



Text messaging to increase patient engagement in a large health care for the homeless clinic: Results of a randomized pilot study

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Abstract

Objectives: To assess the feasibility and effectiveness of text messaging to increase outpatient care engagement and medication adherence in an urban homeless population in Boston.

Methods: Between July 2017 and April 2018, 62 patients from a clinic serving a homeless population were sent automated text messages for four months. Messages were either appointment reminders and medication adherence suggestions (intervention group) or general health promotion messages (control group). Medical records were reviewed to evaluate appointment keeping, emergency room (ER) use, and hospitalizations. Pre- and post-surveys were administered to measure self-reported medication adherence.

Results: No significant differences were found in inpatient or outpatient care between the intervention and control groups, though differences in no-show rates and medication adherence approached significance. Appointment no-show rates were 21.0% vs. 30.6% ($p=0.08$) for intervention and control, respectively, and rates of completed appointments were 65.8% vs. 56.7% ($p=0.12$). Mean ER visits were 3.86 vs 2.33 ($p=0.16$) for intervention and control groups, and mean inpatient admissions were 0.6 versus 1.24 ($p=0.42$). Self-reported medication adherence increased from 8.27 to 9.84 in intervention participants, compared to an increase from 8.27 to 8.68 in control participants ($p=0.07$), on a 1–11 scale.

Conclusions: Text messaging showed the potential to improve patient engagement in care and medication adherence in an urban homeless population (findings approaching but not achieving statistical significance). Work is needed to enhance the effectiveness of text-messaging interventions, which may involve increasing ease of use for mobile phones and texting apps, and addressing high rates of phone theft and loss.

Keywords

text messaging, homeless, digital, patient engagement

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Introduction

The health of people experiencing homelessness is very poor. Infectious diseases¹ and chronic conditions, such as diabetes,^{2,3} mental health problems,⁴ chronic pain,⁵ and substance use disorder,⁶ are significantly more common in homeless populations than in the general U.S. population. Mortality rates in homeless populations are 5–10 times higher than among people who are housed.^{7–10}

Regular engagement with primary care and adherence to prescribed medications can help patients manage the chronic physical and mental diseases.¹⁰ However, people experiencing homelessness face barriers accessing health care such as keeping track of appointments and accessing transportation to medical facilities.^{11,12} When engagement with outpatient care is disrupted, chronic conditions can worsen and lead to reliance on emergency departments (EDs), a costly and relatively common phenomenon in homeless populations.^{11,13,14} Unstable living conditions and competing priorities can also cause difficulty with remembering to take medications or finding time to refill prescriptions, which can lead to days or weeks of no medication or intermittent adherence.^{15,16}

Using cell phones to provide appointment and disease management reminders, motivational messaging, and education has been shown to improve chronic disease management and reduce ED visits among low-income, vulnerable populations.^{15,16} However, there has been little research directly examining the benefit of cell phone support among homeless populations.^{17,18} This may be due to an assumption that few persons experiencing homelessness have cell phones. However, many homeless people own and use cell phones and show interest in cell phone–based medication and appointment reminders.^{17,19,20} Cell phones are portable, relatively inexpensive (or free from some programs),²¹ and can serve multiple functions, helping their users address social, employment, housing, and health-related needs. For this reason, cell phones are well-suited to the unpredictable lives of many homeless people.

For this study, we developed a cell phone–based text-messaging system for high-need patients who receive care and case management services at a safety net homeless clinic in Boston, Massachusetts. Messages included outpatient appointment reminders, education about medication adherence, interactive messages about participants' mood, and general health information. This study examines the feasibility of this intervention to: (1) reduce ED visits and inpatient hospitalization, (2) improve outpatient appointment keeping, and (3) increase medication adherence, in an urban homeless population.

Methods

Setting and participants

Boston Health Care for the Homeless Program (BHCHP) is a federally qualified health center in Boston, Massachusetts.

It is the largest freestanding health care for the homeless program in the country and provides primary care, behavioral health, dental, and other services to over 11,000 homeless individuals each year.²²

The participants for this study were recruited from two patient groups at BHCHP: the Social Determinants of Health Coordinated Care Hub for Homeless Adults (SDH) and the OneCare patient cohort. To qualify for the study, participants had to be at least 18 years of age, able to understand written and spoken English or Spanish, and willing to receive and respond to text messages. Individuals were excluded if they were unable to read and respond to a test text message sent by a research team member during the enrollment process.

Between July 2017 and April 2018, we recruited 39 participants from the SDH cohort and 25 participants from the OneCare cohort. Both cohorts represent high-need patients. Patients in the SDH cohort are in the top 15% of BHCHP's Medicaid population by healthcare cost and had six or more ED visits and two or more inpatient admissions in a six-month period. Patients in the OneCare cohort are dual-eligible for both Medicare and Medicaid coverage because of their income and disability status. Figure 1 depicts the distribution of SDH and OneCare patients in the intervention and control groups. Based on power calculations, 25 participants per group were deemed sufficient to detect a medium-to-large effect size (Cohen's d of 0.735) with 80% power and a two-sided alpha of 0.05. To account for attrition, we aimed to enroll 30 participants per group. The Institutional Review Board of Boston University, Medical Campus, approved this study (IRB number: H-35967); and the study was registered with ClinicalTrials.gov (Identifier: NCT03034993).

Intervention design

The intervention was a system of four types of text messages sent over a four-month period. Messages were sent using CareMessage, a mobile health platform designed for underserved patient populations.²³ One-way messages included appointment reminders for upcoming primary care, behavioral, and dental outpatient appointments; educational and motivational health tips; and medication adherence education. Two-way messages, which requested a text response, asked participants about their mood.

Appointment reminders were populated with appointment information from Epic, BHCHP's electronic medical record (EMR). Following HIPAA regulations, these messages included the address of the appointment, but not the name of the clinic or the provider. Health tip messages were designed to be educational and motivational, for example, "Your health care team is rooting for you!" The final type of one-way message gave information about medication adherence practices, such as, "Set an

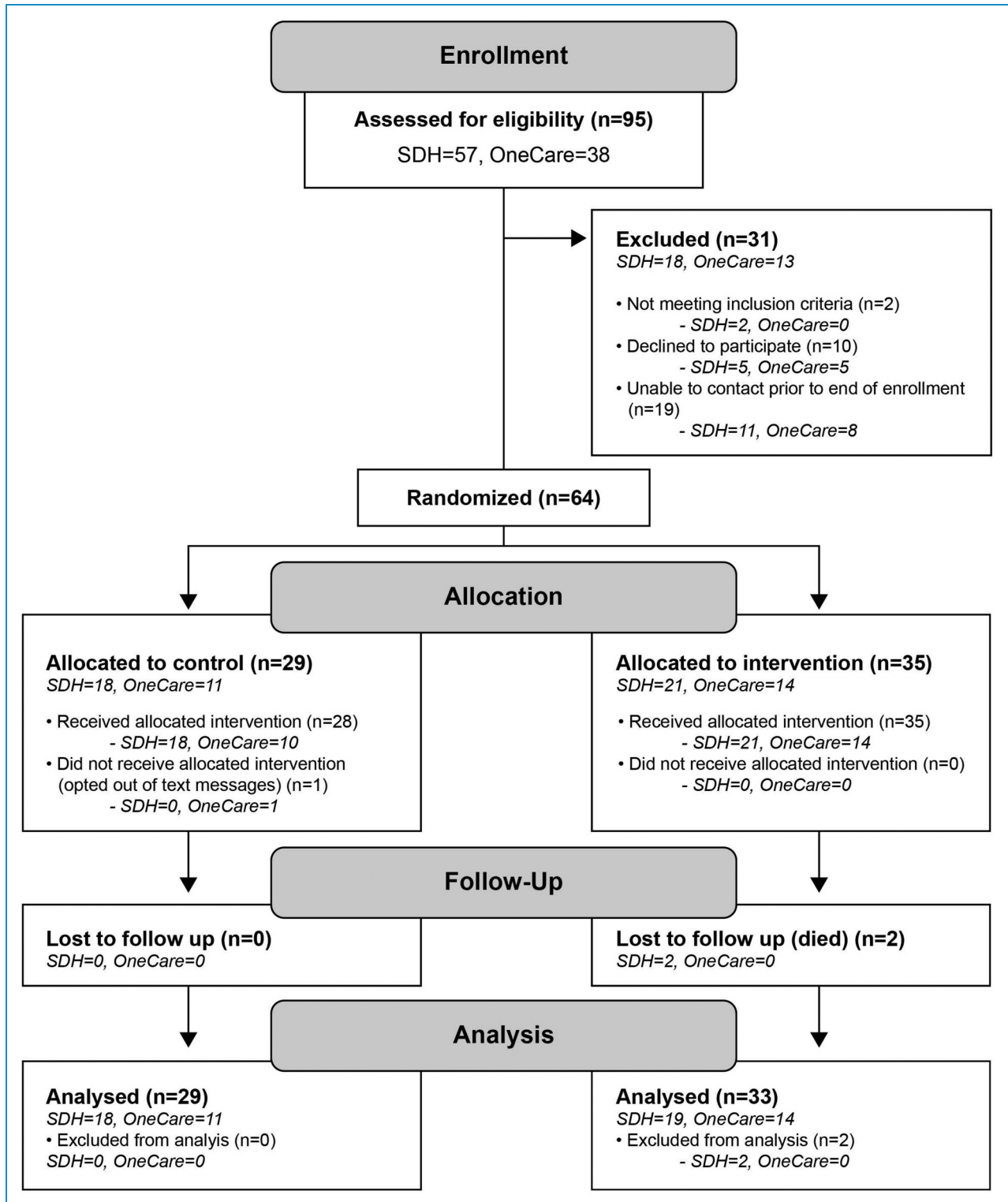


Figure 1. CONSORT flow diagram.

alarm on your phone every day to remind you to take your medication. This way it'll be easier to remember."

Two-way messages asked participants to respond to the question, "How is your mood right now? (0=very

negative, 1=somewhat negative, 2=neutral, 3=somewhat positive, 4=very positive)," with a single digit. If a participant answered with something other than a single digit, they received an error message telling the participant

“if this is an emergency please call 911.” If a participant answered “0” to two consecutive messages, the protocol was to notify the patient’s case manager, however, this did not occur. A complete list of text messages is available in Supplemental File 1.

To incorporate a community-based participatory research approach, and tailor our messaging to the homeless population, we held five meetings with a BHCHP patient community group. This group gave us valuable feedback on the content, timing, and phrasing of the messages, as well as recruitment strategies and types of gift cards to provide that would be useful for the patient population.

Study procedures

After eligibility screening and the informed consent process, participants were randomized to either the intervention or control group, and then they completed a baseline survey. Participants, but not study staff, were blinded to group assignment. After four months of receiving messages, participants completed a follow-up survey, which contained the same measures as a baseline, along with semi-structured qualitative questions to capture participants’ experiences with the study.

Participants who did not own a phone were given a shock-resistant, waterproof feature phone (“flip phone”). These phones were chosen because of their durability and low resale value. The phones were donated to the study by a major phone carrier, and the study paid for participants’ phone plans. Participants receiving a phone were taught to use its basic features, such as setting up voicemail, charging, placing a call, receiving and sending text messages, setting reminders, and using the phone’s calendar for appointment tracking. This training took place face-to-face between a study RA and a participant. The RA demonstrated a feature (e.g. writing and sending a text message) and then asked the study participant to carry out the same procedure. The RA provided tailored guidance to assist the participant with any particular step they had not demonstrated that they could do. Participants were able to receive up to five replacement phones if a phone was lost or stolen. Participants who used their own phone for the study received a \$25 gift card to compensate for incurred text-messaging charges.

Graduate and undergraduate research assistants (RAs) administered the surveys in person. The study PI (DKM) trained the RAs on study procedures and data collection using role-play, discussion of survey administration techniques, and review of proper informed consent procedures. Surveys were typically conducted at BHCHP’s healthcare clinic locations. Some participants were unable to commute to BHCHP, in which case the survey was conducted elsewhere, such as a homeless shelter, or by phone. Participants’ qualitative responses were collected

through note-taking by the interviewers. All participants received a \$15 gift card to a convenience store at enrollment and at the four-month follow-up.

Outcome measures and data collection

The primary outcomes were (1) number of ED encounters, (2) number of inpatient admissions, and (3) appointment keeping. Data on ED and inpatient admissions were accessed through PreManage, a system that aggregates hospital data across most Boston-area hospitals.²⁴ Secondary outcomes were (1) self-reported medication adherence and (2) well-being. Data for secondary outcomes were collected from baseline and follow-up surveys. Due to low response rates, data from the mood message responses were not analyzed in this study. Qualitative data were retained for future analysis.

An ED encounter was defined as any ED visit that PreManage recorded, regardless of visit outcome. ED visits that resulted in hospitalization counted as both an ED encounter and an inpatient admission. A participant could have multiple ED visits in one day. Appointment keeping was defined by three possible outcomes documented in the participant’s EMR: attendance, no attendance (“no-show”), and cancellation.

Medication adherence was measured using a visual analog scale in which participants indicated on a line from 0% to 100% the percentage of medications they had taken as prescribed in the past four weeks.²⁵ Well-being was measured using the nine-item Health-Related Quality of Life (HRQOL) survey developed and validated by the Institute for Healthcare Improvement.²⁶ It includes items for physical, mental, spiritual, and social well-being. Additionally, participants reported general well-being and financial well-being, now and expected in five years, using a visual ladder (“Cantril’s Ladder of Life Satisfaction”) in which the top step represents the best possible situation for themselves and the bottom step represents the worst possible situation.²⁷

Demographic data including age, gender, race, ethnicity, education, marital status, and housing status were reported by participants during their completion of the baseline survey. Data on phone habits and ownership were also collected at baseline. Participants were asked whether they owned a phone, what type of phone they owned (feature phone versus smartphone), what features they used, any barriers to phone use in the prior six months (loss, damage, or theft), and how well they were able to keep their phone’s battery charged. Participants were asked to demonstrate phone function. If this showed little familiarity with a function, they were provided training. For texting, the RA gave brief training on how to use. Shortly thereafter, the RA asked the participant to demonstrate use of texting. A similar procedure was used with other functions, such as charging a phone.

Data analysis

Using double-key data entry,²⁸ RAs entered survey responses collected on paper into a digital format. Unadjusted ANOVAs were used to compare mean number of ED encounters and inpatient admissions between intervention and control groups during the four-month study period. To compare appointment keeping, individual-participant frequencies were calculated for the percentage of appointments with completed, canceled, or no-show outcome. Unadjusted ANOVAs were then used to compare the overall mean frequencies for each appointment outcome between intervention and control groups.

As an exploratory analysis, appointments were stratified by type (physical health or behavioral health) according to the department code assigned in the EMR 3% of appointments were removed from analysis due to unclear codes. Again, unadjusted ANOVAs were used to compare mean appointment outcomes between groups.

For secondary outcomes, following per-protocol analyses of participants who completed the follow-up survey, unadjusted ANOVAs compared post-intervention well-being and medication adherence between intervention and control groups.

As our sample size limited our statistical power, we also calculated effect sizes (Cohen's *d*) and 95% confidence intervals for all of the above-described outcomes in order to provide additional context about the magnitude of the difference between the intervention and control groups.

Results

We enrolled 64 participants in this study after screening 95 BHCHP patients. As shown in Figure 1, two participants died during follow-up and were excluded from analysis, resulting in an analytic sample of 62 for primary outcomes. Eight participants did not complete the follow-up survey, further reducing the analytic sample for secondary outcomes to 54.

Table 1 provides baseline characteristics of participants. The mean age was 51 years, with a range of 28–64 years. Most participants were male (77%), and no participants identified as transgender or nonbinary. Participants were predominantly white (55%) or black (28%). Hispanic ethnicity was indicated by 19%. Most participants (92%) were currently single (67% never married, 25% divorced or separated). Education levels varied widely: almost a third had not graduated from high school (27%), but four participants had a four-year college degree (6%) and one had graduate-level education (2%). Most participants were unstably housed, either living in shelters (25%), on the street (5%), in transitional or treatment programs (5%), or under medical supervision (7%). More than a third of participants reported being housed (38%).

Table 2 includes information on participants' baseline cell phone ownership. Slightly more than half of participants owned a cell phone at enrollment (53%). Of those who did own a phone, the majority owned a smartphone (76%). Most participants paid for their phone via a monthly contract (73%). Most reported being able to afford (68%) and charge (68%) their phone during the prior six months. Participants reported that their phone had been lost an average of two times and stolen an average of three times during the prior six months.

The intervention did not have a statistically significant effect on ED encounters or inpatient admissions (data not shown). The mean number (and standard deviation) of ED visits over the four-month intervention period was 3.86 (5.44) in the intervention group and 2.33 (2.71) in the control group ($p=0.16$); for inpatient admissions, the mean was 0.6 (1.24) admissions in the intervention group and 0.9 (1.3) in controls ($p=0.42$). For ED visits, the estimated effect size was small and positive, although the 95% confidence interval does not preclude a negative effect of the intervention (Cohen's $d=0.36$, 95% CI: $-0.14, 0.89$). For inpatient admissions, the estimated effect size was small and negative and the 95% confidence interval ranges from a large negative to a small positive effect (Cohen's $d=-0.23$, 95% CI: $-0.75, 0.27$) (data not shown).

Appointment keeping results are shown in Table 3. The mean proportion (and standard deviation) of completed appointments was 65.8% (28.0) among the intervention group and 56.7% (28.9) among controls ($p=0.12$). The mean share of no-shows was 21.0% (25.8) among intervention participants and 30.6% (27.0) among controls ($p=0.08$). Effect size estimates for both outcomes were small (Cohen's d of 0.32 and -0.36 , respectively), with confidence intervals for both outcomes encompassing large and favorable intervention effects and small effects in the opposite direction. Lastly, the mean frequency of cancellations was 13.3% (17.2) among the intervention group compared to 12.6% (19.4) among controls ($p=0.87$); the estimated effect size was very small. When stratified by appointment type, there were no significant differences in appointment keeping between intervention and control groups, and estimated effect sizes were small for both appointment types, although effect sizes for completed appointments and no-shows were slightly larger for physical health appointments as compared to behavioral health appointments.

Table 4 presents secondary outcomes of post-intervention medication adherence and well-being among the 54 participants who completed follow-up surveys. Self-reported medication adherence increased from 8.27 to 9.84 in intervention participants, compared to an increase from 8.27 to 8.68 in control participants ($p=0.07$), on a 1–11 scale, where 11 represents 100% adherent. The difference between the intervention and control groups on this outcome corresponds to a medium effect size (Cohen's $d=0.49$, 95% CI: $-0.01, 1.03$).

Table 1. Self-report baseline characteristics and descriptive statistics of participants.

| | | All <i>n</i> = 62 | Intervention <i>n</i> = 29 | Control <i>n</i> = 33 |
|--------------------------------------|---|----------------------|-------------------------------|--------------------------|
| Age | mean (SD) | 51.03 (8.52) | 51.38 (7.56) | 51.73 (9.39) |
| Gender <i>n</i> (%) | Male | 47 (76) | 19 (66) | 28 (85) |
| | Female | 15 (24) | 10 (34) | 5 (15) |
| Race <i>n</i> (%) [†] | White | 34 (55) | 19 (66) | 15 (45) |
| | Black | 18 (29) | 6 (21) | 12 (36) |
| | Mixed/More than one race | 4 (6) | 2 (7) | 2 (6) |
| | Other [‡] | 6 (10) | 2 (7) | 4 (12) |
| Ethnicity <i>n</i> (%) | Hispanic | 11 (18) | 4 (14) | 7 (21) |
| | Not Hispanic | 51 (82) | 25 (86) | 26 (79) |
| Marital status <i>n</i> (%) | Single | 42 (68) | 20 (68) | 22 (67) |
| | Married | 2 (3) | 0 (0) | 2 (6) |
| | Divorced/Separated | 15 (24) | 8 (28) | 7 (21) |
| | Widowed | 3 (5) | 1 (3) | 2 (6) |
| Education <i>n</i> (%) | 8th grade or less | 3 (5) | 2 (7) | 1 (3) |
| | Some high school, but did not graduate | 15 (24) | 6 (21) | 9 (27) |
| | High school graduate or GED | 20 (32) | 10 (34) | 10 (30) |
| | Some college or 2-year degree | 19 (31) | 9 (31) | 10 (30) |
| | 4-year college degree | 4 (6) | 1 (3) | 3 (9) |
| | More than 4-year college degree | 1 (2) | 1 (3) | 0 (0) |
| Housing status <i>n</i> (%) | Shelter | 16 (26) | 7 (24) | 9 (27) |
| | Street | 5 (9) | 3 (10) | 2 (6) |
| | Transitional housing or residential treatment program | 5 (9) | 2 (7) | 3 (9) |
| | Staying with family or friends | 5 (8) | 2 (7) | 3 (9) |
| | Housed | 24 (39) | 13 (45) | 11 (33) |
| | Medical supervision | 7 (11) | 2 (7) | 5 (15) |
| Cell Phone Ownership <i>n</i> (%) | Participant owns a cell phone | 33 (53) | 16 (55) | 17 (52) |

(continued)

Table 1. Continued.

| | | All n = 62 | Intervention n = 29 | Control n = 33 |
|---|--|---------------|------------------------|-------------------|
| | If participant owns a cell phone, it is a smart phone | 25 (76) | 10 (63) | 15 (88) |
| Health-Related Quality of Life (mean, SD) | Current standing on Cantril's Ladder* (0 = Worst possible life, 10 = Best possible life) | 6.19 (2.05) | 6.86 (1.73) | 5.59 (2.07) |
| | Standing on Cantril's Ladder five years from now (0 = Worst possible life, 10 = Best possible life) | 8.50 (1.74) | 8.79 (1.73) | 8.25 (1.74) |
| | Current financial situation on Cantril's Ladder (0 = Worst possible, 10 = Best possible) | 4.77 (2.46) | 5.14 (2.46) | 4.44 (2.45) |
| | General health (1 = Poor, 5 = Excellent) | 2.30 (0.82) | 2.44 (0.91) | 2.18 (0.73) |
| | Physical health (Number of physically unhealthy days in the past 30 days) | 12.35 (10.26) | 11.24 (10.26) | 13.33 (10.20) |
| | Mental health (Number of mentally unhealthy days in past 30 days) | 10.48 (10.03) | 9.00 (10.11) | 11.79 (9.94) |
| | Number of days (in past 30 days) impacted by poor physical and/or mental health | 9.53 (10.13) | 8.14 (9.83) | 10.76 (10.39) |
| | How often participant receives social and emotional support (1 = Never, 5 = Always) | 3.42 (1.08) | 3.72 (1.16) | 3.15 (0.94) |
| Participant leads a "purposeful and meaningful life" (1 = Strongly disagree, 7 = Strongly agree)** | 4.87 (1.71) | 5.21 (1.68) | 4.56 (1.70) | |
| Medication Adherence (mean, SD) | Percentage of medication taken correctly in the past four weeks (1 = 0-10%, 11 = 100%) | 8.56 (2.91) | 8.86 (3.35) | 8.27 (2.49) |

† Race and ethnicity were based on verbal self-identification during administration of baseline survey.

‡ These participants identified as a race other than the categories provided (White, Black, American Indian, Asian, Native American). Participants who provided an "Other" racial identity that met the U.S. Census Bureau's definition of "White" (i.e. French, Italian, Irish) were counted as "White."

* Cantril's Ladder is a validated tool for measuring life evaluation.

** Two participants declined to answer this question.

The self-reported HRQOL measures did not yield a consistent pattern with respect to the impact of the intervention. Indeed, estimated effect sizes for specific measures ranged from a medium positive effect of the intervention for an item capturing receipt of social and emotional support (Cohen's $d = 0.60$, 95% CI: 0.10, 1.14) to a small negative effect for the measure capturing number of days impacted by poor physical health (Cohen's $d = -0.33$, 95% CI: -0.85 , 0.17).

Responses were received to only 27% of the mood text messages over the four-month study period. For that reason, data from the mood text messages are not included.

Feasibility

Participants' experiences using the study cell phones.

Thirty-one percent of participants reported some degree of technical difficulty operating the flip phone in the four-month follow-up survey. Participants described confusion and lack of usability: "The phone was hard to use. I had an Obama phone [from the LifeLine program] before this, so the flip phone was all new to me...I don't know how to use it besides calls"; "I still can't figure out how to respond to the mood questions. This is all very new to me and confusing." The small size of the keypad also presented problems for some participants: "[Study text messages] weren't

Table 2. Cell phone management, and challenges to use, reported by patients at baseline.

| | | All participants |
|---|---|------------------|
| Cell phone plans (n = 33 participants with phone at study start) | Pay as you go | 3 (9%) |
| | Pre-paid | 1 (3%) |
| | Monthly Contract | 22 (73%) |
| | Free phone (e.g. from Safelink, Assurance) | 5 (15%) |
| | Other | 2 (6%) |
| Maintaining use of phone (n = 56 who used a cell phone in the past six months) | Phone was affordable, how often in the last six months: | |
| | Always | 38 (68%) |
| | More than half the time | 8 (14%) |
| | Half the time or less | 10 (18%) |
| | Able to charge the phone, how often in last six months: | |
| | Always | 38 (68%) |
| | More than half the time | 9 (16%) |
| | Half the time or less | 9 (17%) |
| | Frequency losing phone, past six mos., mean (SD) | 3.08 (1.77) |
| Theft of phone, frequency, past six mos., mean (SD) | 3.83 (1.63) | |

annoying, but my fingers were too big so I had to use a pen to text”; “Couldn’t see ... It’s hard to text on the phone. The buttons are small.” A common hurdle was error messages received when trying to respond to mood questions, which caused frustration for many participants: “Sometimes [study text messages] were annoying because it didn’t understand my responses and I got aggravated”; “Every time I tried to respond to mood questions, I would write out the number, and get errors. That was frustrating.”

Phone tracking. Figure 2 displays the participants’ use of their own phone versus a study phone, and the number of study phones research staff replaced during the four-month

study period. About one-third (32.8%) used their own phone during the study, while the remaining 67.2% used a study phone. Of those participants who used a study phone, about two-fifths (39.5%) used only one study phone. The majority, 60.5% (26/43), needed one or more replacement phones so that they could continue participation. Most participants used two phones over the course of the study (61.5%, or 16 of the 26 who used multiple phones), but a sizeable minority used three or more phones during the study (38.5%, or 10 of the 26 who used multiple phones).

Acceptability

Despite difficulties noted above, there were positive comments from participants about receiving text messages from the study. Some participants reported that the intervention complemented their lifestyle: “When you’re on the streets it’s still hard, but they were helpful about reminders. [Appointments] were the last thing on my mind.” Those participants that were able to respond to the mood questions often expressed appreciation: “[The text messages] were very useful. They keep me calm and collected—they are little helpers”; “They were definitely helpful. I got the text message about stress right before I got stressed out and it helped! They came at just the right time.”

Text messages functioning as social support were also a common theme among participant feedback: “They were great, excellent. Nice to have someone other than family checking in”; “[The text messages] were helpful. With my text messages, RN, and my girlfriend, I had a good support system set up to remember my meds”; “The text messages showed me that there’s somebody out there who cares about me”; “I enjoyed getting text messages. Sometimes I got them when I felt down and depressed and the text messages lifted me up.”

Discussion

Text-messaging interventions show promise in increasing preventive care, chronic disease management, and medication adherence.^{29,30} Although some studies have examined the use of text messaging in homeless populations, few of these studies used a randomized trial design.³¹ In one of the first randomized studies to examine the effect of text messaging on chronic disease management in a homeless population, two measures, while not achieving our cutoff for statistical significance, showed some promise that a text-messaging intervention could support engagement in care and medication adherence, with the no-show rate (Cohen’s $d = -0.36$, 95% CI: $-0.84, 0.14$, $p = 0.08$) and self-reported adherence (Cohen’s $d = 0.49$, 95% CI: $-0.01, 1.03$, $p = 0.07$) favoring the intervention group. The full effect of the intervention may have been diminished because of only moderate levels of feasibility and

Table 3. Outpatient appointment keeping, at four months.

| | | Intervention <i>n</i> = 29 | | Control <i>n</i> = 33 | | | |
|--|---------------------------|--|----------------------------------|--|----------------------------------|------------------------------|----------------|
| | | Number of appointments (<i>n</i>) | Mean percentage (mean, SD) | Number of appointments (<i>n</i>) | Mean percentage (mean, SD) | Cohen's <i>d</i> (95% CI) | <i>p</i> value |
| All appointments <i>n</i> (%) | Completed appointments | 214 | 65.8% (28.0) | 238 | 56.7% (28.9) | 0.32 (−0.19, 0.84) | 0.12 |
| | No shows | 84 | 21.0% (25.8) | 137 | 30.6% (27.0) | −0.36 (−0.89, 0.14) | 0.08 |
| | Cancellations | 52 | 13.3% (17.2) | 91 | 12.6% (19.4) | 0.04 (−0.47, 0.55) | 0.87 |
| | Total appointments | 350 | -- | 466 | -- | -- | -- |
| Behavioral health appointments <i>n</i> (%) | Completed appointments | 52 | 61.2% (30.8) | 60 | 54.4% (34.9) | 0.20 (−0.30, 0.72) | 0.51 |
| | No shows | 39 | 21.9% (28.5) | 42 | 34.0% (33.9) | −0.38 (−0.91, 0.12) | 0.22 |
| | Cancellations | 21 | 16.9% (21.4) | 56 | 11.6% (20.6) | 0.25 (−0.25, 0.77) | 0.42 |
| | Total appointments | 113 | -- | 158 | -- | -- | -- |
| Physical health appointments <i>n</i> (%) | Completed appointments | 160 | 69.1% (25.97) | 177 | 58.6% (23.6) | 0.42 (−0.08, 0.95) | 0.12 |
| | No shows | 39 | 20.3% (13.2) | 84 | 28.0% (18.67) | −0.46 (−1.00, 0.03) | 0.21 |
| | Cancellations | 30 | 10.6% (13.2) | 30 | 13.5% (18.7) | −0.17 (−0.69, 0.33) | 0.52 |
| | Total appointments | 229 | -- | 291 | -- | -- | -- |

acceptability – issues that will need to be addressed in future work with these technologies in similar populations.

We had hypothesized that increases in rates of outpatient treatment would lead to reduced ED and hospital inpatient

use, but this was not supported by our results. It is possible that with an intervention period longer than four months, differences between the groups might have emerged since it can take time from improved engagement in care to

Table 4. Well-being and medication adherence, reported by patients at four months.

| | | All n = 62 | Intervention n = 29 | Control n = 33 | Cohen's d, (95% CI) | p value |
|---|--|------------------|------------------------|-------------------|------------------------|---------|
| Health-Related Quality of Life (mean, SD) | Current standing on Cantril's Ladder* (0 = Worst possible life, 10 = Best possible life) | 6.04 (2.70) | 5.67 (3.09) | 6.34 (2.33) | -0.24(-0.76, 0.26) | 0.37 |
| | Standing on Cantril's Ladder five years from now (0 = Worst possible life, 10 = Best possible life) | 8.61 (1.89) | 8.50 (1.91) | 8.70 (1.90) | -0.10 (-0.62, 0.40) | 0.70 |
| | Current financial situation on Cantril's Ladder (0 = Worst possible, 10 = Best possible) | 5.75 (7.19) | 5.40 (3.12) | 4.38 (2.46) | 0.36 (-0.14, 0.89) | 0.18 |
| | General health (1 = Poor, 5 = Excellent) | 2.37 (1.00) | 2.42 (1.06) | 2.32 (0.94) | 0.10 (-0.41, 0.61) | 0.21 |
| | Physical health (Number of physically unhealthy days in the past 30 days) | 13.66 (11.20) | 13.63 (12.00) | 13.69 (10.72) | -0.01 (-0.51, 0.50) | 0.98 |
| | Mental health (Number of mentally unhealthy days in past 30 days) | 13.15 (10.34) | 13.52 (10.67) | 12.82 (10.22) | -0.07 (-0.44, 0.58) | 0.81 |
| | Number of days (in past 30 days) impacted by poor physical and/or mental health | 12.13 (11.33) | 10.12 (10.85) | 13.86 (11.63) | -0.33 (-0.85, 0.17) | 0.23 |
| | How often participant receives social and emotional support (1 = Never, 5 = Always) | 3.41 (1.25) | 3.80 (1.08) | 3.07 (1.31) | 0.60 (0.10, 1.14) | 0.03 |
| | Participant leads a "purposeful and meaningful life" (1 = Strongly disagree, 7 = Strongly agree) | 4.89 (1.91) | 4.92 (2.08) | 4.86 (1.78) | 0.03 (-0.48, 0.54) | 0.91 |
| Medication Adherence (mean, SD) | Percentage of medication taken correctly in the past four weeks (1 = 0-10%, 11 = 100%) | 9.23 (2.37) | 9.84 (1.65) | 8.68 (2.79) | 0.49 (-0.01, 1.03) | 0.07 |

realize health improvements. Additionally, the study sample size was powered to assess engagement in outpatient care and thus may have been underpowered to detect differences in the less frequent ED and hospital use.

The data indicate some threats to feasibility. There were technical aspects of the text-messaging system that gave unintended error messages to participants, and some participants reported difficulty using the study mobile phones to complete texting tasks. These difficulties may have impacted participants' ability to receive the full benefit of

the intervention. Many participants acknowledged that they would have better appreciated the text messages if not for the technical difficulties: "The messages were very useful, but I remember getting a lot of error messages at the beginning"; "Reminders were good—fix the mood questions"; "I like replying to messages if they work." Additionally, the process of exporting appointment data from the EMR and loading it into the text-messaging system was cumbersome and had some manual daily steps. These issues could be avoided in future interventions

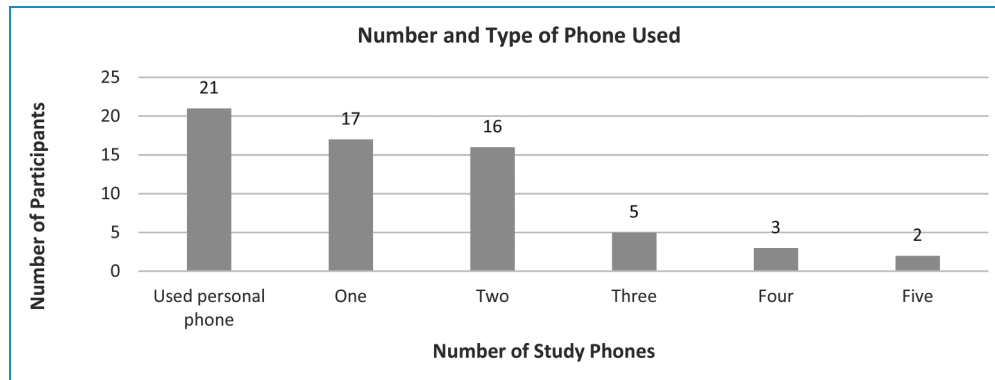


Figure 2. Frequency of phone types and study phones used by participants.

through two adjustments: 1) the use of smartphones, which may have more intuitive functionality than the flip phones used in this study¹⁷; and 2) a text-messaging system that was integrated into the clinic's electronic medical record instead of being a stand-alone system that had to be linked to the EMR specifically for this study.

Acceptability was generally good, despite some of the difficulties participants had using their phones, including responding to text messaging. This may have been because most of the intervention texts did not require responses (e.g. appointment reminders), so even participants who had difficulty responding to the mood question still benefited from the incoming text messages. Intervention participants remarked on the appointment reminders being helpful especially when “*you're on the streets*” without easy access to a calendar or a case worker to provide reminders. Both intervention and control participants noted that there were emotional and social benefits to receiving text messages even as seemingly basic as “*knowing there's somebody out there who cares about me.*”

Limitations

This study was limited by its small sample size and technological challenges. The small sample size ($n = 62$) limited the statistical power and increased individual effects. For example, an individual who had an unusually high number of no-shows or ED encounters could unduly influence the results. We also encountered technical challenges with the two-way mood messaging. First, difficulties configuring the text-messaging system led some patients to receive error messages even when replying correctly to mood questions. Error messages may have dissuaded participants from responding to further mood messages. Additionally, the flip phone T9 texting mechanism requires somewhat tedious and unintuitive maneuvering to get the desired letter or number. Even though a single number response was needed, our qualitative data shows that the

T9 system frustrated some participants. The low response rate to mood messages (26.6%) is likely attributed to these technological challenges. Finally, through the CareMessage text-messaging platform, the researchers were able to determine whether a message was sent, but not to confirm receipt of messages, thus limiting the ability to assess whether participants received the full intervention.

Participants in both intervention and control groups reported a number of obstacles to owning and operating their cell phones, including loss, theft, difficulty keeping phones charged, and challenges with paying service fees. Phones were lost and stolen frequently during the study, requiring numerous replacements. Thus, there were periods of time when some participants were not receiving the intervention, limiting its impact. The rates of loss and theft were not completely unsurprising given that at baseline participants reported an average of nearly four stolen phones in the past six months. This is an issue that will need to be addressed by most studies and interventions that require the use of mobile phones in populations who are at elevated risk for experiencing theft and have limited ability to store their devices securely. As programs serving homeless populations become increasingly sensitive to the needs of their clients who have cell phones there are remedies, such as providing individual secure lock boxes at shelters. Theft also occurs when devices are being charged in public locations. Making charging more readily available where homeless persons spend their time could also help reduce theft, such as near bedsides in shelters (or even inside locked cabinets or lockers), and more widely available in libraries, health clinics, food banks, and soup kitchens.

Future directions

The substantial disparities in health between homeless and stably housed populations call for continued and determined efforts to address this inequity. Structural solutions

such as affordable housing and better access to mental health and substance use disorder services can bring greater stability and employability to homeless persons in the long term. However, short-term measures are also needed. Cell phone-based interventions to help improve appointment keeping, such as the one in this study, show promise for chronic disease management, though work will be needed to address issues such as loss and theft of phones. Finally, more mobile and wireless technologies (mHealth)³² should be tested in vulnerable homeless populations, especially formats that leverage the greater functionality of smartphones. For example, interventions might address social support directly, help link persons to employment, or deliver peer support or case management support with phone calls, text messages, or video chat. If tied to wearables (such as a basic biometric tracker), intervention messages could track real-time biometric data to advise and encourage homeless persons to avail themselves of locally available resources and to make evidence-based best choices, based on their current health status. It is important to note that some of the positive findings in this study may reflect the clinic being examined. It was large, well-organized, and relatively well-resourced. So some of the findings of this study may be less relevant to health clinics in communities with less well-structured clinical care systems for persons experiencing homelessness.

Conclusion

Short- and long-term interventions are needed to reduce the disparities in chronic disease and mortality between homeless and non-homeless populations. In a population that has substantial competing needs that can interfere with the management of chronic conditions, text messaging may help homeless patients engage in outpatient care, adhere to medications, and experience greater social support. Additional effort is needed to make text-messaging interventions easy to use, especially for a population with few supports and limited experience using text messaging.

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