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Journal

The Permanente Journal, 26(1)

ISSN

1552-5767

Authors

Marshall, Cassondra
Adams, Alyce S
Ma, Lin
et al.

Publication Date

2022-03-01

DOI

10.7812/tpp/21.024

Peer reviewed

Clinical Decision Support to Address Racial Disparities in Hypertension Control in an Integrated Delivery System: Evaluation of a Natural Experiment

Cassondra Marshall, DrPH, MPH[1]; Alyce S Adams, PhD[2]; Lin Ma, MA[2]; Andrea Altschuler, PhD[2]; Mark W Lin, MD, MPH[3]; Nailah A Thompson, DO, MPH[3]; Joseph D Young, MD[3]

Perm J 2021;00:21.024 • E-pub: 10/25/2021 • https://doi.org/10.7812/TPP/21.024

Abstract

INTRODUCTION: Effective, equity-promoting interventions implemented by health care systems are needed to address health care disparities and population-level health disparities. We evaluated the impact of a clinical decision support tool to improve evidence-based thiazide diuretic prescribing among Black patients to address racial disparities in hypertension control.

METHODS: We employed an interrupted time series design and qualitative interviews to evaluate the implementation of the tool. Our primary outcome measure was the monthly rate of thiazide use among eligible patients before and after implementation of the tool (January 2013-December 2016). We modeled month-to-month changes in thiazide use for Black and White patients, overall, and by sex and medical center racial composition. We conducted key informant interviews to identify modifiable facilitators and barriers to implementation of the tool across medical centers.

RESULTS: Of the 318,720 patients, 15.5% were Black. We observed no change in thiazide use or blood pressure control following the implementation of the tool in either racial subgroup. There was a slight but statistically significant reduction (2.32 percentage points, $p < 0.01$) in thiazide use among Black patients following the removal the tool that was not observed among White patients. Factors affecting the tool's implementation included physician and pharmacist resistance to thiazide use and a lack of ongoing promotion of the tool.

DISCUSSION: The clinical decision support tool was insufficient to change prescribing practices and improve blood pressure control among Black patients.

CONCLUSIONS: Future interventions should consider physician attitudes about thiazide prescribing and the importance of multilevel approaches to address hypertension disparities.

Corresponding Author
Cassondra Marshall, DrPH, MPH
cassiejm@berkeley.edu

Author Affiliations
[1]School of Public Health, University of California, Berkeley, Berkeley, CA, USA
[2]Division of Research, Kaiser Permanente Northern California, Oakland, CA, USA
[3]Oakland Medical Center, Kaiser Permanente Northern California, Oakland, CA, USA

Author Contributions:
Cassondra Marshall, DrPH, MPH, participated in the study design, data collection, analysis of data, and drafting of the final manuscript. Alyce A Adams, PhD, participated in the study design, analysis of data, and drafting of the final manuscript. Lin Ma, MA, participated in the study design, acquisition and analysis of data, and drafting of the final manuscript. Andrea Altschuler, PhD, participated in the study design, data collection, analysis of data, and drafting of the final manuscript. Mark Lin, MD, MPH, participated in the study design and drafting of the final manuscript. Nailah Thompson, DO, MPH, participated in the study design and drafting of the final manuscript. Joseph Young, MD, participated in the study design and drafting of the final manuscript.

Acknowledgments
The authors would like to acknowledge Eileen Kim, MD, for her contribution to the project.

Disclosures
Conflicts of Interest: None declared
Funding: This study was funded by the Kaiser Permanente Northern California Delivery Science Research Program.

Introduction

Effective, equity-promoting interventions implemented by health care systems are needed to address health care disparities and population-level health disparities. Pragmatic strategies that can be scaled and integrated into routine care to address health disparities, particularly in large, diverse health care settings, are needed, and health care leaders must identify determinants of disparities that are potentially modifiable through health system intervention. One key challenge for health care systems is the identification of modifiable determinants of suboptimal blood pressure management among Black patients.[1,2]

Hypertension is a leading cause of preventable disease and death in the United States,[3] and racial disparities in hypertension prevalence and control are well-documented and persistent.[4] Approximately 40% of non-Hispanic Black adults have hypertension, the highest prevalence among all US racial/ethnic groups, and Black adults have higher rates of uncontrolled hypertension than non-Hispanic White adults.[3] While the causes of hypertension-related disparities are multi-factorial and include factors related to individual patients, their support systems, local and policy environments as well as clinicians and systems,[5] one key aspect of uncontrolled hypertension is appropriate medication therapy. Guidelines from the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure indicate that thiazide diuretics are recommended as first-line therapy for uncomplicated hypertension and frequently should be added to treatment regimens to improve blood pressure control.[6] Thiazide diuretics may be especially effective in the control of hypertension and in the prevention of strokes among Black patients.[6-8]

However, evidence suggests suboptimal prescribing among clinicians with respect to the Joint National Committee recommendation,[4,9] resulting in an underuse of these medications in clinical practice. Thus, the promotion of the use of thiazide diuretics at clinically effective doses in routine clinical practice is one strategy that health systems can use to address racial disparities in hypertension control. In 2015, Kaiser Permanente Northern California (KPNC) implemented a region-wide clinical decision support tool to identify Black patients with poor blood pressure control who might have benefited from thiazide diuretic initiation or intensification.[10] Given that health systems' quality improvement efforts to address disparities are understudied[11] and a need for greater attention to hypertension implementation and dissemination research specifically for African American patients,[12] the purpose of present study was to evaluate the tool's real-world effectiveness in improving thiazide use among Black relative to White patients.

Materials and Methods

SETTING AND DESCRIPTION OF CLINICAL DECISION SUPPORT INTERVENTION

KPNC is a large integrated delivery system consisting of 250 medical offices serving over 4.5 million members in a 13-county area of Northern California. KPNC has a robust population management infrastructure for hypertension,[13] a hypertension quality measure linked to financial incentives for each facility, and an equity-specific measure on hypertension control among Black patients that is shared on a monthly basis with senior leadership. In January of 2015, KPNC implemented a decision support tool region-wide designed to aid clinical care teams in the identification of Black patients at risk for suboptimal use of thiazide diuretics and to facilitate clinically appropriate changes in treatment. The tool utilized data from the electronic health record (EHR), including pharmacy data, to identify patients with poor blood pressure control who were potentially eligible for changes in treatment (ie, no known allergy to thiazides or thiazide-like diuretics). The tool was designed to be used by medical assistants to identify patients for targeted outreach. Once identified, patients were contacted by a medical assistant to encourage repeat blood pressure measurement. Patients whose tests indicated persistent poor control were then contacted by a pharmacist to discuss thiazide use. The tool was implemented following a brief pilot test in one medical center to assess feasibility.[14] All quality improvement managers received training on the tool at a region-wide meeting in February 2015, which included education about disparities in hypertension among Black patients and training in effective communication strategies. The clinical decision support tool was available to health care teams starting in January 2015. However, due to a change in pharmacy management systems, the tool was phased out across the system over a period of time between September 2015 and April 2016.

STUDY DESIGN

We employed an interrupted time series (ITS) design to test whether the proportion of Black patients using thiazides increased after the implementation of the thiazide tool (tool off/on/off again). We also conducted key informant interviews to identify modifiable facilitators and barriers to the tool's implementation. This study was approved by the Institutional Review Board of the Kaiser Foundation Research Institute.

Qualitative Data

We conducted interviews with quality and operations leaders to understand the context of decision-making related to thiazide diuretics and knowledge and use of the tool. We used purposive sampling to select the participants, focusing on the medical centers serving a higher and lower proportion of Black patients in the region. We developed a theory-informed,[15] semi-structured interview to assess how the tool was used, who used the tool, and general impressions of its utility. All interviews were recorded and transcribed. Three authors (CM, ASA, AA) coded interview transcripts using a thematic approach to identify salient themes as well as barriers and facilitators to the tool's implementation. Themes were mapped to a commonly used implementation science framework.[15]

Setting and Study Population

Our sample included Black and White patients aged 18 to 85 with diagnosed hypertension between January 2013 and December 2016. Patients were required to have at least one inpatient diagnosis or two outpatient diagnoses of hypertension (n = 819,300). We excluded patients based on age (269,458), non-Black or White race (n = 17,310), and with known allergies to thiazide or thiazide-like diuretics (n = 28,080). Allergies were ascertained from the EHR. To ensure stable population characteristics over time and complete data on thiazide use, we required that patients be alive for the entire study period and have continuous enrollment for at least 10 months per year. The final analytic cohort consisted of 49,035 Black and 269,415 White patients (Figure 1). Table 1 describes the baseline characteristics of the study cohort by race.

Measures

All data were extracted from the patient EHR. The primary outcome was the monthly proportion of patients with a prescription for a thiazide (thiazide use). Thiazide use referred to any thiazide use during the month (new users or ongoing users). Patients needed to have at least 1 day of drug coverage per month. Thiazides under study were: hydrochlorothiazide, chlorthalidone, metolazone, indapamide, chlorothiazide, and methyclothiazide. Combination therapy was included. Secondary outcomes included the proportion of patients whose blood pressure was controlled and the proportion of patients using an optimal dosage of thiazides. Blood pressure control was defined as blood pressure >139/89 for patients younger than 60, >139/89 for patients 60 or older who had evidence of diabetes, and 149/89 for patients 60 or older who had no evidence of diabetes. Suboptimal dosages were defined as < 50 mg/d for hydrochlorothiazide, < 25 mg/d for chlorthalidone, < 5.0 mg/d for metolazone, < 2.5 mg/d for indapamide, < 500 mg/d for chlorothiazide, and < 2.5 mg/d for methyclothiazide. We created separate dichotomous variables to indicate before the clinical decision support tool was turned on, was available, and was turned off. We also characterized patients into subgroups by race (Black, White), age (18-44/45-64/65-85), sex (male/female), and the racial composition of the home medical facility (≥ 20% Black, < 20% Black) to facilitate stratified modeling approaches. In this setting, race and ethnicity are available in the EHR and primarily self-reported.

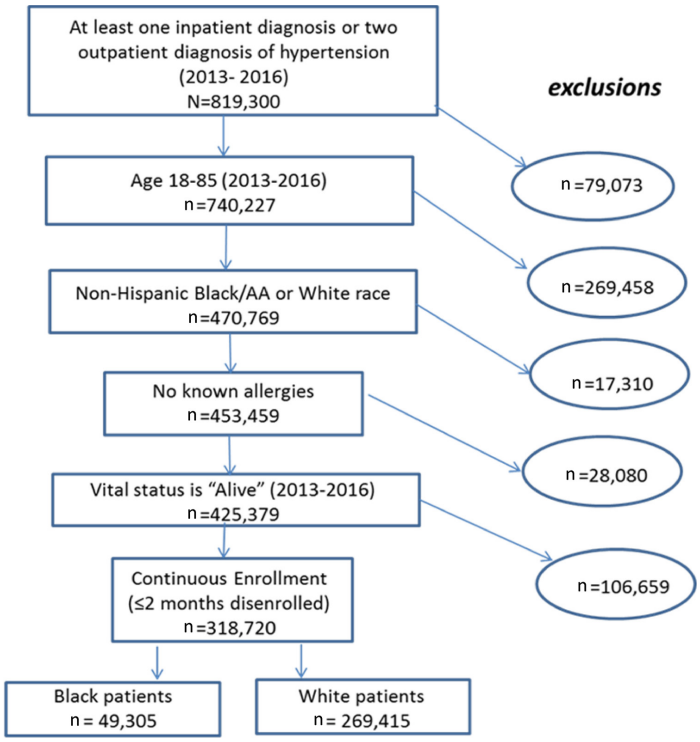

Figure 1: Description of the application of inclusion and exclusion criteria and impact on sample size.

	Black patients		White patients	
	n	%	n	%
Total	49,305	15.46	269,415	84.53
Characteristic				
Age				
18–44	6,443	13.07	17,454	6.48
45–64	26,668	54.09	116,483	43.23
65+	16,194	32.84	135,478	50.29
Sex				
Male	28,951	58.72	134,924	50.08
Female	20,352	41.28	134,488	49.92
Unknown	2	0.00	3	0.00
Facility				
<20% Black	26,967	54.69	237,220	88.05
≥20% Black	21,663	43.94	29,066	10.79
Unknown	675	1.37	3,129	1.16

Table 1: Baseline characteristics of the study cohort by race (N = 318,720)

Data Analysis

We used contingency tables (χ^2) to examine differences in characteristics between Black and White patients in the sample. To examine the impact of the clinical decision support tool on thiazide use and dosing, we used segmented regression models to evaluate the effect of the introduction and subsequent removal of the tool on the proportion of thiazides prescribed among Black and White patients. Segmented regression analysis of ITS data allowed us to evaluate the immediate discontinuity and longer-term slope change in thiazide use after the introduction of the thiazide tool. For the ITS models, we excluded patients from one medical center (n = 15,995) due to the presence of a co-occurring intervention to address hypertension disparities in that setting.[16] The periods before, during, and after the implementation period constitute the three segments of the regression models. For these models, baseline (January 2013 to December 2014), time the tool was active (January to December 2015), and time the tool was off (January to December 2016) were 24, 12, and 12 months, respectively. To control for a phase-in and phase-out period, we excluded the observations between December 2014 and February 2015 and December 2015 and March 2016, respectively. We chose December 2015 to March 2016 for the phase out period as this represents when approximately 50% of the service areas within KPNC had changed over to the new pharmacy management system that led to the phase out of the tool. We had at least 8 monthly observations before and after the introduction of the thiazide tool to have sufficient power to estimate regression coefficients.[17] Our models controlled for autocorrelation by testing for first-order autoregressive processes and correcting for significant correlations. We also tested for nonlinearity of the models. The effect of the thiazide tool for Black patients and White patients was estimated separately. We also constructed models to examine changes in thiazide use among Black and White patients by age, sex, and facility. All statistical analyses were conducted using SAS software version 9.4 (SAS Institute, Cary, North Carolina).

Results

QUALITATIVE FINDINGS

We interviewed six quality and operations leaders at five medical centers. There was considerable variation among the key informants with respect to their knowledge of the tool and its purpose. Interviews revealed that an existing and ongoing interest in addressing racial disparities in hypertension control facilitated use of the thiazide tool. In addition, the presence of a champion, that is, a staff member who was dedicated to patient outreach for hypertension control, also positively influenced the tool's implementation. For example, one medical center described having a medical assistant who was especially effective in interacting with and motivating elderly patients to come in for blood pressure retesting.

In terms of barriers and challenges related to the thiazide tool faced by the medical centers, some participants reported limited awareness of the tool and its purpose. This was described as possibly due to the absence of ongoing messages from health system leadership about the thiazide tool. Another identified barrier was the presence of competing priorities, including other ongoing hypertension-related quality improvement initiatives at the medical center. Some key informants described being focused on these initiatives, such as a program for home blood pressure monitoring, as opposed to the tool. Another barrier was that there appeared to be some level of clinician resistance and hesitation regarding prescribing thiazides at higher dosages. Despite the existence of a systemwide guideline relating to the use of thiazides as first line therapy for Black patients in this setting, some key informants described concerns regarding the safety of thiazides at higher

dosages for patients with hypertension. This belief, which was mentioned as being connected to post-graduate education and training for physicians and pharmacists, contributed to an underutilization of the thiazide tool. Table 2 summarizes the key facilitators and barriers.

QUANTITATIVE FINDINGS

Baseline Characteristics Of the 298,921 patients included in the ITS models, 13.4% of patients were Black (Table 3). A significantly greater proportion of Black patients were women compared to White patients (58.2% versus 50.2%). At baseline, the proportion of patients with their blood pressure controlled was 83.1% for Black patients compared to 89.7% for White patients, a gap of 6.6 percentage points (Table 4). Thiazide use was higher among Black patients than White patients at baseline (40.8% versus 35.2%) (Table 3); with Black women having the highest rates of thiazide use.

Changes in Thiazide Use Among Black and White Patients Overall, throughout KPNC, the proportion of Black patients using thiazides was stable before and after the introduction of the thiazide tool (Table 3). The implementation of the tool was not associated with a statistically significant immediate increase (Black patients: 0.25 percentage point increase; $p = 0.58$) or increasing trend (Black patients: 0.02 percentage point decrease; $p = 0.69$) in the proportion of thiazide use. However, following the removal of the tool, we observed an immediate 2 percentage points decrease in the proportion of Black patients using thiazides ($p < 0.01$). This change was consistent across sex- and age-specific subgroups. The proportion of White patients using thiazides was stable throughout the study period.

Figure 2 depicts time series of changes in the proportion of Black and White patients using thiazides by facility before and after the introduction and removal of the thiazide tool. We observed an increasing trend in the proportion of thiazide use among Black patients in facilities with less than 20% of Black patients following the introduction of the tool, although this did not reach statistical significance (0.1 percentage points; 95% confidence interval [CI]: −0.0, 0.2) (Table 3). Following the removal of the tool, there was a statistically significant reduction in the proportion of Black patients using thiazides in these facilities (2.3 percentage points; 95% CI: −3.9, −0.8). Thiazide use among White patients at both facility types was stable following the introduction and removal of the tool (Table 3).

There were no clinically or statistically significant changes in blood pressure control for either Black or White patients before or after the intervention. Table 4 presents the proportion of Black and White patients in control at baseline, while the tool was active, and after the tool was inactive. The proportion of patients with a suboptimal thiazide dose was similarly stable across the study period (Table 4).

Discussion

The purpose of this study was to evaluate an EHR embedded tool designed to improve thiazide use among Black patients with poor blood pressure control and reduce disparities in hypertension control within an integrated delivery system. Over the 4-year study period, there were no clinically

COM-B Category	Barriers	Facilitators
Capability	• Little knowledge of thiazide tool and/or tool's purpose	• High awareness of tool and tool's purpose
Opportunity	• Lack of ongoing messages about tool from health system leadership • Tool was not designed to be used for use during a clinical encounter • The presence of other facility-initiated hypertension projects	
Motivation	• Clinician and pharmacist concern about safety of thiazides at certain dosages • Belief that tool was just 'one more thing to do' in the presence of many other tasks and quality improvement initiatives	• An already-existing interest in and motivation towards addressing racial disparities in hypertension • Belief that the tool was useful and valuable • The presence of a "champion"

Table 2: Barriers and facilitators of the use of the thiazide tool mapped to the Capability, Opportunity, and Motivation (COM-B) model
COM-B = Capability, Opportunity, and Motivation model.

	n	%	Observed thiazide use at baseline (%)	Baseline Trend Estimate (95% CI)	P	Introduction of thiazide query (95% CI)	P	Post-Introduction Trend Change Estimate (95% CI)	P	Removal of thiazide query (95% CI)	P	Post-Removal Trend Change Estimate (95% CI)	P
Characteristics													
Black patients	39,914	13.4	40.8	0.004 (–0.03, 0.04)	0.79	0.25 (–0.66, 1.17)	0.58	–0.02 (–0.13, 0.09)	0.69	**–1.55 (–2.65, –0.45)**	0.01	0.14 (–0.00, 0.29)	0.06
White patients	259,007	86.6	35.23	–0.02 (–0.05, 0.01)	0.12	–0.08 (–0.83, 0.67)	0.83	–0.04 (–0.13, 0.04)	0.32	–0.21 (–0.99, 0.58)	0.59	0.04 (–0.07, 0.16)	0.43
Age, years													
Black patients 18–44	5,451	2.02	27.98	**0.17 (0.16, 0.18)**	<0.001	0.46 (–0.10, 1.02)	0.1	0.04 (–0.04, 0.11)	0.31	**–1.27 (–1.96, –0.58)**	<0.001	0.001 (–0.11, 0.11)	0.98
White patients 18–44	16,826	5.48	21.38	**0.18 (0.15, 0.21)**	<0.001	–0.20 (–1.13, 0.74)	0.67	–0.004 (–0.12, 0.11)	0.95	–0.07 (–1.18, 1.03)	0.89	–0.05 (–0.21, 0.10)	0.47
Black patients 45–64	21,826	8.37	42.19	**0.05 (0.01, 0.09)**	0.01	0.42 (–0.66, 1.50)	0.44	–0.05 (–0.18, 0.08)	0.41	**–1.60 (–2.89, –0.32)**	0.02	0.16 (–0.02, 0.33)	0.07
White patients 45–64	112,048	36.55	34.67	**0.05 (0.04, 0.07)**	<0.001	–0.49 (–1.19, 0.22)	0.17	–0.003 (–0.09, 0.08)	0.94	–0.56 (–1.66, 0.55)	0.31	–0.004 (–0.12, 0.11)	0.94
Black patients 65+	12,637	5.08	43.86	**–0.15 (–0.17, –0.14)**	<0.001	0.02 (–0.56, 0.60)	0.95	0.02 (–0.05, 0.10)	0.53	**–1.73 (–2.45, –1.00)**	<0.001	**0.19 (0.08, 0.31)**	<0.01
White patients 65+	130,133	42.51	37.24	**–0.11 (–0.13, –0.10)**	<0.001	–0.51 (–1.39, 0.37)	0.24	–0.01 (–0.11, 0.09)	0.86	–0.24 (–1.56, 1.09)	0.71	0.03 (–0.08, 0.14)	0.6
Sex													
Black females	23,213	58.2	44.66	**–0.03 (–0.04, –0.01)**	<0.001	0.35 (–0.41, 1.10)	0.36	–0.02 (–0.12, 0.08)	0.7	**–1.74 (–3.14, –0.35)**	0.02	**0.25 (0.12, 0.37)**	<0.001
White females	129,935	50.2	39.12	**–0.04 (–0.07, –0.01)**	0.01	–0.16 (–0.97, 0.65)	0.69	–0.04 (–0.13, 0.05)	0.41	–0.22 (–1.11, 0.67)	0.62	0.04 (–0.08, 0.16)	0.52
Black males	16,699	41.8	35.44	0.02 (–0.00, 0.03)	0.06	0.21 (–0.34, 0.76)	0.45	0.01 (–0.06, 0.08)	0.77	**–1.4 (–2.08, –0.72)**	<0.001	0.02 (–0.07, 0.12)	0.62
White males	129,070	49.8	31.30	–0.01 (–0.04, 0.02)	0.62	–0.01 (–0.71, 0.70)	0.99	–0.05 (–0.13, 0.04)	0.27	–0.2 (–0.93, 0.5)	0.59	0.05 (–0.06, 0.16)	0.38
Facility													
Black patients, Facility <20% Black	26,967	8.56	41.05	–0.002 (–0.02, 0.01)	0.83	–0.29 (–1.11, 0.53)	0.48	0.08 (–0.02, 0.19)	0.1	**–2.32 (–3.86, –0.77)**	<0.01	0.11 (–0.02, 0.23)	0.09
White patients, Facility <20% Black	237,220	75.33	35.20	–0.02 (–0.05, 0.01)	0.17	–0.10 (–0.85, 0.66)	0.79	–0.04 (–0.13, 0.05)	0.34	–0.22 (–1.01, 0.57)	0.57	0.05 (–0.07, 0.16)	0.42
Black patients, Facility ≥20% Black	12,947	6.88	40.26	–0.01 (–0.03, 0.01)	0.39	0.73 (–0.05, 1.50)	0.06	**–0.12 (–0.22, –0.2)**	0.02	–0.74 (–1.70, 0.21)	0.12	**0.15 (0.02, 0.29)**	0.03
White patients, Facility ≥20% Black	21,787	9.23	35.54	**–0.05 (–0.07, –0.04)**	<0.001	–0.04 (–0.73, 0.66)	0.92	–0.03 (–0.12, 0.05)	0.43	–0.62 (–1.75, 0.51)	0.27	0.07 (–0.03, 0.17)	0.15

Table 3: Baseline characteristics and estimated effects (in percentage points) of the introduction and removal of the thiazide query tool on thiazide use by race, gender, and facility, Kaiser Permanente Northern California, 2013-2016 (N = 298,921)
CI = confidence interval.
Bold type indicates statistical significance.

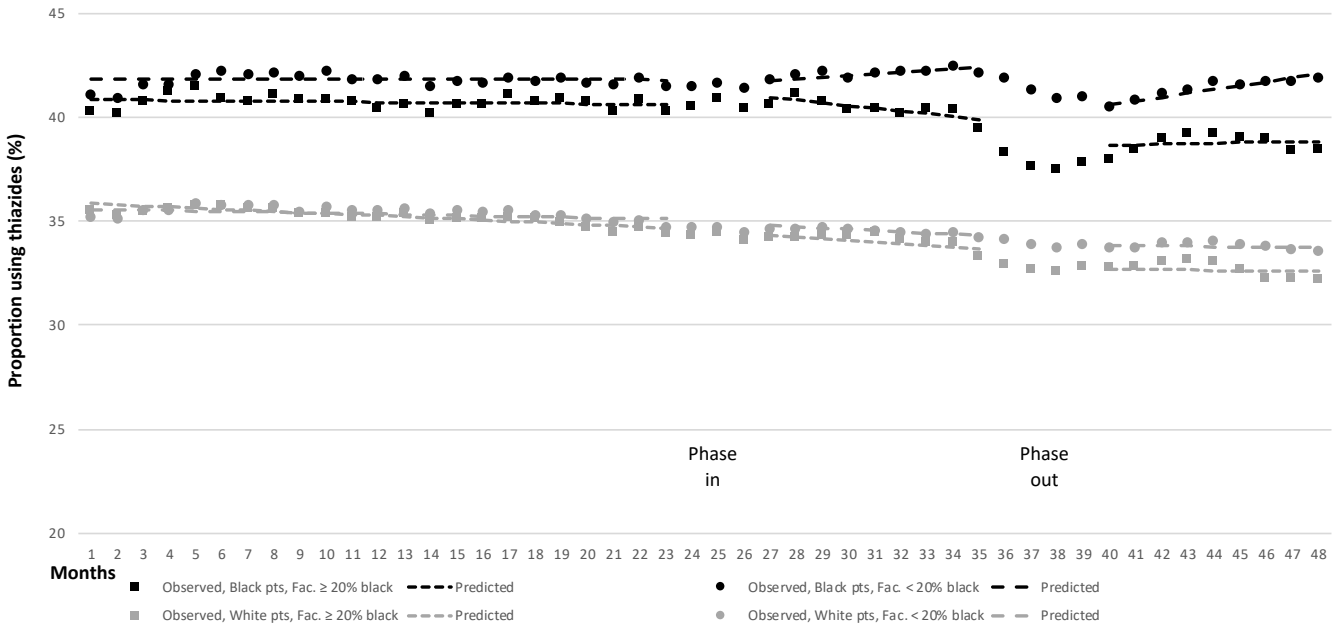

Figure 2: Monthly thiazide use among Black and White patients by racial composition of the home medical facility (≥ 20% Black, < 20% Black) before, after, and following the removal of the thiazide tool (2013 to 2016). The predicted line reflects the regression results for each segment. The shaded areas represent the tool phase-in and phase-out periods. These data points are not included in the regression model.

or statistically significant increases in thiazide use following the implementation of the tool in either racial subgroup. However, we did observe a slight but statistically significant reduction in thiazide use among Black patients following the removal the tool that was not observed among White patients. In addition, there was a slight but clinically significant increasing trend in thiazide use among Black patients in facilities with a smaller proportion of Black patients. These findings indicate the tool may have had some limited impact on thiazide use in Black patients, but no changes were found for hypertension control.

Our findings are similar to another study that examined the impact of an educational intervention for primary care clinicians to increase thiazide prescribing overall.[18] In that study, researchers similarly did not find differences in thiazide prescriptions and identified clinician attitudes and beliefs as one reason for the limited impact. However, another study targeting patient rather than clinician behavior reported increases in thiazide prescriptions among patients with poor blood pressure control.[19]

We believe there are several factors that may have contributed to the limited impact of the tool. The qualitative interviews suggested several possibilities including physician attitudes toward thiazides, lack on ongoing promotion of the thiazide tool, and the limited time the thiazide tool was operational. Of note, physician concerns about thiazides and, specifically, the possibility of serious side effects have been found in other studies.[20,21] Another possible explanation for our findings is that the timing and placement of the tool may not have been optimal for the behavior required to enact change. Kawamoto and colleagues noted that clinical decision support interventions should ideally

	Baseline			Tool on			Tool off		
	All	White patients	Black patients	All	White patients	Black patients	All	White patients	Black patients
Blood Pressure control (%)	88.8	89.7	83.1	89.1	90.0	83.4	88.6	89.5	82.8
Optimal thiazide dose (%)	11.5	10.8	14.9	11.2	10.4	15.3	11.4	10.6	15.7

Table 4: Secondary outcomes of blood pressure control and thiazide dosing during the study period, Kaiser Permanente Northern California, 2013-2016

be delivered at the time and location of decision-making.[22] The optimal timing and placement of the thiazide tool may be in the clinical setting prior to making treatment decisions with a patient. Instead, the tool alerted medical assistants to have patients potentially eligible for thiazides retest their blood pressure. The qualitative findings also suggested that the region-wide implementation plan may not have adequately accounted for differences in priorities across individual medical centers, thereby limiting the impact of the thiazide tool. Finally, as this is a setting with very high rates of hypertension control,[23,24] the lack of movement may also reflect a ceiling effect, limiting the impact of any additional interventions.

An important finding from the interviews is that, overall, the key informants believed there were things that the health system could do to address racial disparities in hypertension control. In fact, some of the medical centers were proactively addressing racial disparities in hypertension control via other center-level initiatives. This is encouraging and suggests an openness toward innovative quality improvement interventions to address disparities.[25,26] Importantly, reducing racial disparities in hypertension control likely requires addressing the barriers to hypertension control in Black patients that exist at multiple levels, including factors related to individual patients, families, communities, and policy.[6,27,28] Thus, health systems should consider multilevel approaches, with clinical decision support as just one piece of the larger picture to address disparities, as it is unlikely that clinical decision support systems alone will improve clinical care.[29] In one integrated system, a multilevel approach that incorporated care team redesign, improvements to access to care, programs on culturally tailored communication, as well as physician-led education on treatment guidelines, closed the gap in hypertension control between Black and White patients.[26]

To our knowledge, our study is one of the first to examine the impact of a clinical decision support intervention to improve thiazide use as a means of narrowing racial disparities in hypertension control by changing physician prescribing related to thiazide diuretics. Strengths of our study include a rigorous quasi-experimental study design and the use of qualitative methods to provide contextual insights. In addition, our use of the well-tested implementation science framework[15] provided a structure to reveal barriers and facilitators of the implementation of the tool into the clinical workflow.

Despite these strengths there are some limitations that deserve consideration. There is a possibility that patients may have obtained their prescription from outside of the KPNC health system and therefore were not captured in our analyses. However, this is unlikely as most KPNC members use KPNC pharmacies to fill their prescriptions due to the co-location of pharmacies and medical centers as well as the strong financial incentive to use KPNC pharmacies. It should be noted that our analysis only included Black and White patients due to the historical disparity in hypertension control between these two groups in this setting. It is possible that there are other racial/ethnic disparities that were not explored in this analysis. Finally, our findings were generated in the context of an integrated delivery system with very high publicly reported hypertension management performance[13] and in which disparities have been eliminated for some subsets of the population,[24] so the results may not be generalizable to other health systems. Further, a decision support tool of this nature, which involves both medical assistants in the clinical setting as well as pharmacists, may not be feasible in nonintegrated health settings.

Nevertheless, we believe this study offers lessons for health care practices and systems. Both integrated and nonintegrated health systems use population management, including hypertension registries and decision support tools, as part of their hypertension care programs.[30] Our study describes one relatively simple way that technology can be leveraged (via the EHR) to address disparities and identify specific patients who may benefit from additional attention. Although we observed the thiazide tool did not improve thiazide use, our findings offer insights into future approaches that may be used to improve the impact of a thiazide decision support tool. This includes better incorporating facility-level variation in quality priorities, accounting for physician concerns about thiazide dosage, and having a clinician use the tool in the clinical setting prior to making treatment decisions with a patient. As mentioned above, decision support tools should be used as part of multilevel approach to improve care and address hypertension disparities.

Conclusion

Our findings suggest that, in the absence of additional educational supports, a clinical decision support tool to increase thiazide use among Black patients was insufficient to change

prescribing and did not impact blood pressure control. Future interventions may need to address variation in competing quality improvement priorities and consider strong physician attitudes about thiazide prescribing in the intervention design.[31] Given challenges in changing physician prescribing behavior and the importance of multilevel approaches to address hypertension disparities, health systems and future studies consider interventions aimed at increasing patient engagement to facilitate self-efficacy and management.[19]

Supplementary Materials

Supplemental Material is available at: www.thepermanentejournal.org/files/2021/21.024supp.pdf

REFERENCES

1. Davis AM, Vinci LM, Okwuosa TM, Chase AR, Huang ES. Cardiovascular health disparities: A systematic review of health care interventions. Med Care Res Rev 2007 Oct;64(5 Suppl):29S–100S. DOI: https://doi.org/10.1177/1077558707305416
2. Chin MH, Clarke AR, Nocon RS, et al. A roadmap and best practices for organizations to reduce racial and ethnic disparities in health care. J Gen Intern Med 2012 Aug;27(8):992–1000. DOI: https://doi.org/10.1007/s11606-012-2082-9
3. Centers for Disease Control and Prevention. Facts About Hypertension. Accessed October 29, 2020. https://www.cdc.gov/bloodpressure/facts.htm
4. Gu A, Yue Y, Desai RP, Argulian E. Racial and ethnic differences in antihypertensive medication use and blood pressure control among US adults with hypertension: The National Health and Nutrition Examination Survey, 2003 to 2012. Circ Cardiovasc Qual Outcomes 2017 Jan;10(1):e003166. DOI: https://doi.org/10.1161/CIRCOUTCOMES.116.003166,
5. Mueller M, Purnell TS, Mensah GA, Cooper LA. Reducing racial and ethnic disparities in hypertension prevention and control: What will it take to translate research into practice and policy? Am J Hypertens 2015 Jun;28(6):699–716. DOI: https://doi.org/10.1093/ajh/hpu233
6. James PA, Oparil S, Carter BL, et al. 2014 Evidence-based guideline for the management of high blood pressure in adults: Report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA 2014 Feb;311(5):507–20. DOI: https://doi.org/10.1001/jama.2013.284427
7. Einhorn PT, Davis BR, Wright JT Jr, Rahman M, Whelton PK, Pressel SL; ALLHAT Cooperative Research Group. ALLHAT: Still providing correct answers after 7 years. Curr Opin Cardiol 2010 Jul;25(4):355–65. DOI: https://doi.org/10.1097/HCO.0b013e32833a8828
8. Chang TI, Evans G, Cheung AK, et al; SPRINT Study Research Group. Patterns and correlates of baseline thiazide-type diuretic prescription in the Systolic Blood Pressure Intervention Trial. Hypertension 2016 Mar;67(3):550–5. DOI: https://doi.org/10.1161/HYPERTENSIONAHA.115.06851
9. Gerber BS, Cho YI, Arozullah AM, Lee S-YD. Racial differences in medication adherence: A cross-sectional study of Medicare enrollees. Am J Geriatr Pharmacother 2010 Apr;8(2):136–45. DOI: https://doi.org/10.1016/j.amjopharm.2010.03.002
10. Schmittdiel JA, Dlott R, Young JD, Rothmann MB, Dyer W, Adams AS. The Delivery Science Rapid Analysis Program: A research and operational partnership at Kaiser Permanente Northern California. Learn Health Syst 2017 Oct;1(4):e10035 DOI: https://doi.org/10.1002/lrh2.10035
11. Wasserman J, Palmer RC, Gomez MM, Berzon R, Ibrahim SA, Ayanian JZ. Advancing health services research to eliminate health care disparities. Am J Public Health 2019 Jan;109(S1):S64–9. DOI: https://doi.org/10.2105/AJPH.2018.304922
12. Whelton PK, Einhorn PT, Muntner P, et al; National Heart, Lung, and Blood Institute Working Group on Research Needs to Improve Hypertension Treatment and Control in African Americans. Research needs to improve hypertension treatment and control in African Americans. Hypertension 2016 Nov;68(5):1066–72. DOI: https://doi.org/10.1161/HYPERTENSIONAHA.116.07905
13. Jaffe MG, Young JD. The Kaiser Permanente Northern California story: Improving hypertension control from 44% to 90% in 13 years (2000 to 2013). J Clin Hypertens (Greenwich) 2016 Apr;18(4):260–1. DOI: https://doi.org/10.1111/jch.12803
14. Schmittdiel JA, Adams AS, Dlott R. Preventing diabetes in high-risk patients: Time for a system-level approach to disease prevention. J Gen Intern Med 2019 Aug;34(8):1367–8. DOI: https://doi.org/10.1007/s11606-019-04994-9
15. Michie S, van Stralen MM, West R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. Implement Sci 2011 Apr; 6(1):42 DOI: https://doi.org/10.1186/1748-5908-6-42
16. Nguyen-Huynh MN, Young JD, Alexeeff S, Hatfield MK, Sidney S. Shake Rattle & Roll - Design and rationale for a pragmatic trial to improve blood pressure control among blacks with persistent hypertension. Contemp Clin Trials 2019 Jan;76:85–92. DOI: https://doi.org/10.1016/j.cct.2018.11.012
17. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. J Clin Pharm Ther 2002 Aug;27(4):299–309. DOI: https://doi.org/10.1046/j.1365-2710.2002.00430.x
18. Presseau J, Grimshaw JM, Tetroe JM, et al. A theory-based process evaluation alongside a randomised controlled trial of printed educational messages to increase primary care physicians' prescription of thiazide diuretics for hypertension [ISRCTN72772651]. Implement Sci 2016 Sep;11(1):121 DOI: https://doi.org/10.1186/s13012-016-0485-4
19. Kaboli PJ, Howren MB, Ishani A, Carter B, Christensen AJ, Vander Weg MW. Efficacy of patient activation interventions with or without financial incentives to promote prescribing of thiazides and hypertension control: A randomized clinical trial. JAMA Netw Open 2018 Dec;1(8):e185017. DOI: https://doi.org/10.1001/jamanetworkopen.2018.5017
20. Rochefort CM, Morlec J, Tamblyn RM. What differentiates primary care physicians who predominantly prescribe diuretics for treating mild to moderate hypertension from those who do not? A comparative qualitative study. BMC Fam Pract 2012 Feb;13(1):9 DOI: https://doi.org/10.1186/1471-2296-13-9
21. Sutton E, Wilson H, Kaboli PJ, Carter BL. Why physicians do not prescribe a thiazide diuretic. J Clin Hypertens (Greenwich) 2010 Jul;12(7):502–7. DOI: https://doi.org/10.1111/j.1751-7176.2010.00299.x

22. Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. BMJ 2005 Apr;330(7494):765. DOI: https://doi.org/10.1136/bmj.38398.500764.8F
23. Jaffe MG, Lee GA, Young JD, Sidney S, Go AS. Improved blood pressure control associated with a large-scale hypertension program. JAMA 2013 Aug;310(7):699–705. DOI: https://doi.org/10.1001/jama.2013.108769
24. Ayanian JZ, Landon BE, Newhouse JP, Zaslavsky AM. Racial and ethnic disparities among enrollees in Medicare Advantage plans. N Engl J Med 2014 Dec;371(24): 2288–97. DOI: https://doi.org/10.1056/NEJMsa1407273
25. Kilbourne AM, Switzer G, Hyman K, Crowley-Matoka M, Fine MJ. Advancing health disparities research within the health care system: a conceptual framework. Am J Public Health 2006 Dec;96(12):2113–21. DOI: https://doi.org/10.2105/AJPH.2005.077628
26. Bartolome RE, Chen A, Handler J, Platt ST, Gould B. Population care management and team-based approach to reduce racial disparities among African Americans/Blacks with hypertension. Perm J 2016 20(1):53–9. DOI: https://doi.org/10.7812/TPP/15-052
27. Musemwa N, Gadegbeku CA. Hypertension in African Americans. Curr Cardiol Rep 2017 Oct;19(12):129. DOI: https://doi.org/10.1007/s11886-017-0933-z
28. Bosworth HB, Dudley T, Olsen MK, et al. Racial differences in blood pressure control: potential explanatory factors. Am J Med 2006 Jan;119(1):70.e9–15. DOI: https://doi.org/10.1016/j.amjmed.2005.08.019
29. Sarkar U, Samal L. How effective are clinical decision support systems? BMJ 2020 Sep;370:m3499. DOI: https://doi.org/10.1136/bmj.m3499
30. Young A, Ritchey MD, George MG, Hannan J, Wright J. Characteristics of health care practices and systems that excel in hypertension control. Prev Chronic Dis 2018 Jun;15:E73. DOI: https://doi.org/10.5888/pcd15.170497
31. Kaiser FG, Arnold O, Otto S. Attitudes and defaults save lives and protect the environment jointly and compensatorily: understanding the behavioral efficacy of nudges and other structural interventions. Behav Sci (Basel) 2014 Jul;4(3):202–12. DOI: https://doi.org/10.3390/bs4030202