FINAL PROGRESS REPORT

TITLE: Text Messaging to Improve Hypertension Medication Adherence in African Americans

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ABSTRACT:

Purpose: This two-phased study sought to develop (Phase I) and test (Phase II) BPMED, a text message system to improve medication adherence in African Americans with uncontrolled Hypertension (HTN).

Scope: In the US, almost 78 million adults ≥20 years of age have hypertension (HTN), a key risk factor for heart disease and stroke. HTN is a condition in which there exists tremendous health disparities. African Americans suffer from greater disease severity, earlier onset, and more HTN-related complications than age-matched Whites. Although HTN can be effectively managed with medication, adherence to antihypertensive medication regimens is poor. Text messaging is a promising strategy to improve medication adherence.

Methods: In Phase I, we conducted formative research through focus groups with target end users to help develop BPMED. In Phase II, we conducted a one-month pilot RCT of BPMED compared to usual care. We hypothesized that BPMED participants would demonstrate improvements over usual care for measures of medication adherence, medication adherence self-efficacy, and blood pressure.

Results: Both usual care and intervention groups showed slight improvements in medication adherence and blood pressure at one-month follow-up, but differences between groups were not significant, suggesting BPMED did not have an effect on primary or secondary outcomes at one-month follow-up. Despite lack of significant effect, BPMED participants self-report overwhelming satisfaction with BPMED, perceptions of greater adherence to antihypertensive medication regimens, and perceptions of overall health improvements. Further study of the BPMED program with a larger sample size and longer-term follow-up is warranted.

Key Words: Cellular Phone; Text Messaging; Hypertension; Blood Pressure; African Americans; Medication Adherence; Mobile Health

PURPOSE

The purpose of this two-phased study was to develop (Phase I) and test (Phase II) BPMED, a text message system to improve medication adherence in African Americans with uncontrolled HTN. In our Phase II evaluation, we sought to test the following hypotheses:

- Hypothesis #1: Individuals assigned to the text message intervention will have a greater increase in medication adherence from baseline to one-month follow-up as compared to individuals receiving usual care treatment.
- Hypothesis #2: Individuals assigned to the text message intervention will have a greater increase in medication adherence self-efficacy from baseline to one-month follow-up as compared to individuals receiving usual care treatment.
- Hypothesis #3: Individuals assigned to the text message intervention will have a greater reduction in systolic and diastolic blood pressure (SBP and DBP) from baseline to one-month follow-up as compared to individuals receiving usual care treatment.

SCOPE

In the US, almost 78 million adults ≥20 years of age have Hypertension (HTN).[1] HTN is a key risk factor for heart disease and stroke (the first and fourth leading causes of death in the US, respectively).[2] HTN is more common among non-Hispanic blacks (42.0%) than non-Hispanic Whites (28.8%),[3] and this pattern has persisted for 50 years.[4,5] In addition to greater prevalence rates, African Americans suffer from greater disease severity, earlier onset, and more complications related to HTN than age-matched Whites.[6] HTN-related disparities are particularly evident in Detroit, MI, where 82.7%[7] of the population is African American and HTN-related outcomes are considerably worse compared to Michigan as a whole, including an approximately 56% higher mortality rate for heart disease and 34% for stroke (Table 1).[8]

Although HTN can be effectively managed with medication, adherence to antihypertensive medication regimens is poor. It has been estimated that only about half of people with HTN are adherent to prescribed medication regimens.[9,10] Despite emphasis on improving medication adherence, no single intervention has emerged as superior to others; however, interventions that include medication reminders have been shown to improve adherence and patient health outcomes.[9]

	City of Detroit n=713,777		**State of Michigan** n=9,877,143	
Age adjusted Mortality Rate per 100,000				
Heart Disease	318.4		203.5	
Stroke	52.6		39.4	
Years of Potential Life Lost				
Heart Disease	2845.1		1226.3	
Stroke	405.7		188.4	
Hospitalization Rate per 10,000				
Heart Disease	193.4 ± 3.2		140.0 ± 0.7	
Stroke	48.9 ± 1.6		34.3 ± 0.4	
Hypertensive Heart Disease as a Cause of Cardiovascular Death				
	n	**%**	**n**	**%**
All Ages	361	12.9%	1,656	5.6%
25-44	23	19.8%	74	12.2%
45-64	165	19.4%	468	9.5%
65 or older	173	9.6%	1,111	4.6%

Table 1: Recent Heart and Stroke Data for Detroit and the State of Michigan

Mobile health approaches are emerging as a beneficial strategy for promoting behavior change in African Americans. Because mobile phones are widely integrated into daily life, they have the potential to offer simple and non-labor intensive interventions for improving medication adherence. For example, Lawton et al. (2008) suggests that innovative approaches to medication management, such as text message interventions, may help to increase medication adherence in adults.[11] Upwards of 81% of US adult cell phone owners report using text messaging, making it the most common activity performed on a cell phone.[12] Although text messaging has been shown to increase treatment compliance, including medication adherence for some conditions,[13] it is not known whether the use of text messaging could improve medication adherence in underserved African Americans with uncontrolled HTN. The text message mobile approach is particularly well suited to this population. Although it is established that African American adults use the Internet less frequently than Whites (80% vs. 87%) and have lesser access to home broadband (62% vs. 74%), there are no significant differences in adoption of cellphones (92% and 90%) or smartphones (56% and 53%).[14] This suggests that a text messaging mobile approach is a viable strategy to reduce HTN-related disparities.

METHODS

The goal of this study was to develop and test BPMED, an automated text message system to increase medication adherence among African Americans with uncontrolled HTN. Using a multistep framework similar to that proposed by Whittaker et al. (2012) for the development and evaluation of mobile health interventions,[15] we conducted this study in two parts. In Phase I (conceptualization formative research, and pretesting stages), we gathered feedback from target end users through focus groups to aid in the design of the BPMED intervention. In Phase II (pilot RCT and qualitative feedback), we sought to test the feasibility, acceptability, and preliminary efficacy of BPMED in a pilot RCT of uncontrolled hypertensive African Americans recruited from a primary care setting.

After conceptualization of the intervention, we conducted formative research through focus groups with target end users to better understand patient perspectives on HTN, medication adherence, cell phone use, and the use of text messaging to support medication adherence. Focus group participants were recruited through targeted recruitment letters sent to primary care patients who met clinical eligibility requirements as identified in a retrospective chart review of electronic medical records of primary care patients at our recruitment site. To be eligible for inclusion in our Phase I focus groups, participants had to meet the following eligibility criteria: self-identified African American, age ≥ 18 years, diagnosis of HTN based on ICD-9 codes in the medical record, have uncontrolled HTN on two successive clinic visits prior to screening (clinic SBP > 140 mm Hg, DBP > 90 mm Hg or SBP > 130, DBP > 80 for those with diabetes or kidney disease) as documented in the medical record, taking at least one antihypertensive medication, own a cell phone capable of receiving and sending text messages, ability to pay for and obtain HTN medications, and English speaking. Enrolled participants were signed up for one of three focus groups.

We worked with the Wayne State University (WSU) Center for Urban Studies (CUS) to develop the focus group script, which was used for all three focus groups, and the WSU CUS conducted

all focus groups in order to reduce the potential for researcher bias. Meals were provided for all focus group participants. In addition to the focus group, participants were also asked to complete a brief survey assessing demographics, cell phone use, and medication adherence as measured by the Morisky Medication Adherence Scale [MMAS].[16] The focus group script was structured into three parts, including explanation of the study; discussion of HTN, medication regimens, medication adherence, and reasons for medication non-adherence; and discussion of cell phones and text message use, as well as perceptions of using text messaging for potential intervention functionality. In addition, participants were asked to identify additional features that could be useful in the intervention, as well as problems that may be encountered by using text messaging for this purpose. The three focus groups lasted approximately 90 minutes each. Participants were given a $25 cash incentive for completing the focus group. In total, 16 individuals participated in one of three focus groups (n=6, n=4, and n=6, respectively). All methods were approved by the Wayne State University Institutional Review Board (#0410810B3E).

In addition to moderating and facilitating focus groups, WSU CUS staff members also analyzed focus group notes and recordings for themes pertaining to HTN and medication adherence, as well as cell phone and text message use. CUS staff also noted whenever focus group members expressed consensus or majority opinions related to potential BPMED functionality. Finally, study staff prioritized all suggestions for possible BPMED functionality according to participant majority consensus and ultimate feasibility of implementation. All survey data collected prior to the focus groups was analyzed with descriptive statistics in STATA 11.0.

Focus group participants were primarily female (87.5%) and ranged in age from 34 to 67 years (M=50.8±9.6). All participants had at least a GED or high school diploma. Despite the level of education of our sample, annual combined household incomes for the previous year were quite low with 31.3% earning less than $10,000, and 25.0% earning between $10,000 and $19,999. Regarding cell phone use, 100.0% of focus group participants reported that they carried their cell phone all day, every day, and had the ability to send and receive text messages. Based on MMAS scores, the majority of our samples were considered to have low medication adherence (62.5%), while 18.8% were medium and 18.8% were high adherers.

Please see Table 2 for a complete breakdown of focus group participant characteristics.

Table 2: Focus group participant characteristics

Characteristic	n (%)
Age (n=16)	M=50.8±9.6
Gender (n=16)	
Female	14 (87.5%)
Male	2 (12.5%)

Highest level of education* (n=16)	
High school diploma or GED	8 (50.0%)
Some college	4 (25.0%)
Bachelors degree	3 (18.8%)
Graduate degree	1 (6.3%)
Marital status* (n=16)	
Single, never married	6 (37.5%)
Married	1 (6.3%)
Divorced	7 (43.8%)
Widowed	2 (12.5%)
Annual household income (n=16)	
< $10,000	5 (31.3%)
$10,000 - $19,999	4 (25.0%)
$20,000 - $39,999	3 (18.8%)
$40,000 - $59,999	2 (12.5%)
≥ $60,000	2 (12.5%)
Employment status* (n=16)	
Work part time	4 (25.0%)
Work full time	3 (18.8%)
Retired	2 (12.5%)
On disability	3 (18.8%)
Laid off / Unemployed	4 (25.0%)
Cell phone plan is prepaid (requires phone cards)* (n=16)	
Yes	1 (6.3%)
No	15 (93.8%)

Length of current cell phone plan ownership (n=15)	
< 1 month	0 (0.0%)
1 – 3 months	2 (13.3%)
4 – 6 months	1 (6.7%)
7 – 12 months	2 (13.3%)
> 1 year	10 (66.7%)
Who pays for cell phone (n=13)	
Self	10 (76.9%)
Spouse	0 (0.0%)
Family member other than spouse	1 (7.7%)
Friend	2 (15.4%)
Frequency of text message use* (n=16)	
Never	3 (18.8%)
A few times per month	3 (18.8%)
A few times per week	1 (6.3%)
Daily	9 (56.3%)
Does cell phone plan include text messaging* (n=16)	
Yes, unlimited text messaging is included in plan	10 (62.5%)
Yes, a limited number of text messages are included in cell phone plan	3 (18.8%)
No	2 (12.5%)
Don't know	1 (6.3%)

* Sum total does not equal 100% due to rounding error.

Based on the themes that emerged from our three focus groups, it was clear that participants did not always take their medications as prescribed. Reasons for non-adherence varied, but the majority of focus group participants cited simply forgetting to take medication as the primary reason. Participants also cited issues related to fears of doubling up, stopping medications when HTN symptoms subsided, and undesirable side effects as reasons for non-adherence. The vast majority of participants thought that text message reminders would be helpful in

improving medication adherence, and requested customizability be built into the system. Specifically, participants requested the ability to customize the frequency and timing of medication reminders each day. Participants also indicated a preference for educational messaging focused on HTN-related topics.

When this study was originally conceptualized, we intended on having participants self-monitor their medication adherence via text messaging, but through our formative research, it became clear that target end users were adamantly opposed to this idea, with several participants stating they would not use such a system. Although self-reporting adherence back to the system was not viewed as acceptable, participants voiced great support for the use of text messaging to provide medication reminders.

Based on our formative research, we developed BPMED to be a one-month intervention that provided daily, automated text message medication reminders at the participant's time of choosing. We also included eight educational messages (two/week) based on HTN management recommendations from the American Heart Association (Table 3). A one-item weekly satisfaction questionnaire was included, which asked participants to rate their satisfaction with the BPMED intervention on a scale from one to ten. All text messages were pretested by content experts with experience working in our target community.

Table 3: Text messages included in BPMED

BPMED: The DASH diet works! Eat foods rich in whole grains, fruits, vegetables, and low-fat dairy, while limiting saturated fat and cholesterol.
BPMED: Physical activity lowers blood pressure. Aim for 30 minutes each day over small chunks or all at once. Try a 30 min brisk walk or three 10 min walks!
BPMED: Smoking can increase blood pressure. If you are a smoker and want help quitting, call 1-800-QUITNOW or talk to your doctor.
BPMED: Foods high in sodium (salt) can increase blood pressure. Try to limit your sodium intake to 1500 mg/day, including what is in and what is added to food.
BPMED: Did you know that 30 minutes of moderate physical activity can help make your blood pressure medications work more effectively and help you feel better?
BPMED: To manage your blood pressure, limit your alcohol consumption to no more than two drinks per day for men and no more than one drink per day for women.
BPMED: To help reduce sodium intake, use spices instead of salt in cooking and at the table. Flavor foods with herbs, citrus, vinegar, or salt-free blends.
BPMED: Did you know that blood pressure rises as body weight increases? Losing even 10 pounds can lower blood pressure and your risk of chronic disease.

To evaluate the feasibility, acceptability, and preliminary efficacy of BPMED in Phase II, we conducted a one-month pilot RCT of BPMED compared to usual care with patients recruited from primary care settings. To be eligible for inclusion in this study, participants had to meet the following eligibility criteria: self-identified African American, age ≥ 18 years, diagnosis of HTN based on ICD-9 codes in the medical record, have uncontrolled HTN on two successive clinic visits prior to screening (clinic SBP > 140 mm Hg, DBP > 90 mm Hg or SBP > 130, DBP > 80 for those with diabetes or kidney disease) as documented in the medical record, taking at least one antihypertensive medication, own a cell phone capable of receiving and sending text messages, ability to pay for and obtain HTN medications, and English speaking. Exclusion criteria included reporting strict adherence to medication regimens; receiving hemodialysis; plans to move >50 miles from the recruitment site within the next three months; diagnosis of resistant HTN documented in the medical record; plans to terminate cell phone contract during the next month; compliance risk; and/or other major health problems that would make participation in this study difficult.

Participants were recruited from primary care settings through several methods, including targeted recruitment letters sent to potentially eligible patients meeting clinical inclusion criteria as identified in a retrospective chart review, recruitment posters located in primary care exam rooms, and direct provider referral. Potentially eligible participants were screened via phone and those eligible were invited to a baseline data collection visit where participants were consented, enrolled, and randomized into either the BPMED intervention or usual care. Again, all methods utilized in this trial were approved by the Wayne State University Institutional Review Board (#0410810B3E).

After consent, all participants completed a baseline survey assessing demographics, cell phone use, medication adherence, and medication adherence self-efficacy, as well as had their blood pressure taken. Participants had been instructed to bring all antihypertensive medications to the baseline data collection visit so pill counts could be taken. Once baseline data had been collected, participants were block-randomized with a 1:1 ratio to either the usual care control or BPMED intervention group. Intervention group participants were then enrolled in BPMED and trained on how to use the program. Regardless of trial assignment, all participants were asked to come back for a one-month follow-up visit where medication adherence, medication adherence self-efficacy, and blood pressure measures were assessed. Also at the one-month follow-up visit, intervention group participants completed a brief BPMED satisfaction questionnaire and qualitative open-ended interview. All trial participants had the opportunity to receive up to $50 for their participation in this study; $25 at the conclusion of the baseline assessment and $25 at the completion of the one-month follow-up data collection visits. Any participant who indicated in their baseline survey that text messaging was not included in their cell phone plan was reimbursed $.20/text message sent or received as a part of their participation in this study. Parking expenses incurred by participants for data collection visits were also covered.

The primary outcome of interest in our BPMED evaluation was change in medication adherence from baseline to one-month follow-up, which was measured using the MMAS,[16] pill counts, and an additional self-report of medication adherence. Medication self-efficacy, as measured by the

Medication Adherence Self-Efficacy Scale,[17] blood pressure, and participant satisfaction with BPMED were secondary outcome measures of interest. To measure satisfaction with the BPMED, intervention group participants completed a short satisfaction questionnaire at one-month follow-up, and a brief qualitative interview was conducted.

To analyze collected data, descriptive statistics were used to describe participant characteristics and intervention satisfaction at follow-up. Categorical data displayed as frequency and percentages, as well as chi-square tests were used for comparison. Continuous variables such as medication adherence, medication adherence self-efficacy, and blood pressure were expressed as mean (SD), and means were compared using two-tailed unpaired independent sample t tests. All statistical analysis were carried out using STATA version 11.0 (StataCorp LP, College Station, TX, USA).

RESULTS

The CONSORT diagram (Figure 1) shows participant flow through our pilot RCT. We ultimately screened 161 potential participants for eligibility and excluded 85 for failing to meet inclusion criteria. Potential participant insistence that they always take their medications as prescribed was the primary reason for exclusion. Participants were also commonly excluded for reporting that their blood pressure was now under control, or that their phone couldn't send or receive text messages. An additional 18 potential participants screened eligible, but failed to enroll in the study.

In total, 58 participants were randomized in the trial; 28 were allocated to receive the BPMED intervention and 30 were allocated to usual care. We ultimately lost one BPMED and four usual care participants to follow-up. Of the 58 participants randomized, the majority were female (66.1%), single (never married) 48.2%, with an average age of 52.2 (SD=7.6) years. Education levels varied with 12.7% reporting completing some high school, 29.1% having a high school diploma/GED, 29.1% completing some college, and 29.1% having an associates degree or higher. Annual household income was relatively low with 45.5% reporting annual household incomes <$10,000, and only 14.5% reporting annual household incomes ≥ $40,000. Many participants were on disability (37.5%) or were laid off or unemployed (25.0%). Only 30.4% of participants were employed full- or part-time. No significant differences were found at baseline between control and intervention group participants in medication adherence, medication adherence self-efficacy, and blood pressure. See Table 4 for a breakdown of trial participant characteristics.

Figure 1: Participant flow through BPMED pilot RCT

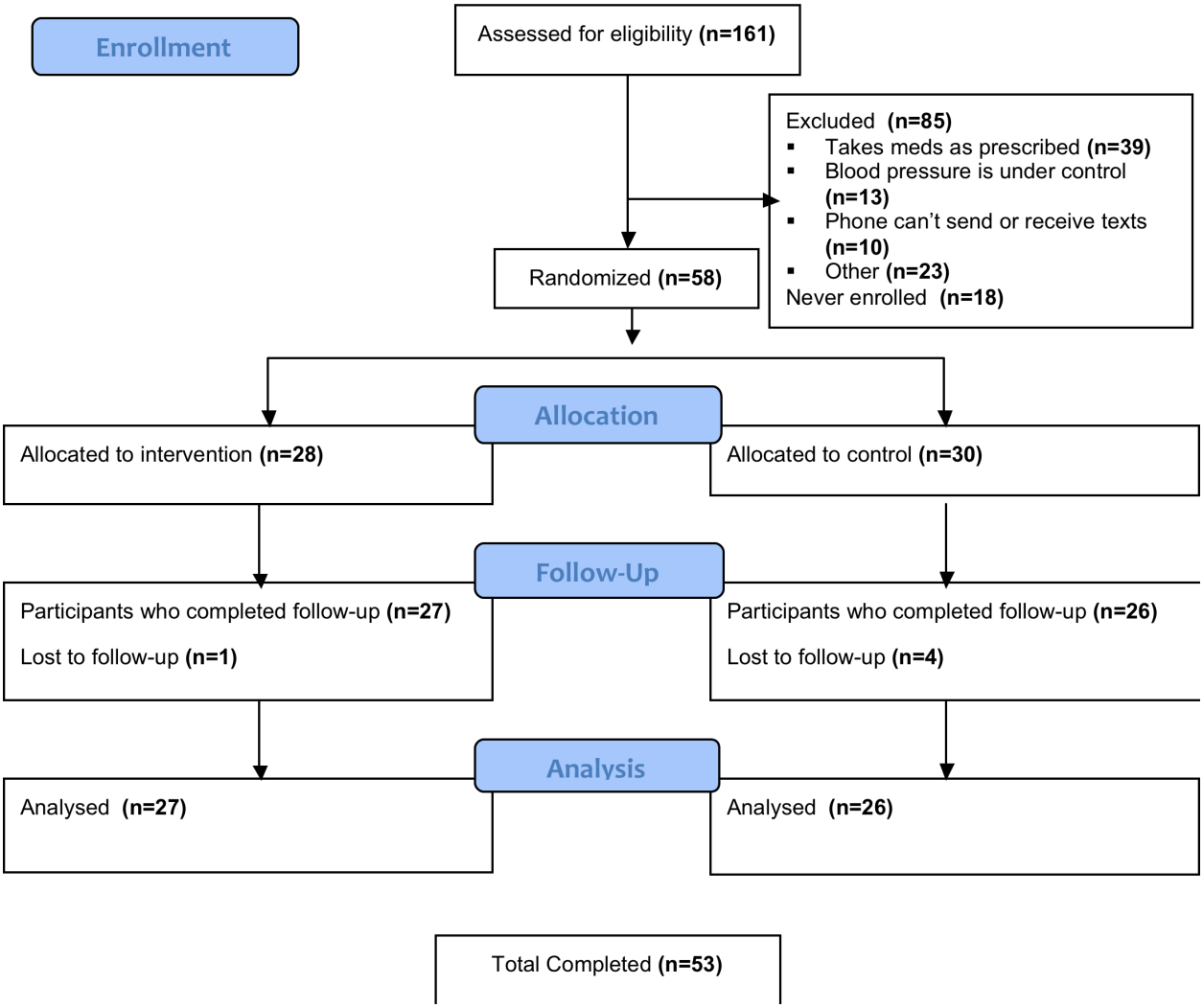

Table 4: BPMED Trial Participant Characteristics

Characteristic	n (%)
Age (n=56)	M=52.2, SD=7.6
Gender (n=56)	
Female	37 (66.1%)
Male	19 (33.9%)
Highest level of education* (n=55)	
Some high school	7 (12.7%)
High school diploma or GED	16 (29.1%)
Some college	16 (29.1%)
Associations degree	7 (12.7%)
Bachelors degree	2 (3.6%)
Some graduate school	2 (3.6%)
Graduate degree	5 (9.1%)
Marital status* (n=56)	
Single, never married	27 (48.2%)
Married	7 (12.5%)
Separated	5 (8.9%)
Divorced	11 (19.6%)
Widowed	6 (10.7%)
Annual household income (n=55)	
< $10,000	25 (45.5%)
$10,000 - $19,999	15 (27.3%)
$20,000 - $29,999	1 (1.8%)
$30,000 - $39,999	6 (10.9%)

≥ $40,000	8 (14.5%)
Employment status* (n=56)	
Work part time	5 (8.9%)
Work full time	12 (21.4%)
Retired	4 (7.1%)
On disability	21 (37.5%)
Laid off / Unemployed	14 (25.0%)
Cell phone plan is prepaid (requires phone cards) (n=55)	
Yes	6 (10.9%)
No	47 (85.5%)
Don't know	2 (3.6%)
Length of current cell phone plan ownership* (n=53)	
< 1 month	1 (1.9%)
1 – 3 months	4 (7.5%)
4 – 6 months	4 (7.5%)
7 – 12 months	9 (17.0%)
> 1 year	35 (66.0%)
Who pays for cell phone* (n=55)	
Self	45 (81.8%)
Spouse	1 (1.8%)
Family member other than spouse	2 (3.6%)
Friend	1 (1.8%)
Other	6 (10.9%)
Frequency of text message use (n=56)	
Never	2 (3.6%)

A few times per month	7 (12.5%)
A few times per week	12 (21.4%)
Daily	35 (62.5%)
Does cell phone plan include text messaging* (n=56)	
Yes, unlimited text messaging is included in plan	40 (71.4%)
Yes, a limited number of text messages are included in cell phone plan	6 (10.7%)
No	4 (7.1%)
Don't know	6 (10.7%)

* Sum total does not equal 100% due to rounding error.

Regarding cell phone use, only 10.9% of participants report using prepaid cell phones, 63.6% report having their cell phone plan for longer than one year, and 81.8% report that they pay for their own cellphone plan. The vast majority of participants (92.5%) report that they carry their cell phones all day, every day, and use text messaging (92.7%) daily (62.5%).

In assessing the preliminary effectiveness of BPMED, we compared intervention and control group participant baseline and one-month follow-up measures. At the outset, we hypothesized that participants in the BPMED intervention group would have greater improvements in medication adherence (Hypothesis #1), medication adherence self-efficacy (Hypothesis #2), and blood pressure (Hypothesis #3) at one-month follow-up. At baseline, the majority of participants were found to be low medication adherers (defined as a score of 5 or lower on the MMAS) (61.5% of control and 50.0% of intervention group). No support was found for Hypothesis #1, as no significant differences were found between control and intervention group participants for medication adherence according to MMAS scores at baseline (4.4 and 4.6, respectively) or follow-up (4.7 and 5.3, respectively), and despite finding overall improvements in MMAS scores for both groups (.3 and .7, respectively), the difference in improvement between groups was not significant. Due to the lack of participants bringing antihypertensive medications to data collection visits so that pill counts could be conducted, we have relied on MMAS scores for understanding the effect of BPMED on medication adherence.

Hypothesis #2, stating that improvements in medication adherence self-efficacy would be greater among BPMED participants, was also not supported. Non-significant differences in Medication Adherence Self-Efficacy Scale scores between control and intervention group participants were found at baseline (45.4 and 41.6, respectively) and follow-up (41.0 and 42.5, respectively), and the overall change was not significant between groups (-4.5 and .9, respectively).

Support for Hypothesis #3 was also not evident as similar patterns were also observed for blood pressure. Regarding systolic blood pressure, no significant differences were found between control and intervention group participants at baseline (135.4 and 137.0, respectively) or follow-

up (133.4 and 133.1, respectively), and despite finding overall improvements in systolic blood pressure scores for both groups (-3.1 and – 4.6, respectively), the difference in improvement between groups was not significant. Likewise, no significant differences were found between intervention and control group participants for diastolic blood pressure at baseline (88.5 and 90.3, respectively) or follow-up (86.8 and 87.5, respectively), and despite finding overall improvements in diastolic blood pressure for both groups (-1.7 and -3, respectively), the difference in improvement between groups was not significant.

Despite not having any improved outcomes over usual care participants at one-month follow-up, BPMED intervention participants report high degrees of satisfaction with the intervention. Specifically, the majority of intervention group participants agreed/strongly agreed that the program was easy to use (95.8%), that they were satisfied with the program (92.0%), that they would recommend the program to others (92.0%), that the program helped them to adhere to their blood pressure medication regimen (88.0%), that the program was a benefit to their overall health (84.0%), and that they would like to continue using the program (72.0%). Moreover, 95.8% of BPMED participants report reading their text message reminders.

DISCUSSION

Through this study, we worked with target end users of African American primary care patients with uncontrolled HTN to develop BPMED, an automated text message medication reminder system. This goal of BPMED was to improve medication adherence among the target population. This current study adds to the literature of short-term follow-up demonstrations of text message medication reminders for improving medication adherence, and is one of the first to focus on this application in the context of HTN. Through our pilot RCT of BPMED, compared to usual care, we found overwhelming satisfaction for the intervention. Participants found the program to be easy to use, expressed their desire to continue to use the program and to recommend the program to others, and self-reported their perception that the use of BPMED helped them adhere to their blood pressure medication regimen and was a benefit to their overall health.

Despite these overwhelmingly positive perceptions of the BPMED intervention, we found no evidence to support that the use of BPMED for one month led to improvements in medication adherence, medication adherence self-efficacy, or blood pressure. While both intervention and control groups saw slight improvements in medication adherence and blood pressure, these improvements were not significantly different between groups. Although improvements in medication adherence have been demonstrated for the use of medication reminders for adherence to antiretroviral therapy (ART) for people living with HIV/AIDs,[18] as well unspecified medication regimens,[19] and a variety of conditions and treatments, including type 2 diabetes,[20] glaucoma,[21] schizophrenia,[22] and asthma,[23] our present findings add to the body of literature that has found no short-term effect, such as those focused on medication reminders for acne medications,[24] and oral contraceptives.[25]

We believe that the non-significant findings from this investigation can be largely attributed to our short-term follow-up, and our small sample size. It is quite likely that our one-month follow-up period was not long enough to affect behavior change and subsequent health outcomes. The

one-month follow-up period was initially chosen for several reasons. First of all, this study was designed as a pilot project and was primarily concerned with showing feasibility and acceptability of our approach, with secondary emphasis on demonstrating preliminary efficacy. As such, a one-month follow-up period seemed a reasonable first step. In addition, our one-month follow-up period was chosen out of an initial concern of the stability of cell phone numbers in this population. Despite finding that the majority of participants in our trial had monthly cell phone plans that they had kept for longer than a year, we had reason to believe at the outset that phone service may not always be turned on due to non-payment of cell phone bills. Furthermore, beyond our short follow-up period, we believe that our RCT was underpowered to detect meaningful differences in primary and secondary outcomes at follow-up. Again, as this pilot was initially concerned with demonstrating preliminary feasibility and acceptability, the smaller sample size was deemed appropriate.

In light of the limitations in our evaluation approach, we believe that longer-term, larger-scale randomized controlled trials of the BPMED intervention are warranted. Although we did not find significant effect of the intervention at one-month, the overwhelming support among participants demonstrates the feasibility and acceptability of this approach in our target population. Because we believe that simple medication reminders delivered via text message are likely to have a small effect size, further evaluation with larger sample sizes and longer follow-up is recommended. In addition, perhaps a more robust approach to medication adherence, where medication reminders are but one part, is warranted.

LIST OF PUBLICATIONS AND PRODUCTS

Peer-Reviewed Publications

Buis LR, Artinian NT, Schwiebert L, Yarandi H, Levy PD. *Text Messaging to Improve Hypertension Medication Adherence in African Americans: BPMED Intervention Development and Study Protocol.* JMIR Res Protoc, In Press.

Publications in Preparation

Buis LR, Artinian NT, Schwiebert L, Yarandi H, Mango L, Dawood R, Dawood K, Hirzel L, Levy PD. *Text Message Medication Reminders to Improve Medication Adherence in Underserved African Americans with Uncontrolled Hypertension: A Randomized Controlled Trial.* Anticipated submission to JMIR in February, 2015.

Peer-Reviewed Presentations

Buis L, Artinian N, Yarandi H, Fotouhi F, Schwiebert L, Hirzel L. March 2011. Using cell phones to aid medication adherence in hypertensive African Americans. 2011 Annual Wayne State University College of Nursing Research Day Meeting in Detroit, MI.

Buis L. Artinian NT, Schwiebert L, Yarandi H, John C, Hirzel L, Torres L. December 2011. Developing a SMS medication reminder system to reduce health disparities in African Americans with uncontrolled hypertension. 2011 mHealth Summit in Washington, DC.

Buis L, Artinian N, Yarandi H, Hirzel L. April 2012. Individuals' preferences for health information delivery modalities. 2012 Annual Wayne State University College of Nursing Research Day Meeting in Detroit, MI.

Buis L, Schwiebert L, Artinian N, Yarandi H, Hirzel L. December 2012. Evaluation of a SMS medication reminder system to improve medication adherence in African Americans with uncontrolled hypertension. 2012 mHealth Summit in Washington, DC.

Invited Presentations

Buis L. September 2011. Using social media in disease management. 23rd Annual Conference of the Michigan Chapter American College of Cardiology, Traverse City, MI.

Buis L. June 2012. Text message medication reminders to improve medication adherence in African Americans with hypertension. Michigan State Medical Society 2012 Health Information Technology Symposium, East Lansing, MI.

Buis L. June 2012. Connecting patients online to improve adherence to behavior change interventions. Michigan State Medical Society 2012 Health Information Technology Symposium, East Lansing, MI.

Buis L. March 2013. *Using technology to promote social connections for health behavior change*. Michigan State Medical Society Foundation conference on the Patient Centered Medical Home. Troy, MI.

Subsequent Projects (Proposed)

MI-BP: mHealth to Improve Blood Pressure Control in Hypertensive African Americans. Buis LR (PI). Funding: National Heart, Lung, and Blood Institute (1R01HL127215-01). This project builds on the findings of the present study to propose a more robust mobile approach to managing uncontrolled HTN in the target population, with a longer follow-up period.

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