Impact of a Low-Intensity Resource Referral Intervention on Patients' Knowledge, Beliefs, and Use of Community Resources: Results from the CommunityRx Trial

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BACKGROUND: Connecting patients to community-based resources is now a cornerstone of modern healthcare that supports self-management of health. The mechanisms that link resource information to behavior change, however, remain poorly understood.

OBJECTIVE: To evaluate the impact of CommunityRx, an automated, low-intensity resource referral intervention, on patients' knowledge, beliefs, and use of community resources.

DESIGN: Real-world controlled clinical trial at an urban academic medical center in 2015–2016; participants were assigned by alternating week to receive the CommunityRx intervention or usual care. Surveys were administered at baseline, 1 week, 1 month, and 3 months.

PARTICIPANTS: Publicly insured adults, ages 45–74 years.

INTERVENTION: CommunityRx generated an automated, personalized list of resources, known as HealtheRx, near each participant's home using condition-specific, evidence-based algorithms. Algorithms used patient demographic and health characteristics documented in the electronic health record to identify relevant resources from a comprehensive, regularly updated database of health-related resources in the study area.

MAIN MEASURES: Using intent-to-treat analysis, we examined the impact of HealtheRx referrals on (1) knowledge of the most commonly referred resource types, including healthy eating classes, individual counseling, mortgage assistance, smoking cessation, stress management, and weight loss classes or groups, and (2) beliefs about having resources in the community to manage health.

KEY RESULTS: In a real-world controlled trial of 374 adults, intervention recipients improved knowledge (AOR = 2.15; 95% CI, 1.29–3.58) and beliefs (AOR = 1.68; 95% CI, 1.07–2.64) about common resources in the community to manage health, specifically gaining knowledge about smoking cessation (AOR = 2.76; 95% CI, 1.07–7.12) and weight loss resources (AOR = 2.26; 95% CI 1.05–4.84). Positive changes in both knowledge and beliefs about community resources were associated with higher resource use ($P = 0.02$).

CONCLUSIONS: In a middle-age and older population with high morbidity, a low-intensity health IT intervention to deliver resource referrals promoted behavior change by increasing knowledge and positive beliefs about community resources for self-management of health.

NIH TRIAL REGISTRY: NCT02435511

KEY WORDS: social determinants of health; health-related social needs; community linkages; community resource referral; self-management; self-care; disease-management; health information technology.

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INTRODUCTION

Efficient and scalable strategies are urgently needed to address unmet social and health-related needs. The premise—that health outcomes are inextricably tied to social, environmental, and behavioral conditions outside the healthcare system—is no longer new.[1,2] In the USA, there has been rapid growth of interventions to minimize dependence on costly hospital-based care and increase access to social and health-related resources in the community.[3–5] Most resource referral interventions to date have tended to focus on disease-specific populations or rely on costly ancillary staff, such as case managers and community health workers. These interventions

often lack integration with routine clinical workflows, creating additional burdens for an already-strained healthcare workforce. Importantly, little is known about how information-based interventions work to improve self-management of health in the real world.[6]

CommunityRx, developed initially with a 2012–2015 Center for Medicare and Medicaid Innovation Health Care Innovation Award, is an information technology (IT) solution that automatically generates personalized prescriptions, called the "HealtheRx," for community resources that are algorithmically matched to patients' needs. Integrating with the electronic health record (EHR), CommunityRx uses real-time patient health and demographic data to generate the HealtheRx during routine clinical encounters. The HealtheRx is a relatively low-intensity intervention delivered at the point of care by healthcare professionals responsible for completing routine discharge procedures. In recently published findings, we documented that 11% of all HealtheRx recipients reported using a community resource listed on the HealtheRx within 3 months of receiving it.[7] We also found that exposure to HealtheRx promoted confidence for finding community-based resources, a resource-specific measure of self-efficacy.[7,8]

The present study analyzes data from the 2015–2016 CommunityRx trial to examine the effect of the HealtheRx intervention on patients' knowledge and beliefs about health-promoting resources in their communities over a 3-month period. Based on Bandura's social learning theory[9] and Grey's self- and family management framework,[10] we theorize that knowledge and beliefs about community resources are key factors linking community resource referral processes, including delivery of the HealtheRx, to improved self-efficacy and use of community resources.[11,12] Understanding the mechanisms that underlie behavior change is important for optimizing not only the implementation and effectiveness of these interventions, but clinicians' willingness to adopt them.[12,13] To test this hypothesis, we examined whether improved knowledge and beliefs about resources were associated with higher confidence for finding resources (resource self-efficacy) and use of resources at follow-up.

METHODS

Study Design and Setting

We conducted a real-world controlled trial in the primary care clinic (PCC) and emergency department (ED) at the University of Chicago Medical Center, an urban academic medical center. Because the HealtheRx intervention was integrated into the EHR and workflow at the time of the study, we implemented study group assignment by alternating calendar week. Participants were assigned to receive usual care only (control group) or usual care and the HealtheRx (intervention group).[7]

Eligible participants lived in a 16 ZIP code study area on Chicago's South and West sides that included the medical center's primary service area. Of the nearly 1 million residents in this region, 58% identified as non-Hispanic Black and 30% were living below the federal poverty level.[14] Of patients seen in the PCC or ED and meeting inclusion criteria during the 6 months prior to the study period, 60% were middle-aged, 91% identified as non-Hispanic Black, and 66% were female. This study was conducted with written informed consent and approved by the University of Chicago Institutional Review Board and registered on clinicaltrials.gov (NCT02435511).

Participants

Study participants were recruited between December 2015 and August 2016. Participants were eligible for the study if they were between the ages of 45–74 years and insured by Medicaid and/or Medicare, sought care in the PCC or ED, and resided in the study area. Of note, although the overall study area included the West Side of Chicago, nearly all trial participants (99.7%) resided on the South Side of Chicago, where the medical center is located. Participants were excluded if they were non-English speaking (a small proportion), lacked cognitive or physical capacity, or recalled receiving a HealtheRx at a prior visit.

Intervention and Procedures

Full details of the CommunityRx design and real-world trial have been previously described.[15,16] For intervention group participants, the HealtheRx was automatically generated in the EHR at the end of the encounter and delivered by a clerk or nurse during routine checkout procedures in the PCC or ED, respectively. The HealtheRx (Fig. 1) was a 3-page document that listed location, hours of operation, and fees for the two resources closest to the patient's home for each indicated resource type. For instance, participants with diabetes might be referred to nutrition services, including healthy eating classes. Indicated resource types were derived from 33 evidence-based algorithms developed for common medical and social conditions in the target population. Each HealtheRx also listed contact information for a community health information specialist and other phone-based resources. Participants who sought care during control weeks received usual care, which could have included receiving information from a healthcare professional about health-related community resources (Fig. 2).

Trained research assistants used computer-assisted personal interviewing software to administer baseline surveys in person, prior to delivery of the intervention, and follow-up surveys by telephone at 1 week, 1 month, and 3 months. Participants received $15 compensation for completing the baseline survey and $25 compensation for each follow-up survey.

Study Outcomes

At baseline and follow-up, we assessed knowledge about the six most commonly referred resource types: healthy eating classes, individual counseling, mortgage assistance, smoking cessation classes, stress management classes, and weight loss

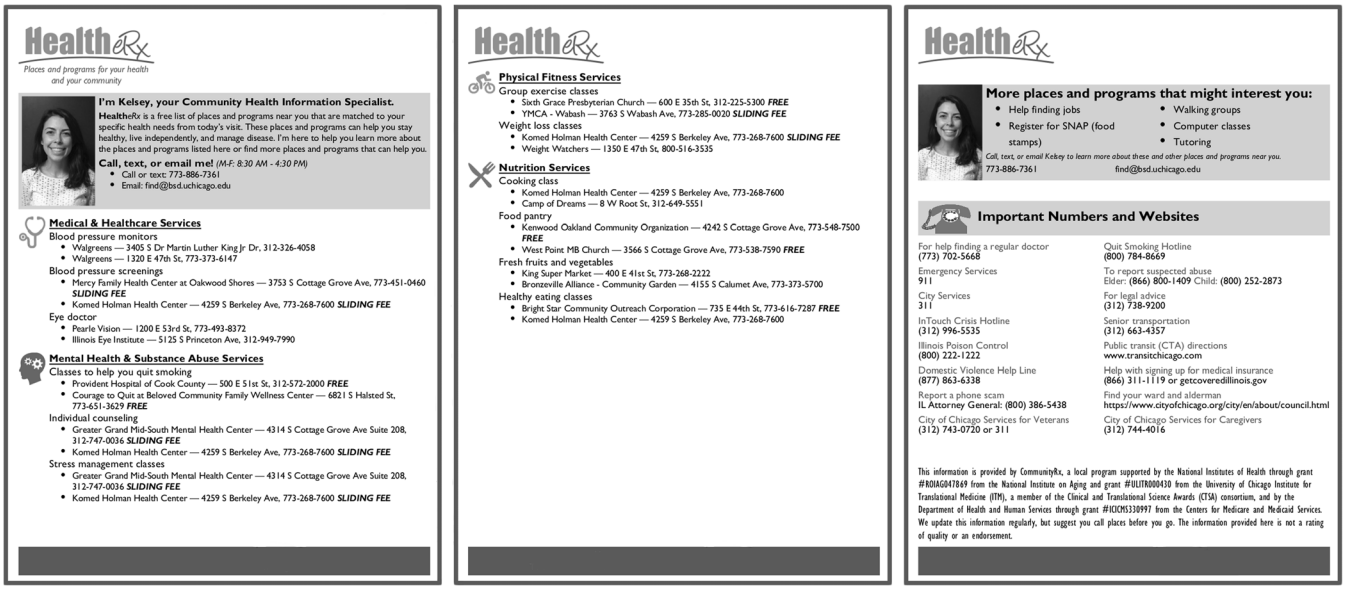

Figure 1 Sample HealtheRx referral.

classes or support groups. Knowledge was assessed by analyzing yes/no responses to the question: "Do you know of any places that offer [resource type] on the South Side of Chicago?" These items were created with the assistance of the University of Chicago Survey Lab and underwent psychometric testing prior to implementation.[17] Because resource referrals were individually tailored, only a proportion of HealtheRx recipients were referred to all six resource types (i.e., 11% based on observational data from the original implementation study).[15] To quantify the number of resource types, we also tested independent models for knowledge of (1) the total number of resource types (ordinal; 1–6 resource types), (2) 1 or more resource types (binary), and (3) 2 or more resource types (binary).

At baseline and follow-up, we assessed beliefs about the availability of resources in the community to manage health. Participants were asked to rate on a 5-point Likert scale (strongly disagree, disagree, uncertain, agree, or strongly agree): "Your community has the resources you need to manage your health." We analyzed beliefs about resources as both an ordinal variable (1–5, with 1 being "strongly disagree") and binary variable (strongly agree and agree were classified as "positive beliefs").

Finally, we queried intervention group participants about behaviors related to the HealtheRx. Participants in the intervention group were asked to think about the HealtheRx they received and were asked (yes/no): "Since you received this information, have you gone to any of these places?" Participants were additionally queried about contacting a community resource ("Since you received this information, have you contacted any of these places?") and their ability to travel to and afford each of the six most common community resource types. Confidence for finding resources was measured using a single item adapted from Bandura's self-efficacy measurement approach:[8] "How confident are you in your ability to find resources in your community that help you manage your health?" To enable side-by-side comparison of the effect estimates for both outcome variables, we analyzed this measure as a dichotomous variable (somewhat confident and completely confident were grouped together as "positive resource self-efficacy").

Statistical Analysis

Descriptive statistics were calculated for patient demographic and health characteristics. These statistics were also stratified by study group to test for adequate balance between the intervention and control group.

We used intent-to-treat analysis to compare differences pre- and post-intervention between the intervention and control group in knowledge and beliefs about community resources. Mixed effects logistic regression models were applied to independently assess (1) knowledge and (2) beliefs about resources as a function of the interaction between intervention group and time period (baseline or follow-up), adjusting for age, gender, self-identified race/ethnicity, educational attainment, insurance status, and clinical site. Follow-up surveys were treated as repeated measures within a single 3-month follow-up period for this analysis; meaning, responses were allowed to vary at follow-up (e.g., a single respondent may have answered "yes" and "no" at two separate follow-up periods). We included a random effect for each patient to allow for individual effects in the modeling of panel data. Ordinal mixed effects logistic regression models were used to analyze ordinal outcomes (improvement in the number of resource types 1–6 and beliefs scale 1–5). Although we were primarily interested in examining changes in knowledge and beliefs pre- and post-intervention, we also performed sensitivity analyses to examine the trends over time, reasoning that outcomes may continue to improve with repeated exposure to the intervention at each follow-up (1 week, 1 month, and 3 months). This analysis compared differences in the slope of change between

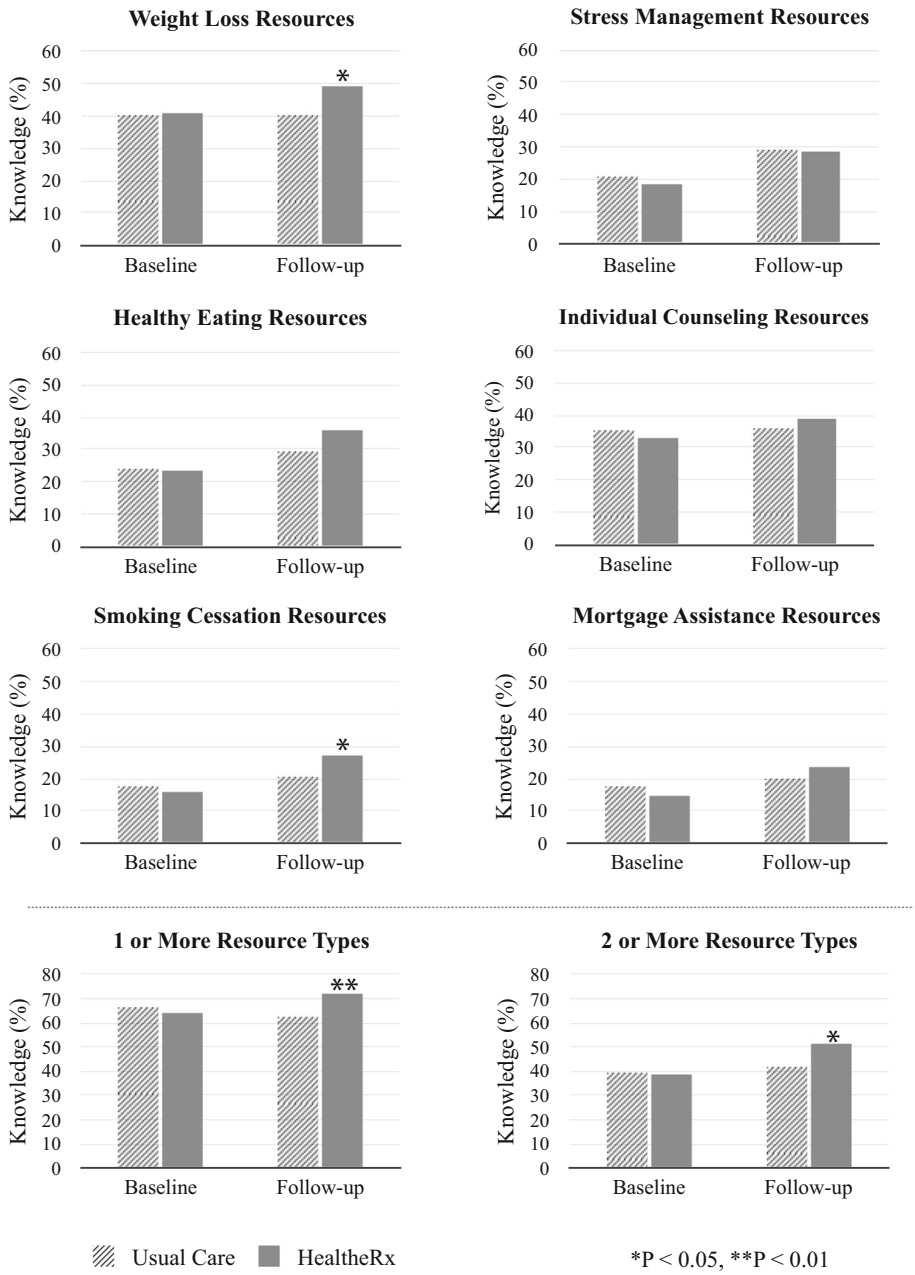

Figure 2 Knowledge of resources at baseline and follow-up by intervention status.

the intervention and control group, using each follow-up time period discretely (Appendix Figure 1 and Appendix Tables 1–2). Of the 411 total participants enrolled in the trial, 37 had missing or incomplete data for primary outcomes; analyses of missing data are included in the Supplement (Appendix Table 3).

Chi-square tests of proportions were used to assess for independent bivariate relationships between the following groups with resource self-efficacy (dichotomous) and resource use (dichotomous): (1) no improvement in knowledge or beliefs; (2) improvement in knowledge only (1 or more resource types, 2 or more resource types), (3) positive change in beliefs only, and (4) improvement in knowledge (1 or more resource types, 2 or more resource types) and positive change in beliefs. Chi-square tests were chosen for this particular analysis due to power limitations. Additional chi-square tests were used to assess for significant bivariate relationships between resource use and the ability to contact, travel to, and afford listed resources.

RESULTS

The cooperation rate (COOP3)[18] was 71%. The overall retention rate for participants completing at least 1 follow-up survey was 91%; retention rates at each follow-up period ranged from

80 to 85%. Of the 374 participants included in this study, 190 were assigned to the HealtheRx group and 184 to the control group (Table 1); a flow diagram of trial enrollment and allocation is provided in previously published work.[7] We observed no statistically significant differences in demographic nor health characteristics between groups. Almost two thirds (63%) were middle-aged. The majority identified as non-Hispanic Black (90%), were female (70%), and had less than a college degree (82%). Most were insured by Medicaid or were dual-eligible (61%). More than half reported a diagnosis of hypertension (57%) or obesity (54%); one quarter reported diabetes (28%) or heart disease (24%); fewer reported depression (17%). More than one third (39%) reported 3 or more conditions.

In the study region, there was wide variation in the number of resources available for each resource type. There were relatively few smoking cessation ($n = 9$), mortgage assistance ($n = 26$), stress management ($n = 32$), and weight loss resources ($n = 40$), compared to healthy eating ($n = 107$) and counseling resources ($n = 201$; Appendix Table 4).[15] Half of available resources were cost-free; one quarter was sliding scale or cost-free. At baseline, the proportion of participants reporting knowledge of each resource type largely reflected the relative distribution of resources in the community: more people knew about counseling resources (34%) than smoking cessation (17%), mortgage assistance (16%), and stress management resources (20%; Table 2). Participants reported median knowledge of 1 resource type (interquartile range, 1–3). Additionally, there was positive correlation among those who reported knowledge of 1 or more resource types.

Compared to the control group, HealtheRx recipients had higher odds of knowing a larger quantity of resource types (adjusted odds ratio [AOR] = 2.15; 95% CI, 1.29–3.58) at follow-up relative to baseline (Table 2). In binary models, HealtheRx recipients had higher odds of knowing about one or more resource type (AOR = 3.38; 95% CI, 1.51–7.61) and two or more resource types (AOR = 2.34; 95% CI, 1.07–5.11) at follow-up relative to baseline. Specifically, HealtheRx recipients had higher odds of knowing about smoking cessation resources (AOR = 2.76; 95% CI, 1.07–7.12) and weight loss resources (AOR = 2.26; 95% CI 1.05–4.84) at follow-up relative to baseline, but no statistically significant improvement in knowledge of remaining resource types (Table 2). In sensitivity analyses, multiple imputation did not substantially alter results: compared to the control group, HealtheRx recipients had higher odds of knowing a larger quantity of resource types (AOR = 2.13; 95% CI, 1.31–3.47) at follow-up relative to baseline (Appendix Table 3). In sensitivity analyses examining trends in knowledge over each discrete follow-up period, the slope of change was higher in the HealtheRx group for the quantity of resource types relative to control (AOR = 1.38; 95% CI, 1.11–1.70; Appendix Table 1). Knowledge of most resource types increased over time in the HealtheRx group relative to control (Appendix Figure 1 and Appendix Table 1), although this was statistically significant only for smoking cessation resources (AOR = 1.64; 95% CI, 1.13–2.40).

At baseline, 47% of participants reported positive beliefs about having resources in their community to manage health (Table 3), compared to one quarter who reported negative beliefs. Compared to the control group, HealtheRx recipients had higher odds of reporting more positive beliefs about resources in ordinal models (AOR = 1.68; 95% CI, 1.07–2.64) at follow-up relative to baseline (Table 3). Results were similar in sensitivity analyses (Appendix Table 2).

Table 1 Baseline Participant Characteristics

Characteristic	Group no. (%)		
	All	Usual care	HealtheRx
Total participants	374	184	190
Clinical site*			
ED	172 (46.0)	82 (44.6)	90 (47.4)
PCC	202 (54.0)	102 (55.4)	100 (52.6)
Age group (years)			
45–54	107 (28.6)	57 (31.0)	50 (26.3)
55–64	127 (34.0)	60 (32.6)	67 (35.3)
65–74	140 (37.4)	67 (36.4)	73 (38.4)
Gender			
Male	113 (30.2)	64 (34.8)	49 (25.8)
Female	261 (69.8)	120 (65.2)	141 (74.2)
Race/ethnicity (self-identified)			
Non-Hispanic Black	338 (90.4)	166 (90.2)	172 (90.5)
Non-Hispanic White	19 (5.1)	11 (6.0)	8 (4.2)
Hispanic	5 (1.3)	3 (1.6)	2 (1.1)
Other or more than one race	12 (3.2)	4 (2.2)	8 (4.2)
Educational attainment			
Less than high school	90 (24.1)	52 (28.3)	38 (20.0)
High school diploma or GED†	80 (21.4)	37 (20.1)	43 (22.6)
Associate degree or some college	137 (36.6)	61 (33.2)	76 (40.0)
College degree	66 (17.7)	33 (17.9)	33 (17.4)
Refused	1 (0.3)	1 (0.5)	0 (0)
Insurance status			
Medicaid only	115 (30.8)	60 (32.6)	55 (29.0)
Medicare only	98 (26.2)	46 (25.0)	52 (27.4)
Medicaid and Medicare	112 (30.0)	56 (30.4)	56 (29.5)
Private and Medicaid/ Medicare	27 (7.2)	13 (7.1)	14 (7.4)
Do not know or refused	22 (5.9)	3 (4.9)	3 (6.8)
Health conditions			
Depression	62 (16.6)	30 (16.3)	32 (16.8)
Diabetes	104 (27.8)	55 (29.9)	49 (25.8)
Heart disease	91 (24.3)	43 (23.4)	48 (25.3)
Hypertension	214 (57.2)	106 (57.6)	108 (56.8)
Obesity	203 (54.3)	97 (52.7)	106 (55.8)

ED refers to Emergency Department; PCC refers to Primary Care Clinic

†GED refers to General Education Diploma*

Table 2 Change in Knowledge of Resources by Intervention Status

	Knowledge of resources			
Resource category or type* Intervention period	**Usual care n = 184**	**HealtheRx n = 190**	**AOR (95% CI)†**	***P* value**
No. of resource types‡ (no. ± sd)				
Baseline	1.6 ± 1.6	1.5 ± 1.6		
Follow-up	1.8 ± 1.9	2.0 ± 1.9	2.15 (1.29–3.58)	0.003
1 or more resource types§ (%)				
Baseline	66.3	63.7		
Follow-up	62.1	71.6	3.38 (1.51–7.61)	0.003
2 or more resource types§ (%)				
Baseline	39.7	39.0		
Follow-up	42.2	51.3	2.34 (1.07–5.11)	0.03
Healthy eating (%)				
Baseline	23.9	23.2		
Follow-up	29.1	36.2	2.15 (0.96–4.83)	0.06
Individual counseling (%)				
Baseline	35.3	33.2		
Follow-up	35.9	38.8	1.64 (0.69–3.90)	0.26
Mortgage assistance (%)				
Baseline	17.4	14.7		
Follow-up	19.8	23.7	2.26 (0.92–5.56)	0.08
Smoking cessation (%)				
Baseline	17.9	15.8		
Follow-up	20.6	27.4	2.76 (1.07–7.12)	0.04
Stress management (%)				
Baseline	20.7	18.4		
Follow-up	29.3	28.4	1.16 (0.50–2.69)	0.74
Weight loss (%)				
Baseline	40.2	41.1		
Follow-up	40.5	49.5	2.26 (1.05–4.84)	0.04

**Participants were asked, "Do you know of any places that offer [resource type] on the South Side of Chicago?" and instructed to think about specific places*
†Mixed effects logistic regression models were used to estimate differences between usual care and HealtheRx groups at follow-up compared to baseline; adjusted for age, race/ethnicity, gender, educational attainment, insurance type, and clinical location (Primary Care Clinic or Emergency Department)
‡For ordinal analyses, the number of resource types were analyzed from 0 (no reported knowledge of any resource types) to 6 (knowledge of all 6 resource types).
§For binary analyses, participants with knowledge of (1) "1 or more resource types" (n = 1 to 6 resource types) were grouped together; and (2) "2 or more resource types" (n = 2 to 6 resource types) were grouped together

Table 3 Change in Beliefs About Resource Availability by Intervention Status

	Beliefs about Resources			
Belief measure* Intervention period	**Usual care n = 184**	**HealtheRx n = 190**	**AOR (95% CI)†**	***P* value**
Belief score‡ (score ± SD)				
Baseline	3.4 ± 1.2	3.3 ± 1.2		
Follow-up	3.4 ± 1.2	3.6 ± 1.2	1.68 (1.07–2.64)	0.02
Positive beliefs§ (%)				
Baseline	48.9	45.5		
Follow-up	51.7	57.6	1.84 (0.95–3.56)	0.07

**Participants were asked to agree or disagree to the statement on a 5-point Likert scale: "Your community has the resources you need to manage your health"*
†Mixed effects logistic regression models were used to estimate differences between usual care and HealtheRx groups at at follow-up compared to baseline; adjusted for age, race/ethnicity, gender, educational attainment, insurance type, and clinical location (Primary Care or Emergency Department)
‡For ordinal analyses, beliefs were analyzed on a 5-point scale from 1 (very negative beliefs) to 5 (very positive beliefs)
§For binary analyses, agree and strongly agree were grouped together as "positive beliefs"

Approximately one quarter of HealtheRx recipients (23%) had no improvement in either knowledge or beliefs; a similar proportion (27%) had improvement in *both* knowledge and beliefs. Intervention group participants who acquired knowledge of 2 or more resource types *and* developed more positive beliefs at follow-up were more likely to exhibit self-efficacy for finding resources ($P = 0.03$) and resource use ($P = 0.02$); however, among those who improved either knowledge or beliefs alone, self-efficacy and resource use were similar between groups at follow-up (Table 4). Those who reported seeking additional knowledge by contacting a community resource (16%) were also more likely to use a community resource ($P < 0.001$). Resource use did not differ between those who did and did not report the ability to travel to and afford resources (results not shown).

DISCUSSION

In this urban population with high rates of co-morbidity, we found that an automated, technology-based resource referral system, CommunityRx, improved patients' knowledge and beliefs about community-based resources. In a previous cross-sectional survey of 458 HealtheRx recipients, 71% reported finding resources on the HealtheRx that they did not previously know about.[15] In this controlled trial of the CommunityRx intervention, we demonstrated a more than threefold increase in the odds of knowing at least one community resource type (i.e., no resource types vs. at least 1 resource type), and nearly twofold increase in the odds of developing more positive beliefs about resources. Increasing patient knowledge about the local resource landscape may potentiate physician recommendations, which often depend on patients using local resources for self-care and disease self-management. For example, physician recommendations about nutrition or physical activity, topics commonly addressed in the ambulatory care setting, are only as good as a patient's ability to access and use resources that enable these lifestyle changes. CommunityRx promoted patients' confidence in their ability to find health-promoting resources in the community, as we have previously shown,[7] and also functioned to promote patients' knowledge of nearby resources. Both self-efficacy and knowledge of community resources are

Table 4 Associations Between Improvements in Knowledge and Beliefs About Community Resources with Resource Self-Efficacy and Resource Use in the Intervention Group*

Improvement in knowledge and beliefs after intervention	Resource self-efficacy†			Resource use		
	No confidence $n=18$	Confidence $n=168$		No resource use $n=167$	Resource use $n=21$	
	%	%	*P* value	%	%	*P* value
Neither knowledge nor beliefs	61.1	18.5	< 0.001	24.6	9.5	0.12
Knowledge alone‡	33.3	44.6	0.36	43.7	42.9	0.94
2 or more resource types§	5.6	25.6	0.06	23.4	23.8	0.96
Beliefs alone	5.6	7.1	0.80	7.2	4.8	0.68
Both knowledge‡ and beliefs	0	29.8	0.007	24.6	42.9	0.07
2 or more resource types§	0	22.0	0.03	17.4	38.1	0.02

**Included only intervention group participants with follow-up data for both knowledge and belief items; follow-up time periods are pooled*
†Self-efficacy scores were analyzed as a dichotomous variable: "not at all confident" and "not very confident" responses were combined, and "somewhat confident" and "completely confident" were combined
‡Indicates the acquisition of knowledge for 1 or more resource types
§Indicates the acquisition of knowledge for 2 or more resource types

necessary for activating patients to implement physician recommendations.

We found that the HealtheRx improved specific knowledge about resources that support a healthy lifestyle, particularly for smoking cessation resources. Interestingly, smoking cessation resources were also the rarest among those examined. Prior studies have shown that less than 5% of patients are able to quit smoking without assistance; and in recent Cochrane reviews, group treatment increased success of smoking cessation by over twofold.[19–21] Enhancing knowledge about smoking cessation resources may thus have broad and resonant impacts in a community, particularly among vulnerable populations with higher rates of smoking.[22] In contrast, HealtheRx recipients did not demonstrate improved knowledge of individual counseling or stress management resources. This finding may suggest that a higher-intensity approach may be needed to promote mental health resource knowledge, such as counseling from the treating physician about the reason for referral, or adjunctive strategies that address mental health stigma and other fundamental barriers to accessing mental healthcare.[23, 24] Certainly, it is possible that while some resource types may only require limited intervention to enhance knowledge and increase resource use, others may require more direct intervention. There has been some discussion about targeting higher-intensity strategies to higher-risk individuals, but our study findings may suggest that these strategies could also be targeted based on the types of resources being recommended.

A second major finding was that positive change in *both* knowledge and beliefs about community resources was associated with higher confidence for finding resources (resource self-efficacy) and resource use at follow-up. The inverse was also true—no improvement was associated with lower confidence and lower resource use. Previous research has theorized that knowledge and beliefs about the neighborhood environment may be key mechanisms linking health information to behavior change. In a study of 751 elderly adults, those reporting beliefs about poor-quality resources in their neighborhood were less likely to engage in community-based activities and more likely to experience difficulties in completing activities of daily living.[25] In another study of 554 urban-dwelling adults, investigators found that those reporting knowledge of a higher proportion of resources within 5 min from home had higher social participation scores (e.g., going to a public library or cultural center, taking courses).[26] Our previous work has shown that people in high-poverty neighborhoods often bypass local resources to use more distant resources, citing both poor quality and lack of knowledge as reasons for doing so.[27] We build on this prior work by demonstrating that a low-intensity, scalable health IT intervention can promote both knowledge and positive beliefs about community resources, which can in turn promote access to resources that enable self-care.

Some healthcare systems have tested high-intensity resource referral strategies, for instance, using community health workers (CHW) and patient navigators to direct patients to needed resources.[28] In a related intervention evaluated by Garg and colleagues,[29] mothers of pediatric patients completed a screening instrument to assess their families' social needs, reviewed this instrument with clinicians, and were connected to resources by clinical staff; the cluster RCT of 336 mothers enrolled in the intervention demonstrated twofold improvement in the odds of resource enrollment relative to control. However, high-intensity strategies are labor intensive and expensive to implement for an entire population with heterogeneous needs. They also rely on individual screening, which may limit their adoption in healthcare systems already facing staffing shortages and workflow strain.[8] Our intervention complements higher-intensity strategies by providing a lower-intensity option for individuals who may not require direct navigation or clinician counseling to benefit from community resource information. Importantly, we have seen in two studies that nearly half of HealtheRx recipients shared community resource information with someone else.[7,15] It is possible that with improvements in knowledge and diffusion of that knowledge more broadly, this type of information spread can promote higher resource use without direct navigation for a large proportion of patients, thus saving higher-intensity

interventions for those who need them the most. However, it is notable that more than one quarter of HealtheRx recipients, in this study of middle-age and older adults with relatively poor health, reported no knowledge of any resource type at follow-up, confirming the need for augmentation with higher-intensity strategies for certain populations.

Limitations should be considered when interpreting the results of this study. We have previously described that some controls were likely exposed to the intervention in this real-world trial.[7] Although we do not know the exact number of controls that may have been exposed to the intervention, this possibility would bias our study toward the null hypothesis. The items measuring knowledge and beliefs about resources were adapted from previous studies and psychometrically tested, but reflect self-reported information. It is possible that some participants over- or underestimated their knowledge of local resources. To partially mitigate this concern, we asked participants to think about specific places for each resource type one by one. Additionally, we were underpowered to use regression modeling in analyses of resource self-efficacy and resource use outcomes, thus providing simple chi-square tests of proportions. Finally, we were unable to link the specific HealtheRx generated for each patient to their survey responses. While only a proportion of patients were referred to all six resource types, we could not examine whether knowledge increased more for those who actually received referrals to each resource type. This limitation reflects a second factor that may bias study results toward the null hypothesis.

CONCLUSIONS

HealtheRx improved both knowledge and overall beliefs about community resources in a highly vulnerable population. Using health IT to systematically and universally deliver resource referrals matched to patients' demographic, health, and social characteristics may lead to better knowledge retention and beliefs about resources in the local community.

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Compliance with Ethical Standards:

This study was conducted with written informed consent and approved by the University of Chicago Institutional Review Board and registered on clinicaltrials.gov (NCT02435511).

Conflict of Interest: *Dr. Lindau directed a Center for Medicare and Medicaid Innovation Health Care Innovation Award (1C1CMS330997-03) called CommunityRx. This award required development of a sustainable business model to support the model test after award funding ended. To this end, Dr. Lindau is founder and co-owner of NowPow, LLC. Neither entity is supported through CMS funding. Neither the University of Chicago nor the University of Chicago Medicine endorses or promotes any NowPow Entity or its business, products, or services. The remaining authors declare no conflicts of interest.*

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