean years (SD)	61.5 (13.5)	63.5 (13.1)	60. (13.6)	66.1 (12.3)	67.6 (11.7)	64.3 (12.7)
Gender						
Female, N (%)	5862 (54.0)	2519 (54.8)	3343 (53.3)	13,510 (46.8)	7127 (45.7)	6383 (48.1)
Male, N (%)	5003 (46.0)	2075 (45.2)	2928 (46.7)	15,379 (53.2)	8478 (54.3)	6901 (51.9)
Race, N (%)						
American Indian or Alaska Native	46 (0.4)	17 (0.4)	29 (0.5)			
Asian	2465 (22.7)	1253 (27.3)	1212 (19.3)			
Black	3320 (30.6)	1472 (32.0)	1848 (29.5)			
Native Hawaiian or Other Pacific Islander	24 (0.2)	14 (0.3)	10 (0.2)			
Other	2919 (26.9)	988 (21.5)	1931 (30.8)			
Multi-racial	357 (3.3)	138 (3.0)	219 (3.5)			
White	1404 (12.9)	592 (12.9)	812 (12.9)	28,243 (97.8)	15,303 (98.1)	12,940 (97.4)
Unknown/missing	330 (3.0)	120 (2.6)	210 (3.3)	645 (2.2)	301 (1.9)	344 (2.6)
Hispanic, N (%)	3328 (30.6)	1099 (23.9)	2229 (35.5)			
Preferred language other than English, N (%)	4073 (37.5)	1658 (36.1)	2415 (38.5)			
Insurance, N (%)						
Commercial	5935 (54.6)	2360 (51.4)	3575 (57.0)	14,899 (51.6)	7358 (47.2)	7541 (56.8)
Medicaid	2094 (19.3)	835 (18.2)	1259 (20.1)	1118 (3.9)	627 (4.0)	491 (3.7)
Medicare	2521 (23.2)	1272 (27.7)	1249 (19.9)	12,622 (43.7)	7501 (48.1)	5121 (38.6)
Other	47 (0.4)	43 (0.9)	4 (0.1)	34 (0.1)	14 (0.1)	20 (0.2)
Unknown/missing	268 (2.5)	84 (1.8)	184 (2.9)	216 (0.7)	105 (0.7)	111 (0.8)
Provider type, N (%)						
Staff	9561 (88.0)	3746 (81.5)	5815 (92.7)	27,286 (94.5)	14,481 (92.8)	12,805 (96.4)
Resident	1304 (12.0)	848 (18.5)	456 (7.3)	1603 (5.5)	1124 (7.2)	479 (3.6)

¹Patients of 5 practices with both PHC & CHW support

²Patients of 10 practices with PHC support only

Table 3 Process Metrics

Equity huddle completion rate												
	All practices				PHC & CHW practices				PHC practices			
	No. of providers	No. of providers with eligible patients	Completion rate	No. of patients reviewed	No. of providers	No. of providers with eligible patients	Completion rate	No. of patients reviewed	No. of providers	No. of providers with eligible patients	Completion rate	No. of patients reviewed
All PCPs	311	262	76.3%	1322	178	158	77.8%	651	133	104	74.0%	671
Resident	155	122	69.7%	221	97	82	74.4%	157	58	40	60.0%	64
Attending	156	140	82.1%	1101	81	76	81.6%	494	75	64	82.8%	607
Most frequently chosen intervention options during equity huddles												
	All practices			PHC & CHW practices			PHC practices					
	Schedule visit with PCP	Refer to CHW program	Obtain home blood pressure	Refer to CHW program	Schedule visit with PCP	Obtain home blood pressure	Schedule visit with PCP	Obtain home blood pressure	Schedule visit with PCP	Obtain home blood pressure	Schedule visit with APP/RN	
All PCPs	41.9%	19.5%	11.7%	39.6%	30%	8.6%	53.5%	14.8%	8.6%			
Resident	44.8%	26.7%	8.1%	37.6%	35.7%	5.1%	67.2%	15.6%	6.3%			
Attending	34.4%	15.1%	10.4%	40.5%	28.3%	9.8%	54.6%	15.4%	5.4%			

could not be reached (39.3%) or declined (14.7%). Of the 116 enrolled patients, 57 (49.1%) completed the program within 6 months.

Primary and Secondary Outcomes

After combining each period-specific intervention effect and accounting for PCP clustering, the intervention led to an increase in hypertension control (RD 0.9%; 95% CI [0.3,1.5]) (Table 4). Most of the improvement came from PHC-only practices (RD 1.9%; 95% CI [1.3, 2.6]) while there was no significant improvement among patients in PHC & CHW practices (RD -0.1%; 95% C [-0.8, 0.6]) (eTable 3). The temporal trend for hypertension control is shown in Fig. 2. The temporal trend stratified by practice type is shown in eFigure 1. Sensitivity analysis excluding residents showed higher hypertension control (RD 1.4%; 95% CI [0.8, 2.0]) (eTable 4).

At baseline, there was a 4.9% difference in hypertension control between target patients and reference patients (73.6% vs. 78.5%). At the end of the study, that difference was reduced to 2.5% (77.2% vs 79.7%). There was no intervention effect among reference patients. After combining each period-specific difference in differences and accounting

for clustering, target patients showed a higher intervention effect in hypertension control compared to reference patients (DiD 2.1%; 95% CI [1.1, 3.1]). The effect mostly came from the PHC-only practices (DiD 3.4%; 95% CI [2.1, 4.7]) and to a lesser degree from the PHC & CHW practices (DiD 1.0%; 95% CI [0.1, 1.9]) (eTable 3).

There were no significant difference-in-differences between target and reference patients for hemoglobin A1c control (DiD 0.5%, 95% CI [-0.8, 1.8]) and breast cancer screening (DiD 0.1%; 95% CI [-0.7, 0.8]) (eTable 3).

DISCUSSION

In this stepped wedge cluster randomized trial, we found that a multi-pronged intervention utilizing an interactive online “equity dashboard” augmented by clinical support by PHCs and CHWs enlisted through “equity huddles” led to a significant improvement in hypertension control among target patients and thus reduced disparities. While most PCPs completed an equity huddle, only a small proportion viewed the equity dashboard, and few patients engaged in the CHW program.

Table 4 Hypertension Control Among Target and Reference Population During Intervention and Control Periods

Population	Intervention ¹ (95% CI)	Control ² (95% CI)	RD ³ (95% CI)
Target (BIPOC, Hispanic, LEP)	77.1% (75.9, 78.4)	76.2% (75.3, 77.1)	0.9% (0.3, 1.5)
Reference (White, English-speaking)	79.8% (79.0, 80.7)	80.9% (80.1, 81.7)	-1.1% (-1.5, -0.7)
Difference-in-differences between target and reference populations ⁴			2.1% (1.1, 3.1)

¹Weighted hypertension control rate during all intervention periods

²Weighted hypertension control rate during all control periods

³Rate difference between intervention and control after combining intervention effects from all periods and accounting for clustering and adjusting for age, gender, and insurance type

⁴Difference-in-differences between target and reference populations adjusting for age, gender, and insurance type

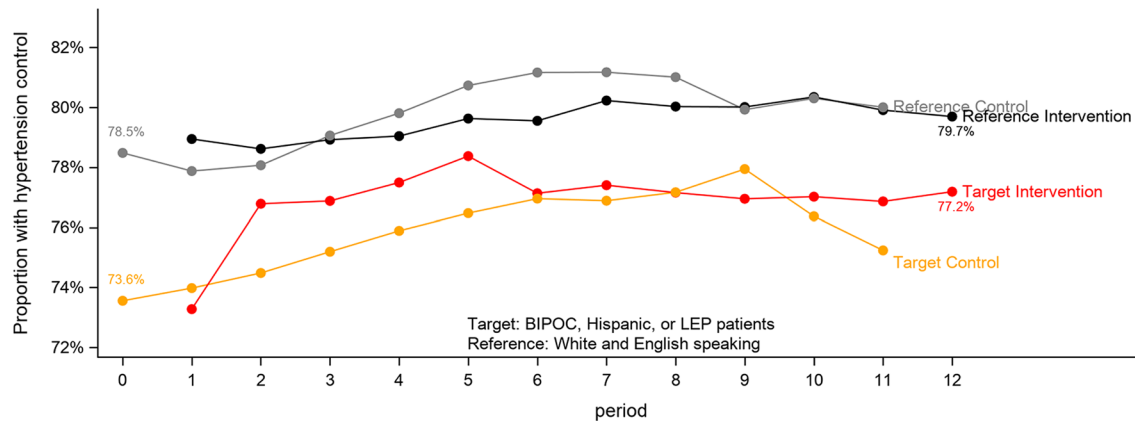


Figure 2 Temporal trends in hypertension control. Reference control: White and English-speaking patients of PCPs who are in the control step. Reference intervention: White and English-speaking patients of PCPs who are in the intervention step. Target control: BIPOC, Hispanic, or LEP patients of PCPs who are in the control step. Target intervention: BIPOC, Hispanic, or LEP patients of PCPs who are not in the intervention step.

Modifiable drivers for disparities in hypertension control include differences in treatment intensification and missed visits.¹⁰ By providing a list of potential actions during the equity huddle, PCPs were encouraged to formulate a concrete plan for each patient not at goal for hypertension control to address these drivers. The most frequently selected intervention during equity huddles was to schedule follow-up with the PCP. This suggests that re-engaging patients who were overdue for a visit or lost to follow-up was the biggest driver for improvement. One of the challenges was completing huddles with residents who spend most of their time in the inpatient setting. Sensitivity analysis limited to attendings, with higher huddle rates, showed greater improvement in hypertension control, suggesting that equity huddles played a key role in improving outcomes. In addition, the finding of no significant reduction in disparities for secondary outcomes further corroborates the impact of equity huddles in addressing disparities.

Given a growing emphasis on health equity,¹¹ engaging PCPs in this type of quality improvement will be critical to improving population health and advancing health equity. Providing PCPs time to participate in such interventions should improve participation.¹² In places without a dedicated Population Health team, pre-existing clinic staff such as medical assistants could lead these equity huddles and implement follow-up tasks.

The relative difference in hypertension control between the control and intervention periods was smaller than anticipated. This is in part because of the low equity huddle completion rate, particularly among residents. This highlights the need to provide residents with adequate time and support to engage in quality improvement efforts. This is especially important as resident PCPs' patients are less likely to be at goal for chronic disease and cancer screening measures.^{13,14} Disparities are further exacerbated when resident PCPs care for a higher proportion of BIPOC, Hispanic, and

LEP patients.^{13,15} This was also true in this study, as resident PCPs cared for 12.0% of the target patients and 5.5% of the reference patients. Therefore, inequitable access to staff PCPs is another important factor that must be remediated to reduce disparities.

Contrary to our expectation, practices that had both PHC and CHW support did not see a significant improvement in hypertension control, whereas practices with just PHC support did. There are several potential explanations. First, there is a possibility of a Hawthorne effect where the United Against Racism initiative in the five PHC & CHW practices may have increased PCPs' attention to hypertension control in the target population. Second, few patients were enrolled after referral to the CHW program as many patients could not be reached or declined. Third, patients who were referred to the CHW but never engaged did not receive any other intervention as there was no process in place to direct these patients back to the PCP and/or PHC for additional follow-up.

Another part of the intervention was giving PCPs access to an equity dashboard. The equity dashboard is unlikely to have had any significant effect as it was only viewed by 11% of PCPs. The fact that the dashboard was disseminated via email and did not provide actionable, patient-level data may have contributed to few PCPs viewing it. While audit and feedback has been shown to be an effective method for improving outcomes,¹⁶ providing feedback that is not actionable or achievable without additional support is unlikely to have a significant impact.

This study has several strengths. First, the study was conducted in a large network of diverse primary care practices including urban, suburban, and community health clinics, increasing the generalizability of results. Second, the patient population that was targeted was diverse in terms of REaL, further increasing generalizability. Third, equity huddles, likely the most important part of the intervention, are not

prohibitively costly and can be conducted by existing clinical team members in most practice environments, which will enable other health systems to replicate this intervention. Fourth, the intervention leveraged pre-existing staff in each practice to ensure the program would be sustainable.

Study Limitations

There were some limitations to this study. First, practice leaders and primary care equity steering committee members who are more likely to be committed to improving outcomes and addressing disparities were excluded from participation. Second, since randomization was at the PCP level, there may have been “contamination” of control group PCPs in the same clinic. Third, engagement in two of the interventions (i.e., equity dashboard and CHW program) was low. Fourth, since an equity huddle was only completed once for each PCP, patients who escaped hypertension control later in the study did not receive any intervention. All these factors likely contributed to a smaller-than-anticipated intervention effect. Lastly, we do not have data on other process measures, such as the rate of hypertension treatment intensification.

CONCLUSIONS

This stepped wedge cluster randomized trial found that addressing disparities in an ambulatory quality outcome measure through equity huddles augmented by clinical support by PHCs and CHWs led to a small but clinically and statistically significant improvement in hypertension control among BIPOC, Hispanic, and LEP patients in our primary care network. These findings have important implications given widespread disparities in hypertension control and a growing emphasis on health equity and population health in the US.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11606-024-08839-y>.

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Declarations

Conflict of Interest: Dr. Horn reports personal fees from Devoted Health, outside the submitted work. All other authors have nothing to disclose.

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