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Effectiveness evaluation of a hypertension management program in a Federally Qualified Health Center (FQHC)

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A B S T R A C T

The objective of this study was to examine effectiveness of a Hypertension Management Program (HMP) in a Federally Qualified Health Center (FQHC). From September 2018 through December 2019, we implemented HMP in seven clinics of an FQHC in rural South Carolina. A pre/post evaluation design estimated the association of HMP with hypertension control rates and systolic blood pressure using electronic health record data among 3,941 patients. A chi-square test estimated change in mean control rates in pre- and intervention periods. A multilevel multivariable logistic regression model estimated the incremental impact of HMP on odds of hypertension control. Results showed that 53.4% of patients had controlled hypertension pre-intervention (September 2016-September 2018); 57.3% had controlled hypertension at the end of the observed implementation period (September 2018-December 2019) ($p < 0.01$). Statistically significant increases in hypertension control rates were observed in six of seven clinics ($p < 0.05$). Odds of controlled hypertension were 1.21 times higher during the intervention period compared to pre-intervention ($p < 0.0001$). Findings can inform the replication of HMP in FQHCs and similar health care settings, which play a pivotal role in caring for patients with health and socioeconomic disparities.

1. Introduction

Approximately 108 million American adults have hypertension and 3 out of 4 of these individuals do not have it controlled (Centers for Disease Control and Prevention (CDC), 2017). Hypertension disproportionately impacts Black/African American communities and individuals with low income, those covered by public health insurance, and those with no health insurance (Schober et al., 2011; Centers for Medicare and Medicaid Services, 2016). Evidence suggests that team-based care is an effective way to achieve hypertension control in clinical settings (Centers for Disease Control and Prevention, 2017). An evaluation conducted in 2009 found that a particularly effective model is Kaiser Permanente Colorado's (KPCO) Hypertension Management Program (HMP). Among all patients in the KPCO health system, HMP was found to improve blood pressure control, with clinic-wide control rates of approximately 61% in 2008 rising to 78% in 2010 and 83% in 2012 (Centers for Disease Control and Prevention, 2021). The intervention population at KPCO was predominantly white and insured. Given the disparities in hypertension outcomes in the U.S., evidence beyond the success of KPCO was needed on the implementation, effectiveness, and costs of HMP to support wider adoption of the intervention in other health care settings, particularly those that have fewer resources and serve a population disproportionately burdened by hypertension.

Diagnosing and managing hypertension through medication is a key clinical pathway toward controlling hypertension and improving cardiovascular disease outcomes (Centers for Disease Control and Prevention (CDC), 2017). Reducing average population systolic and diastolic blood pressure (DBP) could substantially reduce the risk of stroke and other adverse cardiovascular disease outcomes (Law et al., 2003; Lewington et al., 2002). Pharmacists can play an important role in supporting patients as they manage chronic disease conditions through medication therapy management in Federally Qualified Health Centers (FQHCs) (Rodis et al., 2019).

Implementation studies have demonstrated that health system delivery changes and adaptations of the Kaiser-originated intervention can be beneficial in safety net settings (Fontil et al., 2018), diverse populations (Shaw et al., 2014), and integrated health care delivery settings (Jaffe et al., 2013). within the Kaiser system. To advance the evidence

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for implementing a hypertension management program to improve hypertension control and address health disparities, from 2017 to 2019 we adapted, implemented, and evaluated the effectiveness of HMP in an FQHC.

2. Methods

2.1. Study design

We used a pre/post design to estimate the association of programmatic activities with clinic- and system-level hypertension control rates and systolic blood pressure (SBP) using electronic health record (EHR) data.

Our Institutional Review Board determined this was not human subjects research and exempted the study from further review.

2.2. Study setting and population

We implemented HMP in seven clinics of an FQHC in rural South Carolina, Family Health Centers, (hereafter, FHC), which is the sole provider of comprehensive primary and preventive health care services in their service area. FHC operates a central site in Orangeburg and six additional satellite sites in Orangeburg, Bamberg, Calhoun, and Dorchester counties. Their patient population is 89% Black/African American, 86% of patients are at or below the 100% Federal Poverty Guideline, and 21% are uninsured. In 2017, FHC's main site served 3,539 patients with a diagnosis of hypertension, and each satellite clinic served 500–800 patients with a diagnosis of hypertension. All seven clinics share a common EHR and were included in the evaluation.

2.3. Description of intervention

HMP uses a team-based, patient-centered approach that relies on contributions of clinical pharmacists to better manage hypertension patients. HMP consists of 10 components: 1) an integrated care team; 2) EHR patient registries and outreach lists; 3) no copayment walk-in blood pressure checks; 4) EHR alerts for blood pressure re-checks; 5) education for nurses and other staff on appropriate blood pressure measurement technique; 6) promoting use of combination medications to treat high blood pressure; 7) hypertension management visits (HMVs); 8) promotion of home blood pressure monitoring; 9) specialty department blood pressure measurements with referral to primary care when needed; and 10) incentives, rewards, and recognition for members of the care team (i.e., pharmacists, providers, nurses, etc.).

FHC implemented all 10 HMP components. Prior to implementing HMP, FHC conducted some elements of components 1, 7, 8, and 10, along with engaging pharmacists to play an active role in hypertension management through intensive coaching of high-risk patients (Table 1). FHC implemented all components of the program and had biweekly technical assistance calls to solve implementation challenges and ensure fidelity to program components throughout the observation period.

Table 1
HMP Components, implementation highlights, and program adaptations.

#	HMP Component	Implementation Highlights
Components Not Yet Implemented at Baseline		
2	Patient Registries and Outreach Lists in the Electronic Health Record (EHR)	Clinical pharmacists conducted outreach to patients with uncontrolled hypertension at their last patient encounter, via phone calls.
3	No-Copayment Walk-in/Scheduled Blood Pressure Checks	Nursing conducted no-copayment blood pressure checks to those who met specified criteria.
4	EHR Alerts for Blood Pressure Re-checks	Information technology (IT) staff programmed an alert to appear in FHC's EHR as soon as the nurse entered an elevated blood pressure reading.
5	Education for Nurses and Other Staff on Blood Pressure Measurement Technique	Nursing staff training was conducted at the start of HMP implementation and included step-by-step instructions for taking, reading, and recording blood pressure, as well as information about factors that affect blood pressure.
6	Promote Use of Combination Medications to Treat High Blood Pressure	FHC created a hypertension medication prescribing protocol based on Seventh Joint National Committee (JNC 7) guidelines.2 This protocol also included procedures for follow-up, labs, referrals, hypertension urgency, and hypertension emergency.
7	Hypertension Management Visits (HMV)	Clinical pharmacists developed and implemented medication management plans during HMVs. While they were not allowed to titrate medications without provider approval, pharmacists met with providers to approve medication titration recommendations.
Components Partially Implemented at Baseline		
1	Integrated Care Team	The Associate Director of Pharmacy, who led the Hypertension Coaching program in place before HMP, moved seamlessly into the HMP program champion role.
8	Promotion of Home Blood Pressure Monitoring	Although home blood pressure monitoring was encouraged prior to HMP implementation, a wrist blood pressure monitor was provided to all HMP patients at no charge during their second HMV with the clinical pharmacist.
10	Incentives, Rewards, and Recognition	FHC rewarded and recognized staff before HMP, but included meeting specified key goals tied to program implementation metrics, such as the number of blood pressure checks conducted while implementing HMP.
Components Already Fully Implemented at Baseline		
9	Specialty Department Blood Pressure Measurements with Referral to Primary Care When Needed	FHC focused on encouraging specialists within FHC to refer patients with uncontrolled blood pressure to primary care.

2.4. Data collection

We created an analytic dataset using EHR encounter data provided by FHC, which included all encounters for eligible patients observed during the pre-intervention and intervention periods. We used EHR data collected from September 1, 2016, to September 4, 2018 (pre-intervention period), and from September 5, 2018, to December 31, 2019 (intervention period). Data included patients who had 1) three or more visits to FHC; 2) at least one visit in both the pre-intervention and intervention periods; 3) were aged 18 to 85 years old with a diagnosis of hypertension in the pre-period; and 4) had no diagnosis of end-stage renal disease, transplant, or pregnancy.

Data variables included patient demographics, insurance information, blood pressure measurements and vital statistics, comorbidity flags for patients with diagnoses codes for three categories of conditions or risk factors (diabetes, smoking, and kidney disease), clinic location, provider at each encounter, and HMV information. We cleaned data errors and created variables to measure time (the number of days since the first date observed in the data), and encounters that occurred in the adult extended unit which provides urgent care services. Cleaning involved removing encounters with invalid hypertension readings, persons without encounters in both time periods, and persons with<3 total encounters. This reduced the evaluation sample size from 4,811 prior to cleaning to 3,941 after. Based on the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7) (Chobanian et al., 2003) and the

hypertension control threshold used at FHC, we estimated hypertension control at each encounter based on SBP and diastolic blood pressure (DBP) below 140/90 mmHg.

2.5. Measures & statistical analysis

We estimated the impact of HMP on hypertension control rates, using the dataset of persons with encounters in both periods. We compared unadjusted control rates, overall and by clinic, using a dataset that included only the last observed hypertension value in each month for each patient. We estimated mean control rates in the pre-intervention and intervention periods and assessed the statistical significance using $\chi 2$ tests. Using the same data, we estimated the incremental impact of HMP on the odds of hypertension control. We used a multilevel, multivariable logistic regression and controlled for the following variables: patient-level random intercept term; the lag of hypertension control (hypertension control observed at the prior patient encounter); time trends; clinic location; month of the year; age, race, and sex; patient zip code; diagnosis of diabetes, smoking, or kidney disease; patient body mass index (BMI); whether the encounter occurred in FHC's specialty adult extended unit; and absence of recorded health insurance.

Variables measuring HMP consisted of 1) an HMP time period flag that was equal to 1 for all encounters during the HMP time period and 0 during the pre-period; 2) duration of HMP in months measured as the number of days between the encounter in which BP was measured and the start of HMP divided by 30; and 3) a flag for those who had received a HMV that was equal to 1 after the HMV occurred and 0 otherwise. We selected final variables for inclusion based on the Akaike Information Criteria and the Bayesian Information Criteria, as well as qualitative choices between equivalent variables to increase result interpretability. The final model estimated patient control rate in time t as a function of a patient random intercept, the HMP flag, lag of hypertension control, clinic location, and other covariates (race, male, month, adult extended unit encounter, BMI, no insurance, kidney diagnosis). We estimated the model using SAS 9.4 (Cary, NC) using the Glimmix procedure. We specified a second model that dropped the overall HMP flag and replaced it with the interaction of HMP and clinic location to estimate the incremental impact of HMP at each location.

We also specified a linear model of the continuous outcome of SBP using the SAS mixed procedure with a similar estimation strategy. We estimated a simplified model to illustrate the program effect of HMP. The simplified model specified patient SBP as a function of a variable marking observations that occurred after an HMP clinical pharmacy visit had occurred and the interaction of the HMP period flag and the clinic location. The model controlled for whether the patient had ever received an HMP visit, the location effect across the two time periods, the measured SBP at the last clinic visit, demographic factors of age, sex, and race, patient BMI, the month in which the blood pressure reading was taken, whether a patient was uninsured, whether the measure was taken in an extended adult unit, whether a patient had received a chronic kidney diagnosis, and a patient level random effect.

3. Results

As displayed in Table 2, 3,941 patients met the eligibility criteria for inclusion in the analysis. The individuals in the sample were 64.7% female, 89.4% Black, with a mean age of 60.8 years; 41.8% had a diagnosis of diabetes.

Across FHC, 53.4% of patients had controlled hypertension in months observed during the pre-intervention period, and 57.3% had controlled hypertension in the months after the intervention was implemented ($p < 0.01$), based on last observed hypertension value in each month for each patient. Statistically significant increases in hypertension control rates were observed in six of the seven clinics ($p < 0.05$). Using this measure, hypertension control rates also increased in the additional clinic (clinic F) but this increase was not statistically significant at the 5% level (Table 3).

Table 2
Demographics of patients included in analysis at first encounter.

Patient characteristics	
Count of Patients	3,941
Age (Mean)	60.8
Sex, % (n)	
Male	35.3% (1,391)
Female	64.7% (2,550)
Race, % (n)	
Black/African American	89.4% (3,523)
Other	2.8% (111)
White	7.8% (307)
Location, % (n)	
Clinic A	6.72% (265)
Clinic B	8.93% (352)
Clinic C	10.07% (397)
Clinic D	52.02% (2050)
Clinic E	6.98% (275)
Clinic F	5.96% (235)
Clinic G	9.31% (367)
Comorbidities, % (n)	
Obesity	22.1% (871)
Diabetes	41.8% (1,647)
Smoking	6.8% (268)
Kidney Disease	6.6% (260)

Proportionally, fewer patients attending pharmacist-led HMV had controlled hypertension. Among patients who attended at least one pharmacist-led HMV (i.e., Component 7 of the intervention), 28.7% of patient encounters had controlled hypertension during the pre-intervention period and 33.0% had controlled hypertension after the intervention was implemented ($p < 0.05$). By contrast, among patients who did not attend an HMV, 54.6% of patient encounters had controlled hypertension during the pre-intervention period and 59.4% had controlled hypertension after the intervention was implemented ($p < 0.01$) (data not shown).

Using a multilevel multivariable logistic regression model across all clinic locations (not allowing effect to vary by clinic location) controlling for differences in effect by location, we found that the odds of controlled hypertension were 1.21 times higher during the intervention period than during the pre-intervention period ($p < 0.0001$) (data not shown).

The HMP period variable and the After HMP Visits (AHMPV) flag were significantly associated with reductions in SBP across all clinics (Type III F-test $p < 0.0001$ for both), with the effect of HMP varying statistically by clinic, and no observed statistical differences in AHMPV by clinic (see Table 4). Across all clinics, visits that occurred after an initial HMV were associated with a 3.93 mmHg point lower SBP (95% C. I. −5.5 to −2.3). Beyond the effect of HMV, the HMP period was associated with statistically lower SBP in four clinics, and reductions in SBP at two additional clinics, but this effect was not statistically significant ($p < 0.05$). The intervention was associated with a slight increase in SBP at one clinic, but this effect was not significant ($p < 0.05$).

Table 3
Pre/post intervention hypertension control rates at FHC.

Control Rate by Location (LAST OF MONTH)	Before HMP (%)	After HMP (%)	p
All Clinics	53.4	57.3	<0.001
Clinic A	38.0	49.0	<0.001
Clinic B	43.8	49.6	<0.001
Clinic C	46.4	51.1	<0.01
Clinic D	57.5	59.9	<0.001
Clinic E	53.3	65.3	<0.0001
Clinic F	47.0	50.5	0.15
Clinic G	58.0	62.9	<0.01

Note. HMP = Hypertension Management Program.

Table 4
Fixed effects for intervention by location for SBP.

Location	Estimate (mmHg)	CI Low	CI High	*P*
After HMV across All Clinics	−3.93	−5.53	−2.34	<0.0001
Additional Impact of HMP Period in Each Clinic				
Clinic A	−4.07	−5.48	−2.66	<0.0001
Clinic B	−1.18	−2.31	−0.05	0.0416
Clinic C	−2.56	−3.73	−1.40	<0.0001
Clinic D	0.12	−0.36	0.61	0.6182
Clinic E	−4.30	−5.57	−3.03	<0.0001
Clinic F	−0.91	−2.74	0.92	0.331
Clinic G	−0.77	−2.00	0.46	0.2186

Note. SBP = systolic blood pressure; HMV = hypertension management visit; HMP = Hypertension Management Program; CI = confidence interval.

4. Discussion

An initial effectiveness evaluation of the KPCO's Hypertension Management Program demonstrated improvements in practice-level hypertension control rates from 61% to 83% in a four-year period from 2008 to 2012 (Centers for Disease Control and Prevention, 2021). A more recent study showed the effectiveness of replicating Kaiser's hypertension management model in urban safety net health care systems (Fontil et al., 2018). To our knowledge, this is the first study to evaluate the effectiveness of this HMP model in an FQHC. FHC implemented the HMP for 15 months from September 2018 through December 2019. Across all clinics at FHC, encounter-level hypertension control improved from 53.4% at baseline to 57.3% ($p < 0.001$) at the end of the observed implementation period. While absolute improvements in hypertension control varied across clinic sites, six of the seven clinics demonstrated statistically significant improvements in hypertension control among their patient encounters. Clinics A and E demonstrated the greatest change in SBP (−4.07 $p < 0.0001$ and −4.30 $p < 0.0001$ respectively). While these clinics were averaged sized serving a rural population that was demographically similar to the overall clinic system, key implementation staff were officed in clinics A and E which may suggest greater intensity of implementation. Overall, the odds of a patient having their blood pressure controlled at a patient encounter was more than 20% higher during the intervention period compared to pre-intervention (OR: 1.21, CI: 1.15 to 1.28, $p < 0.0001$). Notably, the intervention period for the present study was 15 months which is shorter than the observation periods for other studies (Fontil et al., 2018).

While FHC's implementation of HMP was comprehensive and included 10 program components, their program included a key adaptation that focused on the intensive engagement of clinical pharmacists in managing patient hypertension through hypertension management visits (HMVs). Patients that were referred to participate in pharmacist-led HMVs tended to have more uncontrolled hypertension, but still saw significant improvements in hypertension control across patient encounters—from 28.7% pre-intervention to 33.0% after the intervention was implemented ($p < 0.05$). This finding supports the hypothesis that focused hypertension management visits led by clinical pharmacists may realize improvements in hypertension control among patients with the greatest needs.

Nearly half (48%) of adults have at least one type of cardiovascular disease (CVD), including coronary heart disease, heart failure, stroke, and hypertension (defined as ≥ 130/≥80 mm Hg) based on NHANES data 2013–2016 (Virani et al., 2020). These conditions disproportionately affect Black/African American communities and populations with low income, those covered by public insurance, and those with no insurance (Schober et al., 2011; Centers for Medicare and Medicaid Services, 2016), FQHCs are a promising practice site for focusing on hypertension control efforts because they specifically provide care to populations and locations that may have limited health care access. They are also often the primary health care access point for the populations they serve and play a critical role in treating and managing chronic conditions and their related sequalae. Pharmacists play an important role in a team approach to managing chronic conditions through medication management in FQHCs (Rodis et al., 2019). This evaluation provides evidence for the effectiveness of this approach in an FQHC system that serves Black/African American patients (89%) with high rates of comorbidity (42% diagnosed with diabetes), and in a geographic region that has some of the highest rates of hypertension diagnosis (Centers for Disease Control and Prevention, 2020), hypertension-related mortality (Centers for Disease Control and Prevention. National Center for Health Statistics, 2020), poverty (Centers for Disease Control and Prevention, 2015), and lack of health insurance (Centers for Disease Control and Prevention, 2020) in the nation. Implementing HMP at FQHCs has the potential to address disparities in health outcomes among groups experiencing a disproportionate impact of CVD.

There are a few limitations to consider when interpreting the results of this evaluation. First, we were only able to analyze hypertension values recorded during clinical encounters. This limitation likely resulted in a lower observed impact of HMP than if we had measured self-measured blood pressure taken by patients using their at home blood pressure devices because the act of clinical measurement in a health care setting may result in elevated blood pressure among some patients (Franklin et al., 2013). Second, we based our estimates on the last observed hypertension measurement in each month. Measurements taken at other times may be different than those measured on the last appointment of the month, although initial analyses using all encounters in each month yielded similar results to those shown here. Third, because of lack of data on unmeasured characteristics such as sodium intake, our modeling approach used patient-level random effects to control for unmeasured patient characteristics but including fixed effects for specific patient level characteristics or behaviors related to hypertension, especially on or near the encounter date could have provided more precision. Additionally, the evaluation did not track prescriptions of antihypertensive medications or medication adherence at the patient level which limits insight into attribution of that program component toward outcomes. While each site implemented all components of the program with fidelity and were supported with ongoing technical assistance, there may have been nuanced variation in the day-to-day operations of the program at the clinic site that was not observed. Finally, the pre-post design of the study prevents us from determining causality. We are able to conclude that hypertension control and SBP improved during the HMP time period and that this improvement was statistically significant, but our design prevents us from concluding that this improvement was caused by HMP. However, our model controlled for time, unmeasured patient characteristics, and patient-related serial correlation in addition to other confounding variables. The fact that we continued to observe an effect of HMP after controlling for these variables suggests causality.

5. Conclusions

5.1. Next steps in disseminating and building evidence for the approach

The pharmacist-led hypertension management visits were an important program component for addressing patients with uncontrolled hypertension. Future replications of this model should consider the need for high levels of pharmacist engagement, and availability of staff and financial resources in high-burden settings.

5.2. Potential for translating this model to other disease areas

Given that HMP aims to improve health outcomes by advancing health care delivery through multiple patient-focused program components and clinic-level systems interventions, this approach may not be restricted to improving hypertension outcomes alone. Future work could

explore the viability of this model to be adapted, translated, or integrated into other chronic disease areas that require comparable ongoing management and patient care. Further examination may consider identifying factors that facilitate greatest improvements in blood pressure control within a clinic setting to support dissemination.

5.3. Leveraging lessons learned to address health disparities through clinical care

Findings from this evaluation can inform the expansion and replication of this hypertension management model in FQHC and similar health care settings, which play a pivotal role in caring for patients that bear a disproportionate risk of adverse hypertension and CVD outcomes and socioeconomic disparities. Translating effective interventions from higher capacity health systems like Kaiser Permanente to those that have higher resource constraints is a critical step toward leveling the playing field of health care in the United States. Future implementation research studies should investigate the remaining obstacle of program coverage and acceptability among patients in FQHCs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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