Factors Influencing Primary Care Physicians’ Intent to Refer Patients with Hypertension to a Digital Remote Patient Monitoring Program

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Abstract

Background: Remote monitoring programs have an increasingly larger role in hypertension management. Primary care physicians’ (PCP) referral rates to digital health programs are highly variable. Understanding the factors behind a physicians' likelihood to refer is important in understanding how to increase future adoption of programs through referrals. Prior studies have shown that likelihood to refer is dependent on prior knowledge about clinics and their characteristics, providers' own clinical expertise on the area, communication and relationship with their PCP and patient, and the clinic referral process.

Objective: The study explores whether knowledge of our remote blood pressure monitoring program program and information on referral patterns influence a PCPs’ intention to refer patients.

Methods: This is a mixed methods study integrating quantitative analysis of EHR data regarding frequency of PCPs’ referrals of patients with hypertension to a digital health program and quantitative and qualitative analyses of survey data about PCPs’ knowledge of the program (on a scale of 0-10, with 10 being extremely knowledgeable) and their intention to refer patients. PCPs responded to a clinical vignette featuring an eligible patient which approximated their baseline tendencies to refer. They were then randomized to either receive their own referral data or their own plus their peers’ referral data from the EHR. They were assessed their intent to refer eligible future patients. Descriptive and multivariable linear regression analyses examined the characteristics of participants and the factors associated with their intent to refer patients. Narrative reasons for their intention to refer were thematically analyzed.

Results: Of the 242 eligible PCPs invited to participate, 31% (N=70) responded to the survey. From EHR data, the mean (SD) referral rate of patients per PCP was 11.80% (13.30%). The self-reported knowledge of the digital health program was 6.47 (1.81). The mean likelihood to refer for an eligible patient in a vignette was 8.54 (2.12). The mean likelihood to refer in the group that received their own prior referral data was 8.91 (1.28), while in the group that received their own and peer prior referral data was 8.35 (2.19). Regression analyses suggested the intention to refer vignette patient was significantly associated with their knowledge (coefficient 0.46, 95%CI 0.20 to 0.73, P<.001) whereas the intention to refer future patients was significantly associated with their intent to refer the patient in the vignette (coefficient 0.62, 95% CI: 0.46 to 0.78, P<0.001). No evidence of association was found on receiving own plus peer referral data compared with own referral data and intent to refer future patients (coefficient 0.23, 95% CI: -0.43 to 0.89, P=.48). Respondents called for more communication regarding the program’s superior clinical outcomes, its support of patients in their own care, and the simplicity of the technology to improve PCPs’ awareness and uptake of the program.

Conclusions: Physicians’ intention to refer patients to a novel digital health program can be extrapolated by examining their intention to refer an eligible patient portrayed in a vignette, and this was found to be significantly influenced by their knowledge of the program. Future efforts should engage PCPs to better inform them so that more patients can benefit from the digital health program.

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Factors Influencing Primary Care Physicians' Intent to Refer Patients with Hypertension to a Digital Remote Patient Monitoring Program

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Abstract:

Introduction

Remote monitoring programs have an increasingly larger role in hypertension management. Primary care physicians’ (PCP) referral rates to digital health programs are highly variable. The study explores whether knowledge of the program and information on referral patterns influence a PCPs’ intention to refer patients.

Methods

This is a mixed methods study integrating quantitative analysis of EHR data regarding frequency of PCPs’ referrals of patients with hypertension to a digital health program and quantitative and qualitative analyses of survey data about PCPs’ knowledge of the program (on a scale of 0-10, with 10 being extremely knowledgeable) and their intention to refer patients. PCPs responded to a clinical vignette featuring an eligible patient which approximated their baseline tendencies to refer. They were then randomized to either receive their own referral data or their own plus their peers’ referral data from the EHR. They were assessed their intent to refer eligible future patients. Descriptive and multivariable linear regression analyses examined the characteristics of participants and the factors associated with their intent to refer patients. Narrative reasons for their intention to refer were thematically analyzed.

Results

Of the 242 eligible PCPs invited to participate, 31% (N=70) responded to the survey. From EHR data, the mean (SD) referral rate of patients per PCP was 11.80% (13.30%). The self-reported knowledge of the digital health program was 6.47 (1.81). The mean likelihood to refer for an eligible patient in a vignette was 8.54 (2.12). The mean likelihood to refer in the group that received their own prior referral data was 8.91 (1.28), while in the group that received their own and peer prior referral data was 8.35 (2.19). Regression analyses suggested the intention to refer vignette patient was significantly associated with their knowledge (coefficient 0.46, 95%CI 0.20 to 0.73, P<.001) whereas the intention to refer future patients was significantly associated with their intent to refer the patient in the vignette (coefficient 0.62, 95% CI: 0.46 to 0.78, P<0.001). No evidence of association was found on receiving own plus peer referral data compared with own referral data and intent to refer future patients (coefficient 0.23, 95% CI: -0.43 to 0.89, *P*=.48). Respondents called for more communication regarding the program’s superior clinical outcomes, its support of patients in their own care, and the simplicity of the technology to improve PCPs’ awareness and uptake of the program.

Discussion

Physicians’ intention to refer patients to a novel digital health program can be extrapolated by examining their intention to refer an eligible patient portrayed in a vignette, and this was found to be significantly influenced by their knowledge of the program. Future efforts should engage PCPs to better inform them so that more patients can benefit from the digital health program.

Keywords:

Digital health; remote blood pressure monitoring; primary care

Introduction:

Hypertension is a leading independent and modifiable risk factor for several adverse cardiovascular outcomes including coronary artery disease, stroke, heart failure, and chronic kidney disease, as well as a wide variety of mental and metabolic conditions[1]. While hypertension is influenced by genetic predispositions, it is heavily influenced by lifestyle, diet, and exercise, and is responsive to clinical interventions. Long-term control of hypertension can be achieved through proven interventions including regular blood pressure monitoring[2]. Monitoring and treating hypertension by a health care team traditionally occurs in the clinical setting, with recommendations based on in-office blood pressure results. In some cases, in-situ blood pressure measurements are biased, as patients respond to the stress of being in a medical exam with an artificially elevated blood pressure that did not reflect their baseline[3]. This phenomenon is called white coat syndrome[4].

Digital technology is allowing healthcare to increasingly be conducted remotely for improved monitoring of chronic diseases like cardiovascular disease[5] and diabetes[6]. Remote blood pressure monitoring (RBPM) for patients with hypertension is also expanding as it shows increasing efficacy[7]. The costs – financial, administrative and temporal - to patients and physicians of having a patient come in-person to a medical facility for blood pressure readings is high when compared to the facility of measuring blood pressure. Moreover, these costs are disproportionately borne by those least able to afford them, such as those of low socio-economic status, racial minorities, and individuals in rural areas with poor access to healthcare. In addition to reducing patient and physician burden, RBPM also assists in weeding out the misdiagnosis of white coat hypertension[8]. Modern Bluetooth-enabled RBPM cuffs, aligned with a smartphone app, can today measure blood pressure for patients from the comfort of their home.

RBPM programs have historically experienced systemic friction in US biomedicine that has prevented their widespread adoption. However, during the COVID-19 pandemic, when patients often avoided coming in for appointments[9], healthcare providers were faced with a significant barrier to adequately care for their patients with hypertension or other chronic diseases. Many eligible patients with hypertension were not being seen in the office, and therefore could not be managed. Inevitably, there were also many patients developing new and/or uncontrolled hypertension that went unrecognized due to missed appointments. The physical constraints imposed by the COVID-19 pandemic on patient appointment attendance, while regrettable, did prompt broad legislative permissions facilitating at-home and telemedicine interventions necessary to pragmatically manage the pandemic, which led to an increase of at-home digital healthcare programs[10-12], including ones for measuring blood pressure.

UCSD P1000 Program

In 2020, UC San Diego implemented Project 1000 (P1000); a free, EHR-integrated, Bluetooth-enabled RBPM program available to all patients with a hypertension diagnosis, namely those who were seen in PCP clinics and whose most recent blood pressure measured 140/90 mmHg or higher. PCPs were initially introduced to the RBPM by the Population Health Services Organization (PHSO) on how to refer eligible patients. The original method of outreach was through automated phone calls, which resulted in low enrollment. An adjustment to the recruitment approach was made to involve patients' PCPs using direct electronic referral within our EPIC (Verona, WI) electronic health records (EHR) system. Once the referral is entered, a digital health program team member reviews eligibility, acknowledges the referral in the EHR and reaches out to the referred patient. Participating patients were provided with a Bluetooth-enabled digital BP cuff that automatically transmits BP data to the patient portal of the EHR via a smartphone app. Enrollees are supported by a digital health specialist via telephone or in the patient's home for device setup and any technical issues. The EHR system stratifies BP measures into three risk groups: normal, high/priority, critical, and presents them on a daily dashboard. Nurse care managers review the dashboard and make treat-to-target adjustments per protocol, encompassing medication adjustments and behavioral change recommendations. Outcomes of the referral are documented by the team member reviewing the patient dashboard and a message is sent back to the referring provider. Since 2020, over 2500 patients have been referred to the program. Blood pressure (BP) control data analyzed since inception of this program has shown improvement in BP control for those referred to the program regardless of participation in or continuation with the RBPM program[13]. However, analysis of referral patterns suggested heterogeneous referral rates among PCPs.

Literature suggests that adoption of new primary care practices is not solely influenced by knowledge of available resources and programs, but can also be influenced by implementation of strategies that target the needs of the PCP's practice[14,15], as well as attitudes and perspectives of the clinician[8,16-18]. In particular, physician uptake of digital healthcare initiatives hinges upon clearly demonstrated clinical improvements for their patients, ease of integration with their clinical workflow, and easy to use technology that is also amply supported with technical assistance[19]. In addition, adoption of new treatment options can be influenced by knowledge of or observation of their peer's behavior in the case of pharmaceuticals[20], but not in other instances, e.g. uptake of electronic health records[21]. Notably, primary care physicians are likely to be early adopters of digital healthcare initiatives[22]. Therefore, performance data on referral rates was deliberately included to study the influence of current performance data on the decision to refer.

We explored the reasons behind such diverse practice patterns by developing a physician survey. We had three goals: 1) assess physicians' knowledge of the digital health program, 2) explore their proclivity to refer patients who clearly meet eligibility criteria, as portrayed in a vignette, and 3) inform them of their own prior referral rates, or their own and their peers' referral rate, and re-assess their likelihood to refer future patients. We hypothesize that 1) more knowledge of the digital health program is positively associated with physicians' proclivity to refer eligible patients; 2) information on their own prior referral rates versus their own and their peers' referral rate could influence their likelihood to refer future patients. Using mixed-methods approach, we examined factors associated with physician intention to refer patients to the RBPM program.

Ethical Considerations

The project was reviewed by the UC San Diego Aligning and Coordinating Quality Improvement, Research, and Evaluation (ACQUIRE) Committee. The ACQUIRE Committee approved this project as a quality improvement project and its approval included a decision that the project would satisfy the requirements for maintenance of certification (MOC) credit through UC San Diego's MOC Portfolio Program.

Methods

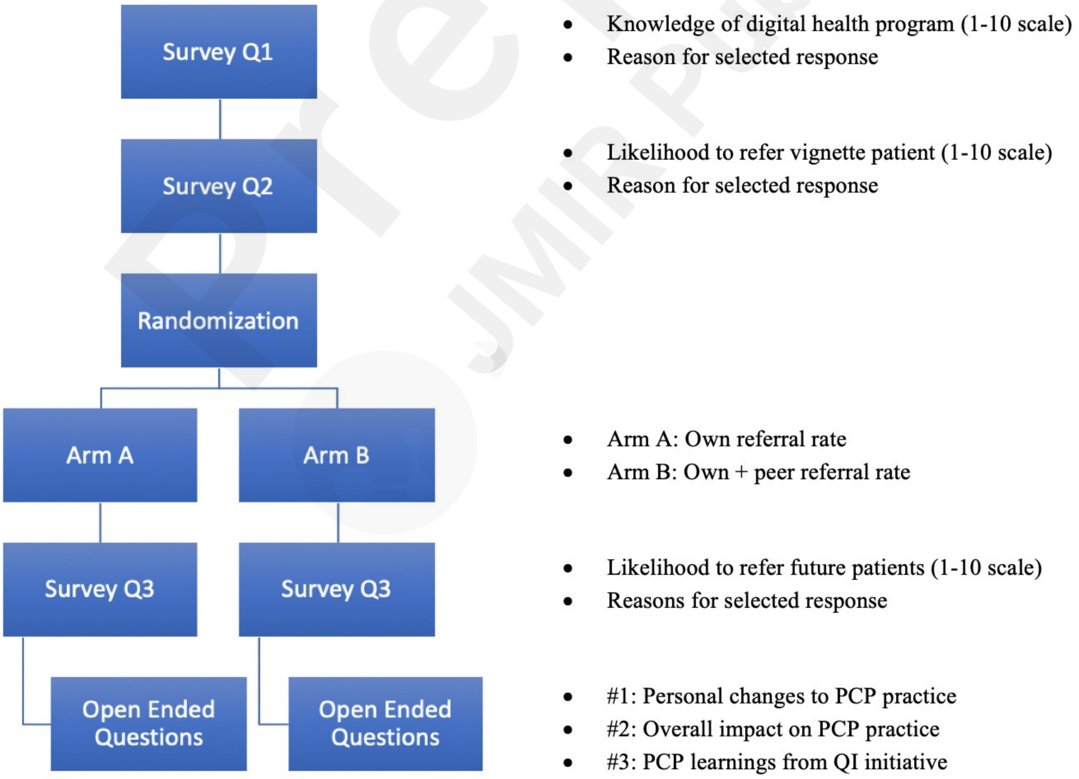
Design

We used an exploratory, sequential design for this mixed-methods study. PCPs were recruited from Family Medicine, General Internal Medicine, and Community Care at UC San Diego Health. N=93 Family Medicine PCPs received a dedicated presentation on the project during a clinical service meeting, alongside an email from the Family MedicineClinical Services Chief with an individual link to complete the survey. N=149 were informed at departmental meetings that an invitation to participate would be emailed to them and encouraged them to reply. A unique provider ID was generated for each PCP, which was used to link and pipe referral rate data from the EHR into the survey. Only one team member (AW) could view the physician names and identifiable information so that the data could be provided to the ACQUIRE MOC office. All eligible physicians were randomized into one of two study arms, with a link to a personalized survey that included either their own referral data (Arm A) or their own referral data plus their peers' referral rates (Arm B). Two email reminders were sent to PCPs who had not responded.

In the context of a quality improvement (QI) program, the initial introduction of the digital health program to PCPs in 2020 was the QI intervention. The survey in late 2023 assessed what changes they had made to their practice, what impact it had had on their practice, and what they had learned as a result of this QI intervention. Responses to the survey satisfied requirements for maintenance of certification (MOC) credits for their boards.

The survey contained five stages. (Figure 1) First, PCPs rated their knowledge of the digital health program on a scale of 0-10 (10 being extremely knowledgeable) and provided a free text response explaining their score (Q1). Second, they assessed their intention to refer an eligible patient by their response to a clinical vignette, a valid method for distinguishing between physician practice[23], that portrayed a patient meets inclusion criteria of the digital health program (Q2). Third, based upon random assignment, PCPs were either shown information on their own referral rate (Arm A) or shown their own and their peers' referral rates concurrently (Arm B). In the fourth stage, their intention to refer future patients to the digital health program was assessed again (Q3). Fifth, qualitative reflections were gathered on what they learned, understood, and planned to change in their future practice regarding the RBPM program.

Figure 1. Study Steps and Their Components



Analysis

Univariate and bivariate descriptive statistics were examined. Multivariable linear regression models were used to assess factors associated with the intention to refer the patient in the vignette and likelihood to refer future patients after seeing own versus own+peer referral rates. For the qualitative analysis, one member (RG) of the research team developed four codebooks (knowledge, vignette, future referral likelihood, and program takeaways) using an inductive grounded theory approach[24]. This involved iteratively refining and condensing themes extracted from a random subset of the qualitative data. In partnership with a second team member (AW), these codes were adjusted and refined. Then, these two research team members coded a subset of the data to ensure interpretive alignment (Cohen’s Kappa = 0.84), before the remaining data were thematically coded.

Results

Participant Characteristics and Quantitative Results

Table 1 provides an overview of the sample (N=70). The median range of years in practice was 11-15 years. 57% (40/70) of respondents were female, 64% (45/70) were from academic Family Medicine, 24% (17/70) were from academic General Internal Medicine or Geriatrics, and 11% (8/70) were from Community Practice (comprised of Internal Medicine or Family Medicine). The average (SD) prior familiarity with the Digital Health Program was 6.47 (1.81). The average (SD) likelihood to refer the patient from the vignette (on a scale of 0 to 10, with 10 being extremely likely) was 8.54 (2.12). 54% (38/70) of the sample received their own and peers’ referral rates, while 46% (32/70) received their own referral rates. The average (SD) referral rate of physicians from EHR data was 11.80% (13.30%), while the average (SD) peer referral rate was 11.90% (9.60%). The average (SD) likelihood to refer patients in the future was 8.61 (1.83).

Table 1: Participant characteristics (N=70)

	n (%)	Mean (SD)
Years of Practice		
1-5 years	22 (31%)	
6-10 years	11 (16%)	
11-20 years	18 (26%)	
More than 20 years	15 (21%)	
Prefer not to answer or NA	4 (6%)	
Gender		
Female	40 (57%)	
Male	25 (36%)	
Prefer not to answer or NA	5 (7%)	
Department		
Family Medicine	45 (64%)	
Internal Medicine & Geriatrics	17 (24%)	

Community Care	8 (11%)	
Familiarity with Digital Health Program		6.47 (1.81)
Likelihood to refer		
Patient in vignette		8.54 (2.12)
Randomized to receive information on		
Own referral rate	32 (46%)	
Own + peer referral rate	38 (54%)	
Own referral rate from EHR data		11.80% (13.30%)
Peer referral rate from EHR data		11.90% (9.60%)
Likelihood to refer in the future		8.61 (1.83)

Table 2 compares respondent characteristics and their likelihood to refer patients within the two treatment groups – whether they were shown only their own referral rate, or their own and their peers' referral rates.

Table 2: Participant characteristics by randomization to receiving own versus own+peer referral data

	Own (n = 32)		Own + Peer (n = 38)	
	n (%)	Mean (SD)	n (%)	Mean (SD)
Years of Practice				
1-5 years	8 (25%)		14 (37%)	
6-10 years	6 (19%)		5 (13%)	
11-20 years	10 (31%)		8 (21%)	
More than 20 years	8 (25%)		7 (18%)	
Prefer not to answer or NA	0 (0%)		4 (11%)	
Gender				
Female	19 (59%)		21 (55%)	
Male	11 (35%)		14 (37%)	
Prefer not to answer or NA	2 (6%)		3 (8%)	
Familiarity with Digital Health Program		7.09 (1.42)		5.92 (1.95)
Likelihood to refer patient in vignette		8.94 (1.61)		8.11 (2.45)
Own referral rate from EHR data		11.2% (11.6%)		12.3% (14.6%)
Peer referral rate from EHR data		12.1% (10.4%)		11.8% (9.0%)
Likelihood to refer patients in the future		8.91 (1.28)		8.35 (2.19)

Table 3 displays results from multivariable linear regression analyses to assess factors that could be associated with physicians' likelihood to refer an eligible patient presented in the vignette (model 1) and eligible patients in the future (model 2). Explanatory variables in model 1 included length of practice (dichotomized by ≤10 years, and >10 years), PCP gender (dichotomized by female, and male/NA/prefer not to answer), prior knowledge of the Digital Health Program, and department (reference group was Family Medicine). Prior knowledge of the Digital Health Program was significantly associated with likelihood to refer the eligible vignette patient (coefficient 0.47, SE 0.13, 95% CI: 0.20 to 0.73, *P*<.001).

The intention to refer future eligible patients was the dependent variable for Model 2 whose explanatory variables included random assignment of information received (reference group was shown own referral rate), the self-rated likelihood to refer the vignette patient, and all explanatory variables from model 1. The likelihood to refer the vignette patient was significantly associated with their intention to refer future patients (coefficient 0.62, SE 0.08, 95% CI: 0.46 to 0.78, *P*<.001).

Table 3: Factors associated with vignette referral and likelihood to refer future eligible patients

	Model 1: Likelihood to refer eligible patient in vignette				Model 2: Intention to refer future eligible patients			
	Coefficient	Std. Error	P value	95% CI	Coefficient	Std. Error	P value	95% CI
(Intercept)	6.14	1.02	<.001	(4.11, 8.18)	2.21	0.93	.02	(0.35, 4.08)
Practice Length: >10 years (ref ≤ 10 years)	-0.28	0.54	.61	(-1.36, 0.80)	0.31	0.34	.37	(-0.37, 0.99)
PCP Gender: Male/ NA/Prefer not answer (ref: female)	-0.63	0.48	.20	(-1.60, 0.33)	0.02	0.31	.96	(-0.59, 0.63)
Prior knowledge of Digital Health Program	0.46	0.13	<.001	(0.20, 0.73)	0.11	0.10	.26	(-0.08, 0.30)
Department: CommCare (ref: Fam Med)	-1.09	0.72	.14	(-2.53, 0.36)	0.48	0.47	.315	(-0.46, 1.42)
Department: IntMed/Ger (ref: Fam Med)	-0.14	0.58	.82	(-1.30, 1.03)	0.22	0.36	.56	(-0.51, 0.94)
Shown referral rate: own+peers (ref: own)	NA	NA	NA	NA	0.23	0.33	.48	(-0.43, 0.89)
Likelihood to refer patient in vignette	NA	NA	NA	NA	0.62	0.08	<.001	(0.46, 0.78)
Number of Observations	69				69			
R^2	0.14				0.53			

Qualitative Results

After participants were asked to numerically score their knowledge of the digital health program for hypertension management provided by UC San Diego Population Health, they were then asked to provide free text comment on their score. Twenty-three participants expressed high perceived knowledge of the program, scoring themselves 8-10 on the 10-point scale. Twenty-eight participants expressed moderate perceived knowledge (score 6-7) of the program. Nineteen participants expressed low perceived knowledge (score <6) of the program. Of these, thirteen exhibited low knowledge about the existence or basic function of the PHSO digital hypertension management program, while six participants were aware of the program, but had low knowledge about patient eligibility criteria, which in turn meant they did not use it. Table 4 summarizes the findings.

Table 4: Perceived knowledge of the program (0-10) alongside qualitative responses

Knowledge of digital health program and code	Quote
Very knowledgeable (8-10) (n=23)	*"used the program frequently"*
	"[I] Feel confident in how to access their services, how to view the home blood pressures, and how to communicate with the main nurses, pharmacists...etc."
Somewhat knowledgeable (6-7) (n=28)	*"refer many patients, see some messages, but not truly aware on logistics and options of services provided"*
Lacking knowledge of program features (<6) (n=13)	*"I have no idea on how this program works and how the data collected help me directly manage my patients. Or whether the Population health will manage these patients for me."*
Lacking knowledge of patient eligibility (<6) (n=6)	*"Unclear which patients are eligible."*

After participants were asked to numerically score how likely they were to refer an eligible vignette patient with blood pressure 150/95 mmHg, they were asked to explain their reasons why. Primarily, it was clinical reasons that justified referral to the program, e.g. "blood pressure is uncontrolled," as well as the *additional* help provided by the program to physicians in monitoring patients of this type, e.g. "Having additional oversight for this patient's blood pressure would be beneficial especially when we as providers can only see the patient on an intermittent basis," "[patient is] more likely to continue to engage if more people are touching base with him." Others stated that the program is "not appropriate for all cases" and that the hypothetical patient's trajectory also "depends on other factors." Those who suggested they would not refer had hesitations about the program rather than clinical need; one participant said, "I forget about this resource;" while another said, "many older patients are not interested in the extra hassles and intimidated by technology."

After being randomized to be shown their referral rate to the program (Arm A) versus their own referral rate and the referral rate of their peers in the same clinic (Arm B), they were asked to score the likelihood that they would refer patients to the program in the future. After giving their score, they were asked to explain the reason for their score. Nine participants (n=4 Arm A, n=5 Arm B) discussed how they already use the program, and intend to continue doing so, e.g. “I have been using the program more recently and have seen improvements in my hypertensive patients.” Six participants in Arm B and 2 in Arm A professed that their newfound understanding about the utility of the program would lead to greater referrals, e.g. “Seeing this information prompts me to recognize that maybe I am not taking advantage of this resource as much as I thought.” However, some expressed hesitations about future referrals. Notably, 9 in Arm A and 4 in Arm B hesitated about further patient adoption of the program, worrying about technological aptitude: “I find most of my patients do not enroll in the program because they cannot manage the technology involved;” about insurance coverage: “I don’t know about insurance coverage for this service;” or simply refusing: “most patients referred decline.” Five from Arm A and 1 from Arm B had no intention to refer.

To meet the requirements for MOC, participants were asked to reflect on the quality improvement intervention, and how it would affect their future practice. They were asked about what they would change personally and clinically because of the intervention, as well as what their key learnings and takeaways were. Participants were excited by how the clinical data would improve their practice and patient gaps. Some simply appreciated having more, and more continuous, data: “I have gained valuable data about my patients from their home monitoring, and have been able to, and felt more comfortable to intervene with medical treatment when needed for blood pressure that is uncontrolled.” Many highlighted how at-home monitoring clearly demonstrated the extent of overdiagnosis of hypertension stemming from white coat syndrome: “I also found that patients with anxiety and white coat hypertension were less likely to be overtreated with medications when referred to this program.” Having contemporaneous data would lead to better clinical outcomes, many felt: “This blood pressure monitoring program and hypertension management program can lead to better cardiovascular outcomes and better overall health for patients because of the real-time monitoring.”

29 providers (41%) expressed a determination to refer to PHSO more often as part of their clinical practice, acknowledging its great value: “I plan to utilize the PHSO HTN program more often. Also to use it when indicated. This improves patient’s outcomes.” Some went further, noting the availability of collaborative programs within UC San Diego Health that may improve clinical outcomes and reduce clinician workload: “Better understanding of health systems programs that can

address complex cardiovascular care from the primary care perspective.” A few noted that the program brought them confidence and assurance: “Participating in the program reassured me about the quality and accuracy of their reading.”

Another theme emerging from the reflections was that providers were happy with how the patients were empowered to participate in their own care through the program. One said that patients “were excited when starting digital health monitoring,” while another said, “I have learned the benefit of patient participation in collecting data to view where they are in their health.” One went further, saying “patients can be more engaged in their health when we make access to decision making easier.” Also emerged was a theme patient education, for instance: “The digital health options have increased patient compliance, participation and knowledge in the management of hypertension.”

Finally, more physicians in Arm B (n=10) than in Arm A (n=6) expressed an increased desire and capacity to harness medical technology, particularly in concert with their patients, in the future due to the quality improvement intervention. One provider suggested they underestimated the ability of their elderly, non-native speaking patient population to do this: “Maybe not under-estimating PHSO ability to provide services to my elderly Mandarin-speaking population through the use of interpreters as many of them are still tech-savvy enough to use smart phones so could likely incorporate similar technology at home.” By utilizing technology, patients and providers could be in closer contact, but also better connected to the wider medical infrastructure for a more thorough, networked care experience: “IT renewed a sense of institutional support for keeping our patients healthy. It also renewed my appreciation that there are teams of healthcare staff in our system who stand ready to assist us in our work and keep us focused.” Finally, the program enabled physicians to practice state-of-the-art medicine: “I feel like the QI project has made my practice more up to date with current medical care trends.”

Table 5 summarizes key facilitators and barriers to physician participation in the program. There are four key facilitators to ongoing physician participation in the program. First, getting an initial referral underway is important, as the benefits of the program become apparent quickly and diffuse many initial apprehensions. Second, having BP data at more regular intervals provides greater data clarity to inform clinical decision making, and identifies instances of white coat hypertension. Third, physicians are encouraged to continue in the program by two improvements to patients; first, their clinical care, but also the education, empowerment and agency they receive by participating in their care in collaboration with their doctor. Fourth, physicians can benefit from advances in medical technology, and are well supported by a team while doing so. Four key barriers to physician participation in the program also surfaced. First, PCPs express concerns about patients' ability to adhere to the program, like an inability to use the technology or reluctance to take BP measurements. Second, some PCPs view the program as reducing their control over managing their patient's hypertension, and possibly increasing their workload in the process rather than reducing it. Third, some physicians do not understand the program structure, thinking it costs patients or requires insurance. Fourth, physicians were unclear about patient eligibility to enroll in the program.

Table 5: Facilitators and barriers to physician use of the program.

	Subtheme	**Quote**
Facilitators to PCP participation in the program.	Getting PCPs started is vital, once they begin using the program they see improvements in patients and understand it better	*I discovered the benefits of home BP readings which directed to manage and control my patients' Hypertension. But, I was not sure that their readings were accurate or the quality of their devices since they were not calibrated. Participating in the program reassured me about the quality and accuracy of their reading.*
	Continuous clinical oversight improves PCP understanding of hypertension, reduces white coat and other clinical errors	*I also found that patients with anxiety and white coat hypertension were less likely to be overtreated with medications when referred to this program*
	Observing two-fold patient benefit, whereby patient care is improved but also patient experience and agency is heightened	*I have learned the benefit of patient participation in collecting data to view where they are in their health*
	Program is a way to harness advancing medical technology and increasing patient touchpoints with team-based support	*I'm learning about the power of harnessing remote digital technology to provide another layer of support to patients outside of the office. The more regular the medical contact with a poorly controlled medical problem the better.*
Barriers to PCP participation in the program.	Concerns about patient capacity to adhere to the program	*Many older patients are not interested in the extra hassles and intimidated by technology*
	Fear over losing control over how patient hypertension is managed	*I feel like it is taking away from my own work for helping patients with their htn*
	Misunderstanding of program funding structure	*I don't know about insurance coverage for this service*
	Misunderstanding of eligibility criteria for program	*I was not aware who qualifies for the program*

Discussion

Principal Results

Quantitative analyses suggest knowledge of the program was significantly associated with physicians' likelihood to refer the eligible vignette patient, which itself was significantly associated with intention to refer future patients. Those with high knowledge scores frequently explained how this knowledge came from frequent use and experience with the program, and those with low knowledge scores frequently expressed reservations about basic eligibility criteria and the clinical and practical utility of the program, which indicates lower usage.

Similarly, those more inclined to refer the vignette patient tended to mention their experience receiving additional help referring prior patients with these clinical needs and were less likely to be concerned about whether their patients could use the technology – other studies indicate fears about patients using RBPM are often overestimated by physicians[10] . Some of those who were reluctant to refer the vignette patients expressed the need for more clinical context which, in essence, is what the program offers with minimal additional clinical or administrative burden to PCPs. Additionally, as seen in existing literature[16], some providers are hesitant to refer as they feel it affects the clinician's ownership of the patient's care.

Despite some participants identifying barriers to referring patients, reflections from PCPs about the program were generally positive. Many referenced the improved clinical outcome it produced, and its capacity to provide patients with education and enhanced agency over their care as key reasons why they would use the program in the future. One important clinical insight, which supports other studies of digital monitoring for hypertension[3], is that the program helps clarify the incidence of white coat syndrome – one participant said "I also found that patients with anxiety and white coat hypertension were less likely to be overtreated with medications when referred to this program" - which wastes clinical resources as well as physician's and patient's time[4]. One previous study discovered as many as 8% of their cohort had white coat syndrome[3] when enrolled in a digital blood pressure monitoring program; our qualitative data gently supports this clinical justification for digital blood pressure monitoring programs.

Criteria for hypertension can vary in different clinical contexts, and misalignment between being categorized as hypertensive in a PCPs native data environment (>130/80mmHg) and being a candidate for the population health program (>140/90mmHg) may have left some physicians questioning the appropriate time to refer. How to best prompt physicians to consider this resource for eligible patients remains a somewhat unanswered question. In addition to PCP awareness of clinical eligibility criteria for the program – which qualitative and quantitative data suggests is mixed – it is important for physicians to be aware of the program's payor–neutral status. Patients face no cost-sharing in this program. Some PCPs incorrectly believed that insurance status and financial limitations might preclude patient participation.

Furthermore, it is vital that healthcare organizations ensure that team-based services like these are perceived as a supportive partner rather than adding to already-excessive administrative burden. In the future, it would be prudent to solicit physician input on determining the most appropriate channels for communication regarding patients co-managed by the PHSO digital health program and PCP. This applies to communicating eligibility, enrollment, and ongoing monitoring. Several physicians who used the program frequently noted that it not only supported and empowered patients, but also actively reduced physician burden, particularly with patients who had poor access to consistent healthcare for reasons of socioeconomics, geography, or age-related mobility issues. Simple BP follow-up appointments can easily clog a physician's already limited availability, especially if no-shows are frequent, while also placing demands on patients ill-suited to frequent clinic visits due to chronic disease burden. A collaborative emphasis that does not place responsibility solely on the PCP is most appropriate[10].

Some physicians reported concerns regarding patient receptivity to digital monitoring tools, whether it be older patients who are less technologically savvy, patients who are non-English speakers, or those with limited financial resources – highlighting the need to address these potential barriers more proactively to enhance the footprint of this program to those in need. There may be patients with negative attitudes about having others involved in their care, and perhaps that perception reflects PCP practice habits if physician autonomy in care management tends to be prioritized or viewed as superior to referring to other members of the healthcare team. Though one might intuit that earlier career physicians may be more receptive to team-based care initiatives such as this program as a new way of practice, our data did not show evidence of an effect in likelihood to refer across years of practice groups. Furthermore, physician concerns regarding their autonomy in patient management did arise in qualitative findings, highlighting the need to emphasize the collaborative nature of such initiatives which recognizes the physician as an essential member of a patient's care team.

The study found no evidence of an effect of seeing own and peer's referral rates compared with seeing only their own referral rate. That said, it is unclear whether awareness of the clinical practices of one's peers might warrant an immediate impact on one's own practices but over time could be a factor of influence. As such, future studies might follow a cohort for a longer time, sharing peer referral data rates, to determine if the effect has a greater influence over time.

Limitations

Outreach approaches varied. Family medicine physicians received a 10-minute presentation on the survey project and some allotted time to complete the survey, following an email invitation from the Family Medicine Clinical Services Chief, who is well known to this department. General Internal Medicine and Community Care practices physicians did not receive a formal presentation nor allotted time to answer the survey that could lead to MOC credits during a meeting. The latter 2 practices were under-represented.

Patient referrals were attributed to the patients' PCP in the EHR. Patients may not see their attributed PCP at every visit, so a colleague, Resident Physician or Advanced Practice Provider may have made the referral. Thus, the referral rates as abstracted might not be entirely representative of any given physician's actual personal utilization of the program based upon the data, though we presume that this general foundation of co-managing patients in academic practices likely evens out such that it still is an adequate approximation of their referral patterns. Given our sample size is relatively small and collected at a single institution, our study may be underpowered and limited in its generalizability. Future studies might seek larger PCP populations across multiple institutions situated in diverse socioeconomic and geographic contexts with variable overall chronic disease burden. They might also investigate whether differences exist between Family Medicine, Internal Medicine and other departments, or between academic and community settings, in acceptance and utilization of digital health for chronic disease care.

Conclusion

Our study indicates that PCP knowledge and understanding of digital health monitoring programs, in terms of clinical outcome, practical application, and the reduction of work burden, is crucial to increased usage and thus widespread effectiveness of these programs. Contextualizing PCP referrals with their peers' referrals showed no evidence of an effect in furthering their intention to adopt the program. Since remote patient monitoring has an increasing volume of empirical support for improving clinical outcomes, we encourage more robust communication of the effectiveness of these programs, their ease of use, and the availability of support to PCPs to increase enrollment and improve population health.

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Conflicts of Interest: None

Abbreviation:

EHR: electronic health records

MOC: Maintenance of certification

PCP: Primary care physician

RBPM: Remote Blood Pressure Monitoring

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