Using Personalized Education Delivery to Improve Community Clinic Patients' Knowledge of Hypertension

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Introduction

Clinics that treat low-income, medically underserved communities function as critical safety-net providers for the primary and preventive healthcare needs of their patients; they are often used as the only site of care continuity. The largest network, Federally-Qualified Community Health Centers (CHCs), serves 20 million people annually (1). Nearly all patients treated at CHCs have low family incomes, and 75% of the patients are either uninsured or on Medicaid. In addition, a large proportion of CHC patients are members of racial or ethnic minority groups (1).

Medically underserved patients are often at greater risk for acquiring preventable, chronic diseases, such as hypertension. The incidence of hypertension in community health center settings is nearly three times as high as in primary care offices (2). Further disparities exist by race and ethnicity. For example, in an analysis of blood pressure control among patients diagnosed with hypertension in four federally-qualified health centers in New York, Shelley and colleagues (3) found that hypertension prevalence was highest in blacks (32.8%) compared to whites (16.2%) and Hispanics (11.5%). Blacks also showed poorer hypertension control (42.2%) compared to whites (50.9%) and Hispanics (50.8%).

In addition to higher rates of chronic illnesses, CHC patients may be at greater risk for low health literacy. Health literacy refers to "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (4)". Nearly half the U.S. population is thought to have difficulty understanding or acting upon health information, and low income, minority populations are thought to be particularly vulnerable to poor health literacy. Persell and colleagues (5) found that 31% of participants recruited from federally qualified health center affiliations in Grand Rapids, Michigan had inadequate health literacy. A study by Kaphingst and colleagues (6) found that only 34% of CHC patients from Suffolk County had adequate health literacy. A study by Schlichting and colleagues (7) revealed that few CHC providers gave patients materials designed specifically for low health literacy patients but that many believed such an approach would be effective.

Several studies report that improving patient communication results in better outcomes, including increased patient satisfaction, increased adherence to treatment regimens, and decreased ordering of unnecessary tests (8). Furthermore, several reports describe an association between enhanced patient communication and improvements in the management of chronic diseases, including hypertension, diabetes, and cancer. One study found patients' knowledge about coronary heart disease risk factors to be significantly correlated to weight loss, physical activity, stress management, improved diet and lipid level reductions to recommended treatment levels(9,10). Despite the high prevalence of low health literacy, patient education materials are often written at the high school or college level, and are thus, inaccessible to the majority of CHC patients (10).

A widely used tool to promote better learning outcomes in education is the use of learning styles, which describe the preferred ways individuals "gather, interpret, organize, recall, and think about information (11)." However, many patient educational materials are not designed according to each individual's unique learning preferences (12,13). To assess the effectiveness of tailoring health educational information to patients' health literacy level and learning style preference on disease knowledge outcomes, we initiated a multi-phased research investigation.

In Phase One of the research plan, we conducted a series of randomized controlled trials in the Vanderbilt emergency department (ED) (14). In the first ED trial, we recruited 85 adults with high blood pressure and randomized them to receive either standard of care discharge instructions or standard of care instructions complemented with health education material matched to their individual health literacy level. In a second ED trial, we recruited 87 adult patients and randomized them to receive intervention materials matched to both health literacy level and learning style preferences. A comparison of scores on a high blood pressure assessment showed that study participants who received materials tailored to both health literacy level and learning preferences showed greater gains in hypertension knowledge than those receiving information tailored to health literacy level alone (14). In Phase Two of the research plan, reported here, we tested the applicability of the model in an urban community health clinic. We additionally examined hypertension knowledge at both two and six weeks to assess information retention over time.

METHODS

The Institutional Review Board at Vanderbilt University Medical Center approved this protocol. Participants were recruited in the Vine Hill Community Clinic (VHCC). The VHCC, operated by University Community Health Services (UCHS) and the largest clinic in their healthcare network, provides no-cost or low-cost primary care and preventive mental, dental, and prenatal health services to Nashville's uninsured and medically underserved community (15,16). Clinic services are delivered six days a week by advanced nurse practitioners and clinical nurse specialists. Annually, the UCHS receives more than 27,000 visits; approximately 50% of all patients are uninsured, another 35% receive health benefits from the state's Medicaid program, TennCare, and 90% of patients are at or below the 100% poverty level. Hypertension affects 22% of the clinic network population (17).

Patients recruited for the study were hypertensive, aged 18 or older and spoke either English or Spanish. Exclusion criteria included illiteracy, cognitive impairment, and psychiatric concerns as the primary reason for the clinic visit. We collected information from participants regarding age, gender, race, ethnicity, education, employment status, household income, smoking status, personal and family history of hypertension, and use of hypertension medications. One hundred and eighty-six patients were enrolled in the study from September-November 2011 (Table 1).

Table 1. Baseline Patient Characteristics

Characteristic	Control (n=90)	Intervention (n=96)
Age in years, *M (SD*)	55 (11.91)	51 (11.24)
Language, *n* (%)		
English	85 (94)	90 (94)
Spanish	7 (8)	10 (10)
Gender, *n* (%)		
Female	57 (63)	68 (71)
Male	33 (37)	28 (29)
Race, *n* (%)		
White	29 (32)	45 (47)
Non-White	53 (59)	44 (46)
Missing	8 (9)	7 (7)
Ethnicity, *n* (%)		
Hispanic or Latino	7 (8)	10 (10)
Not Hispanic or Latino	62 (69)	66 (69)
Not Reported	21 (23)	20 (21)
Education, *n* (%)		
High school or less	56 (62)	60 (63)
More than high school	34 (38)	36 (38)
Employment status, *n* (%)		
Full-time	10 (11)	20 (21)
Part-time	9 (10)	8 (8)
Homemaker	6 (7)	6 (6)
Disabled	33 (37)	29 (30)
Retired	13 (14)	10 (10)
Unemployed	13 (14)	13 (14)
Other	6 (7)	7 (7)
Not Reported	0 (0)	3 (3)
Household income, *n* (%)		
$20,000 and lower	43 (48)	54 (56)
More than $20,000	11 (12)	15 (16)
Chose not to answer	36 (40)	27 (28)
Smoker, *n* (%)		
Yes	32 (36)	42 (44)
No	58 (64)	54 (56)

Table 1. Continued

Characteristic	Control (n=90)	Intervention (n=96)
Family history of HBP, *n* (%)		
Yes	68 (76)	87 (91)
No	16 (18)	9 (9)
Do not know	6 (7)	0 (0)
Personal history of HBP, *n* (%)		
Yes	88 (98)	93 (97)
No	2 (2)	2 (2)
Not Reported	0 (0)	1 (1)
Taking HBP medications, *n* (%)		
Yes	84 (93)	89 (93)
No	6 (7)	7 (7)
HL level[a], *n* (%)		
Adequate	65 (72)	70 (73)
Marginal	13 (14)	11 (11)
Inadequate	12 (13)	15 (16)
Median HL score (Q1,Q3)	3 (0, 5)	2 (0, 5)
Learning style, *n* (%)		
Single Mode	65 (72)	56 (58)
Multimodal	25 (28)	40 (42)

Note. Percentages may not equal 100% due to rounding.

Abbreviation: HBP = High Blood Pressure; HL = Health Literacy

[a] Health literacy level was measured using the Chew et al. questions (18)

Subjects were randomized in a 1:1 ratio to control or intervention groups using a permuted block design with random block sizes of 2, 4, and 6, resulting in 90 control subjects and 96 intervention group subjects. Across groups, the patients were similarly distributed by age, language, gender, race, ethnicity, education, household income, and the percentage of smokers. Most participants did not receive an education beyond the high school level and received an annual income not exceeding $20,000. The majority of participants (73%; 135/186) had adequate health literacy. Participants with marginal health literacy comprised 13% (24/186) of subjects, and participants with inadequate health literacy represented close to 15% (27/186) of the population.

Measures

A 16-item knowledge test (19) was used to evaluate participants' understanding of hypertension. Patients also completed a health literacy test developed by Chew and colleagues (18) consisting of three questions regarding their confidence filling out medical forms, the frequency they needed help

reading hospital materials, and how often they had problems learning about medical conditions because of reading difficulties. The test is scored on a 12-point scale, with a low score denoting adequate health literacy. Participants' health literacy levels were classified as adequate, marginal, or inadequate, based on a score of 0-4, 5-6, or 7-12, respectively (14).

All subjects were also asked to indicate their preferences for learning about health information via visual, aural, read/write, or kinesthetic modalities. An adhoc analysis of data collected during our previous ED study revealed patient responses were consistent with results from a formal learning preferences questionnaire.

Intervention

Patients in the intervention groups received hypertension education materials, targeted to a 5th grade comprehension level, that were tailored to their preferred learning style (visual, read/write, aural, or kinesthetic). The 5th grade level information included the details necessary to correctly answer the hypertension knowledge questionnaire. Patients with adequate health literacy also received supplemental materials, targeted to an 8th grade comprehension level, that provided additional information about hypertension. Patients with marginal health literacy had the option of also receiving the supplemental materials. The intervention modalities and delivery methods parallel our approach as previously described (14). Patients in the control group did not receive hypertension educational materials.

Follow-up Assessment

Patients in both the control and intervention groups were re-administered the hypertension knowledge test via telephone two and six weeks after their initial visit to the clinic. At the six week follow-up, we also asked the participants to rate their agreement on a 5-point scale (1 = strong disagreement; 5 = strong agreement) with statements about their satisfaction with the materials and whether they had consulted resources on their own to learn about hypertension. We gave participants who completed the six-week follow-up interview a $15 gift card to a local grocery store.

Statistical Analysis

Learning outcome differences were determined by comparing between group change in the mean number of questions answered correctly on the hypertension knowledge quiz at baseline, two weeks follow-up and six weeks follow-up using paired t-tests. Data from participants in the ED study demonstrated a standard deviation in quiz scores of 2.8 questions. With a sample size of 186, this study provides at least 95% power to detect a difference of two correctly answered questions on the hypertension knowledge quiz before and after intervention at a two-sided 5% significance level.

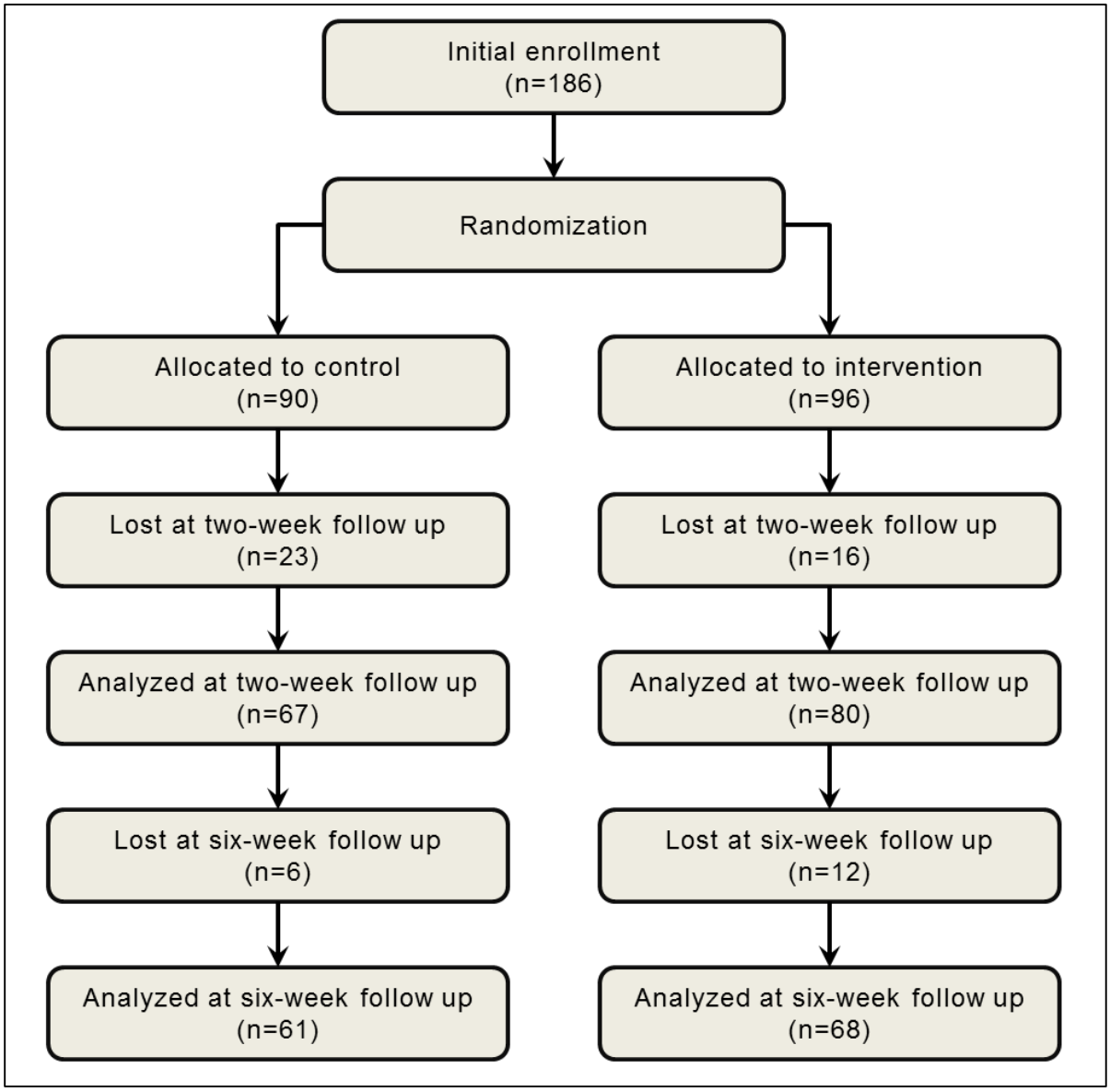
To determine the influence of specific factors on hypertension quiz scores, we performed multivariate linear regression analyses and adjusted for covariates. We adjusted the analysis for the following variables: pre-test score, assignment to the intervention group, gender, non-white race, health literacy score, multimodal learning style (vs. single modal learning style), having more than a high school education, having a household income greater than $20,000, follow-up interviewer, and time to follow-up. All missing data values were estimated using multiple imputations and hypotheses were tested at the 0.05 significance level. Study data were collected and managed using REDCap electronic data capture tools hosted at Vanderbilt University. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources (20). All analyses were

performed using the R statistical package (v. 2.13.0) by a statistician blind to the treatment assignment.

RESULTS

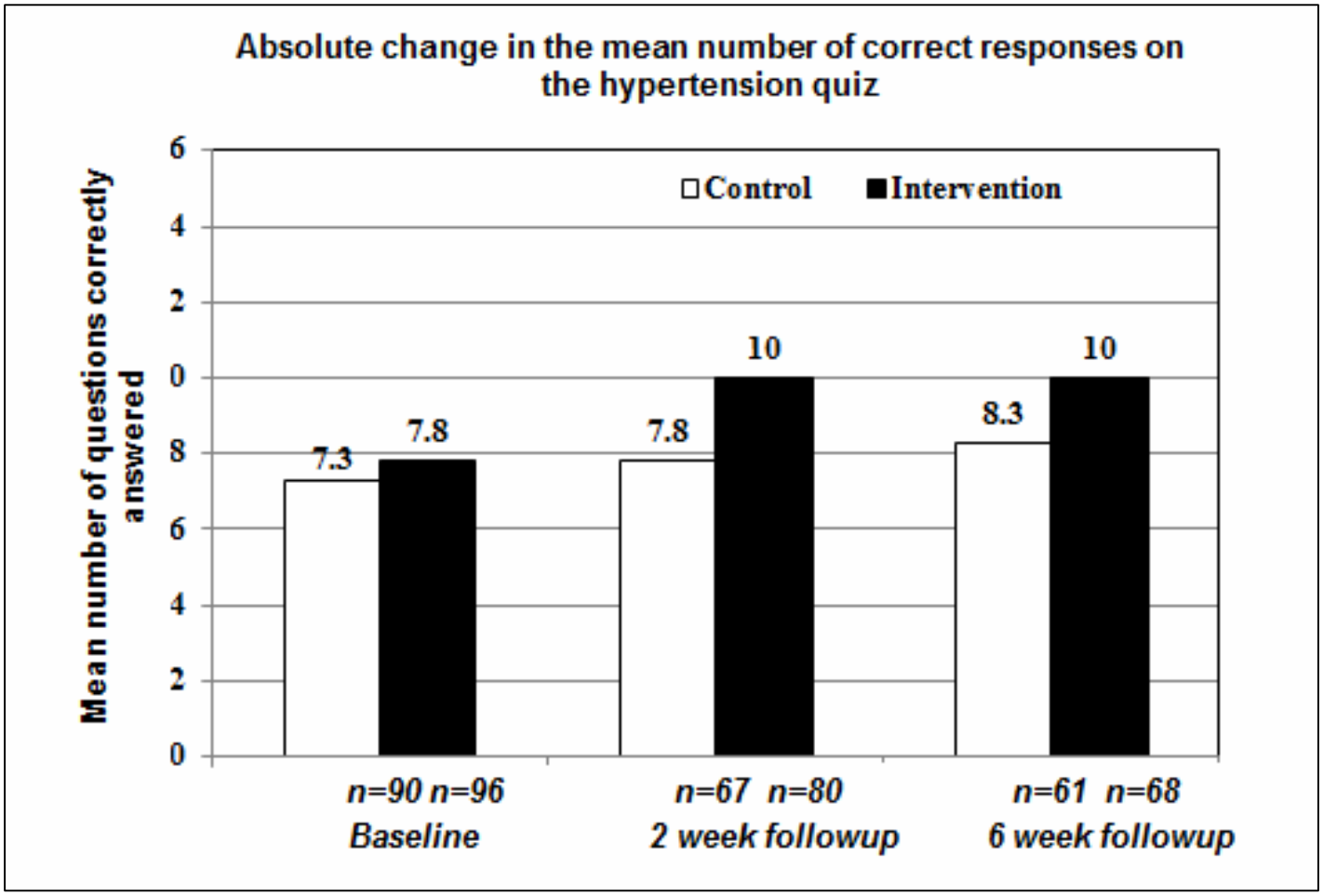
One hundred eighty-six patients were initially enrolled in the study. Ninety subjects were then assigned to the control group and 96 were assigned to the intervention group. At the two week follow-up, we were unable to contact 39 patients, resulting in 147 participants (67 control and 80 intervention) completing the post-test questionnaire. At six weeks, we were unable to reach an additional 18 subjects, resulting in 129 patients (61 control and 68 intervention) completing all phases of the study (Figure 1).

Figure 1: Patient Flowchart



At baseline, control subjects (n=90) answered a mean of 7.3 questions (SD= 2.33) correctly on the hypertension knowledge pre-test, and intervention subjects (n=96) answered 7.79 questions (SD=2.76) correctly (Figure 2). Control subjects showed a very modest increase in test scores at 2 weeks (mean number of questions answered correctly = 7.8; SD =2.12; $p>0.05$; N.S.) and 6 weeks (mean number of questions answered correctly = 8.3; SD=2.23; $p>0.05$; N.S.). By contrast, intervention group participants showed marked improvements on the post-test at 2 weeks, answering a mean of 10 questions correctly (n = 80; SD = 2.97; $p<0.01$). The improvements in test scores by intervention group patients persisted at 6 weeks (mean number of questions answered correctly = 10; SD = 2.48; $p<0.01$).

Figure 2: Absolute Change in the Mean Number of Correct Responses on the Hypertension Quiz



Multivariate linear regression analyses revealed the following significant predictors of post-test score at both two and six weeks: performance on the high blood pressure quiz at baseline, assignment to the intervention group, and education beyond the high school level. Throughout the study, we relied on six interviewers to interact with patients during the clinic visit and follow-up phone calls; each interviewer was assigned a unique ID number. Comparisons of all interviewers at every time point was not feasible, as not all spoke to patients during the clinic visit and each follow-up phone call. In the regression model for the six week follow-up time point, patients interacting with Interviewer #2 performed statistically better on the hypertension posttest than patients interacting with Interviewer

#3. The six week linear regression model also showed a significant outcome between those randomized to the intervention group who interacted with Interviewers #2 and #3.

Results from the mixed effect model, created to account for repeated measures over time, revealed that health literacy score, education beyond the high school level, and assessments conducted by Interviewer #3 and Interviewer #4 were significant predictors of hypertension quiz score outcomes. The mixed effect model also revealed a significant predictive outcome between those in the intervention group and time to follow-up.

Table 2: Multivariate linear regression of adjusted association between intervention and knowledge retention

Variable	Hypertension post-test score		
	2-week (n=147) B (SE)	6-week (n=129) B (SE)	Mixed effect model (n=289[1]) B (SE)
Intercept	-0.04(1.33)	1.31(1.53)	7.80**(1.37)
Baseline quiz score	0.61**(0.07)	0.44**(0.07)	N/A
Intervention group	2.09**(0.50)	3.14**(0.79)	0.71(0.48)
Gender	0.04(0.38)	-0.73(0.38)	-0.49(0.49)
Non-white race	-0.01(0.37)	-0.66(0.36)	-0.58(0.45)
Chew score[2]	-0.02(0.06)	0.00(0.06)	-0.16*(0.07)
Multimodal learning style (vs. single)	0.35(0.37)	0.51(0.35)	-0.55(0.45)
More than high school education	0.88*(0.36)	1.11*(0.35)	1.62*(0.45)
Household income higher than $20,000	0.28(0.36)	0.38(0.34)	0.38(0.44)
Interviewer #2	1.98(1.13)	3.69*(1.49)	0.32(0.45)
Interviewer #3	1.05(1.89)	2.16(1.64)	-0.91*(0.43)
Interviewer #4	3.31(4.35)		3.73*(1.83)
Interviewer #5			-0.13(0.42)
Interviewer #6			0.45(1.19)
Intervention group X Interviewer #2	-1.05(0.69)	-2.52*(0.89)	
Intervention group X Interviewer #3	-1.47(1.30)	-2.24*(0.99)	
Intervention group X Interviewer #4	-1.27(2.51)		
Time (2-week)			-0.91(0.78)
Time (6-week)			0.10(0.79)
Intervention group X Time (2-week)			1.27*(0.46)
Intervention group X Time (6-week)			0.96* (0.47)

Note: * p (2-tailed) < .05. ** p (2 -tailed) < .001

[1] Completed data only (no imputation was applied)

[2] Scored on an inverse scale; the lower the Chew score, the higher the health literacy.

DISCUSSION AND CONCLUSION

Community clinic patients who received personalized health education materials tailored to health literacy level and learning style preferences performed better on the hypertension knowledge questionnaire than those in the control group. Control group participants performed slightly better on the hypertension quiz at six weeks compared to their scores at two weeks; however the changes were not statistically significant. More than 50% (32/61) of these participants indicated they had

taken the opportunity to look up information about high blood pressure on their own, possibly suggesting their participation in the study resulted in an increased desire to learn more about their condition. The significant results of the mixed effects model for the interaction between intervention group participants and time to follow-up demonstrated that our personalized approach to information delivery yielded knowledge improvements that were sustained over the six week study period.

In our previous study, we observed a positive interaction between patient performance on the hypertension test and the interviewer assigned to study follow-up (14). Participants who received follow-up phone calls from the clinical librarian who interviewed them in the ED, a librarian with more than 30 years of education experience combined with strong customer service skills, performed better than their counterparts (14). We hypothesized that the librarian's ability to establish a rapport with study participants facilitated their engagement during the hypertension knowledge assessment. In this study, we observed similar results which may suggest rapport to be an important factor for health education delivery. Over time, if the interviewer was involved with the patient throughout multiple stages of the study, that interaction became a significant predictor of performance on the hypertension test. Undoubtedly, this result will require further investigation as it has implications for scalability.

Chronic disease management in medically underserved communities requires providers to overcome a myriad of challenges for optimal delivery of care (2). Novel approaches to increase knowledge and promote higher levels of patient engagement, such as explored in our research, can provide effective strategies for improving overall healthcare delivery. It is worth noting that the efforts described in this paper were entirely conducted by a team of library information professionals. The team, with expertise in information science, education and training, content and knowledge understanding of the medical field, combined with their excellent customer service abilities, were key throughout the different phases of the research project; their skill set greatly contributed to both the creation and delivery of educational material. The initiative reported in this paper clearly demonstrates the important added value a team of experienced and skilled medical librarians could have in helping in any outreach efforts aimed at educating a diverse population with multiple health literacy and learning style needs.

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