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Proof of Concept of a Mobile Health Short Message Service Text Message Intervention That Promotes Adherence to Oral Anticancer Agent Medications: A Randomized Controlled Trial

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TITLE PAGE

Title: Proof-of-Concept of a mHealth SMS Text Message Intervention that Promotes Adherence to Oral Anti-Cancer Agent Medications: A Randomized Controlled Trial

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ABSTRACT

Background
Systematic reviews on oral anti-cancer agents indicate adherence rates are less than 80%.

Introduction
This multisite, randomized controlled trial assigned 75 adult cancer patients prescribed an oral anti-cancer agent to either an experimental group that received daily text messages for adherence for 21 days plus usual care; or a control group that received usual care.

Materials and Methods
Measures were administered at baseline, weekly (week 1—8), and at exit (week 9). A satisfaction survey was conducted following the intervention. Acceptability, feasibility, and satisfaction were examined. Primary outcomes were adherence and symptoms. Secondary outcomes were depressive symptoms, self-efficacy, cognition, physical function, and social support. Mixed or general linear models were used for the analyses comparing trial groups. Effect sizes (ES) were estimated to gauge clinical significance.

Results
Regarding acceptability, 57.2% (83 of 145) of eligible consented; 88% (n = 37 of 42) receiving text messages read them; and 90% (n = 38) were satisfied. The difference between experimental and control groups ES were 0.29 for adherence; 0.21 for symptom severity and 0.21 for symptom interference and differences were not statistically significant. Further, perceived social support was higher (*P* = .04; ES 0.54) in the experimental group.

Discussion
Proof-of-concept and preliminary efficacy of a mHealth intervention using text messages to promote adherence for patients prescribed oral anti-cancer agents was demonstrated. Patients accepted and had high satisfaction with the intervention; and adherence improved after the intervention. Text messages show promise. Additional research is needed prior to use in practice.

INTRODUCTION

Recent reviews on oral anti-cancer agents (OAs) indicate adherence rates are often less than 80%.[1,2] OAs often come with side effects, which in turn may lead to adverse events and non-adherence.[2] OA treatment requires patients to self-manage side effects from treatment and adherence in the home setting.[3] Most cancer patients are older and also have comorbid conditions and take multiple medications, which likely make symptoms more severe, and adherence more difficult.[4] The available evidence suggests self-management of OAs is a significant clinical problem that may impact treatment success or failure.[5,6]

Cell phones have been widely adopted and are rapidly evolving as a cost-effective mode of delivering tailored behavioral interventions.[7,8] There are more than 285 million cell phone subscribers in the United States;[9] and it is estimated 81% of users text message (TM).[10] Evidence is beginning to show that TMs built on Social Cognitive Theory[11] increase self-efficacy and improve health outcomes.[12] TMs have also improved medication adherence in multiple diseases;[13] with one trial finding more correct medication doses taken on time.[14]

Patients who are prescribed OAs are often vulnerable, as most are older, have comorbidities, or are receiving the OA as a second or third line of cancer treatment over an extended period of time. Thus, OA adherence is challenging. The purpose of this study was to examine proof-of-concept of a TM intervention and to conduct a preliminary evaluation of efficacy of TMs with respect to adherence and symptom severity and interference in adult cancer patients prescribed OAs.

MATERIALS AND METHODS

Study Design

This study used a multisite, longitudinal (10-week), randomized controlled trial design with two groups, the experimental group with 21-days of Short Message Service (SMS) TMs for adherence plus usual care and a control group with usual care (2:1 allocation ratio). Assessments occurred at baseline before random assignment, weekly, and at exit. The satisfaction survey occurred immediately after TMs ended. The protocol was approved by the institutional review boards at each site; and was published.[15]

Inclusion and Exclusion Criteria

Inclusion criteria were: being 21 years of age or older, newly prescribed an OA within the past 30-days, having a personal cell phone, and be willing and able to receive and send TMs. Patients with cognitive impairment that limited ability to understand and answer questions; and those who did not speak and read English were excluded.

Recruitment

Recruitment occurred between October 2013 and October 2014 at four community cancer centers in the Midwest; a National Comprehensive Cancer Center in the East; and a large specialty pharmacy that serves the United States. At the cancer centers, medical records were screened to identify those eligible by recruiters who were nurses or physician assistants. Recruiters approached patients face-to-face, explained the study, and obtained informed consent from those willing to participate. At the specialty pharmacy, dispensing records were screened to identify those eligible by recruiters who were pharmacists or pharmacy technicians. Recruiters sent a letter explaining the study, with a consent form and return envelope to mail the signed consent form back to the specialty pharmacy if willing to participate. Recruiters also called on the phone, explained the study, and obtained informed consent via an electronic email signature. All recruiters recorded the number of patients who were contacted and subsequent accrual rates.

Procedures

After consents to participate were obtained, baseline interviews (week 0) were conducted by phone. An automated voice response (AVR) system was used to complete weekly assessments (weeks 1 to 8) of OA adherence and 19 commonly experienced symptoms. Satisfaction surveys were conducted at the completion of the TMs (week 4) by phone. Exit interviews were conducted by phone at the end of the study (week 9). Medical records were audited at the end of the study to gather data on the prescribed dosages of OAs, dose changes and stoppages.

Random Assignment and Blinding

After baseline data were collected, participants were randomly assigned using a 2:1 ratio of experimental to control condition using a minimization algorithm, designed by the biostatistician in SAS 9.4. The minimization balanced the groups on age (< 50 or ≥ 50) and recruitment site. The intervention began at the

time the patient started the OA prescription; or within 7 days of random assignment, if patients already started the OA.

Intervention

Social Cognitive Theory-based TMs were developed using 160 characters or less (see Figure 1). This included: a welcome and test TM, six medication adherence TMs used on a rotating basis, and an end of study TM. An automated platform delivered the TMs and stored data. Patient name, cell phone number, OA medication name, and delivery time for TMs (regimen schedule) were entered in the platform to send the TMs after randomization. The experimental group patients were sent the test TM to confirm the cell phone number and assure they were able to respond by TM. Adherence TMs were delivered at the time of day the OA was to be taken for 21 days. Patients were asked to respond by TM if the OAs were "taken." Upon completion of the intervention, a final, end of study TM was sent. To assure TMs were not sent when patients were not prescribed to take the OA, regimen schedules were confirmed with the recruiter and patient. Patients were also trained to inform the study office of OA changes, such as reduction, interruption, or stoppage of the medication. Patients were also asked to password protect their cell phone to assure privacy.

Usual Care

Usual care included instructions and information on the OA regimen, side effects, managing symptoms, medication adherence and safety, and how to contact a clinician for problems that arise provided by oncologists, nurses, or pharmacists.

Measures

Background. Demographics (age, sex, race and ethnicity, marital status, education level, employment) and comorbid conditions were assessed.

Disease parameters and treatment. Record reviews were conducted to determine cancer type and stage of disease, and OA regimen prescription at the time of study enrollment.

Proof-of-concept. Acceptability of TMs was measured by the number of patients who accepted enrollment out of the number offered to participate; and by the percent that completed the study. Feasibility was

measured by the number of TMs delivered and returned. Satisfaction with TMs was measured using a tool developed in previous studies.[16,17] Satisfaction was deemed high for scores exceeding 80%.

Primary Outcome Measures

Adherence was measured by patient report of whether they took the OA pills as prescribed over the past 7-days and by pill counts during the exit interview. Feasibility of calculating the Relative Dose Intensity (RDI), the ratio of delivered dose of OA given over a period of time in relation to what was prescribed, an additional measure of adherence, was evaluated.[18-20]

Severity and interference with daily life of 19 symptoms were assessed using the Symptom Inventory[21,22] at baseline, weekly, and at exit. Each symptom was rated as to its presence in the past week (yes/no), severity on the scale from 1 (very little) to 9 (worst possible), and interference with daily life on the scale from 0 (no interference) to 9 (interfered completely).

Secondary Outcome Measures

Measures of secondary outcomes were obtained at baseline and exit. Cognition was assessed using the Attentional Function Inventory for cancer patients, which examines three constructs in subscales: effective action, attentional lapses, and interpersonal effectiveness.[23] Patient Reported Outcomes Measurement Information System (PROMIS) tools were used to assess depression (8a) and physical function (6a).[24] Self-efficacy was assessed using the Medication Adherence Self-efficacy Scale (MASES-R);[25] the Self Efficacy Adherence Medications (MARS-M);[26] and the Brief Medication Questionnaire (BMQ-Specific).[27] Social support was assessed using the Medication Specific Social Support (MSSS) tool.[28]

Data Analysis

Descriptive statistics, including frequency distributions, measures of central tendency, skewness, and variability, were evaluated for variables of interest. Baseline equivalence of groups created by the randomization was verified using chi-square, Fisher's exact or t-tests. To determine acceptability, feasibility, and satisfaction of TMs among patients on OAs, the proportion of patients who agreed to participate, attrition reasons, and characteristics of patients who dropped out from the study were summarized. The proportions of TMs received and returned were described along with satisfaction. To determine preliminary efficacy of TMs

on adherence, as well as secondary outcomes of symptom severity, depressive symptoms, physical function, cognitive function, self-efficacy, and social support, general linear or mixed modeling was used. The covariates included study group and outcome value at baseline. Value at baseline was not applicable for self-report adherence measures, thus for those outcomes, general linear models included only one explanatory variable, the study group. Effect sizes (ES) were computed as Cohen's d, the difference between group adjusted means expressed in the adjusted standard deviation units (square root of the mean square error), to gauge clinical significance and inform planning of a larger study. [29,30] SAS 9.4 was used for analysis.

RESULTS

The flow of participants is depicted in Figure 2. A total of 1,356 TMs were sent to patients in this study. This included 1,189 TMs for adherence: 741 sent at the time the OAs were to be taken; and 448 repeat TMs when the patient did not respond with the correct response text. In addition, 49 test TMs and 49 end of study TMs were sent. There were 1,036 TM replies received from patients, 87.1% (1036 of 1189).

Participants

Of the 198 patients screened, 78 consented, and 75 completed baseline interviews. Randomization yielded 49 in the experimental group and 26 in the control group. Table 1 details the sample characteristics. No differences in sociodemographic, clinical, or psychological characteristics were found among groups at baseline.

Attrition

Following baseline interview and randomization, 4 patients were lost to follow-up, 2 decided they did not want TMs but continued with AVR assessments, 1 no longer wanted to participate, and 1 was too sick to continue in the experimental group. In the control group, 2 patients were lost to follow-up.

Proof-of-Concept

Regarding acceptability, 75.7% (78 of 103) of eligible patients consented. Mean age of consented was 60.2 years (range 33 to 79), while eligible but not enrolled was 57.8 years (range 36 to 76); and ineligible 69.9 years (range 42 to 89). No difference in age was found according to eligibility and consent. Females accounted for 53.8% (n = 42) of consented, 41.7% (n = 10) of eligible not enrolled, and 50.6% (n = 41) of ineligible; with

a significant difference in enrollment by sex between consented versus eligible but not enrolled (*P* = .02). Of those who were ineligible, 41.1% (39 of 95) did not have a cell phone, 33.7% (32 of 95) did not TM, and 23.2% (22 of 95) were no longer prescribed an OA. Regarding feasibility, of those who were eligible but chose not to enroll, 92% (23 of 25) were not interested.

Regarding satisfaction (see Table 2), 39 completed the survey. Notably, in this sample of very ill cancer patients, many of whom were on their second or third line of treatment, 85.7% (42 of 49 participants) completed the entire TM intervention, further confirming acceptability of this intervention. Of those who completed the survey, 78.9% (n = 30) read the TMs all the time; and 18.4% (n=7) read the TM most of the time. The majority of patients (92.2%, n = 35) reported high satisfaction with receiving the TMs. Overall, 97.4% (n = 38) recommended TMs as a way to help patients remember to take OAs; and 100% (n = 39) would recommend TMs to their oncologist as a way to monitor adherence.

Primary Outcomes: Adherence and Symptoms

Table 3 provides a weekly summary of self-reported OA adherence in the experimental and control groups for weeks 1 to 8 and the exit interview. The control group started with a higher percentage of OA adherence in week 1 (73.1%, n = 19) compared to the experimental group (66%, n = 31). Weeks 2-6 and 8 had higher percentages of OA adherence in the control group (76.9% to 55.3%; 80.8% to 74.5%; 88.5% to 59.6%; 73.1% to 72.3%; 69.2% to 66.0%; and 69.2% to 61.7%, respectively). The control group had declining adherence over time; while the experimental group had increasing OA adherence over time. Week 7 and exit had higher adherence in the experimental group (70.2% to 61.5%; and 86.7% to 79.2%). The mean number of weeks of adherence to OAs in the experimental group was 6.5 (SE 0.4) compared to 7.2 (SE 0.5) in the control group (*P* = .26), with an ES of -0.29 (see Table 4). This difference was not statistically significant with the available sample size. We were unable to calculate RDI as an objective measure of adherence from medical record and prescription data audits (N = 75), as we did not obtain good agreement of patient self-report and medical record documentation of dose changes, number of refills prescribed and number of refills reported by patients. For example, out of 59 patients with no dose changes documented in the medical records, 5 (8%) said

the dose was changed; out of 65 patients who did not report any dose changes, 11 (17%) had dose changes documented in the medical records.

The number of symptoms and summed symptom severity and interference did not significantly differ by study arm (see Table 5). Table 4 reports on group differences post-intervention. Although not significant, the experimental group had fewer total number of symptoms (ES 0.09); lower summed symptom severity (ES 0.21); and lower summed interference (ES 0.22); all small effect sizes.

Secondary Outcomes

There were no group differences on physical function (ES 0.06); or on the three sub-scales on cognitive function (effective action, attentional lapses and interpersonal effectiveness), and the effect sizes for group differences were small. Similarly, the three self-efficacy measures demonstrated small effect size differences in the experimental group compared to the control: the BMQ1 (ES 0.04), the BMQ2 (ES 0.08), the MASES-R (ES -0.06), and the MARS-M (ES -0.44), which was only done at exit. Experimental group differed significantly from the control on Medication Social Support (P=0.4, ES 0.54).

DISCUSSION

This study demonstrated proof-of-concept of TMs to promote self-management of adherence for patients prescribed OAs. Among the eligible patients, age was not related to willingness to TM, while females were more likely to TM. Patients were multi-morbid, with many symptoms that interfered with activities of daily life. In this sample of cancer patients, TMs demonstrated feasibility as an intervention, with most patients reading the TM. Satisfaction was high for medication adherence and monitoring, demonstrating that patients thought TMs were helpful. The self-reported medication adherence measure showed improving adherence rates in the experimental group at later weeks, suggesting that patient may start with good adherence, but may need support of TMs later. Self-report is the most widely used method of assessment medication adherence; however, there are several shortcomings. Self-reporting has the problem of over-estimating adherence; inaccuracies can also be caused by recall bias, social desirability bias, and errors in self-observation.[31, 32] Further, the timeframe of adherence recollection can affect the accuracy of the recall during self-report.[33] TM reminders may sensitize patients to missed doses, and they may be more likely to report missed doses compared to patients not receiving

reminders. Wording of questions, the way the medication adherence question is asked, and the skills of the interviewer can either facilitate or be detrimental to obtaining measures of medication adherence.[32] When assessing RDI, we experienced difficulty obtaining objective data from medical and pharmacy dispensing records to determine if the oncologist had increased, decreased, or stopped OA dosages. Thus, measuring medication adherence remains a challenge for both clinicians and scientists. Finally, although we did not find differences in measures of self-efficacy in this small sample, the scripted TMs based on self-efficacy theory were thought to be encouraging and motivating to patients, and began to show promise at engaging behavior change in the form of improved adherence toward later weeks of the study.

Limitations

The majority of patients were recruited shortly after they were informed of a new cancer diagnosis or after other treatment failure. Consequently, in either situation, patients may have experienced high levels of stress, which may have led to difficulty completing data collection during our weekly assessments (78.9% or 442 of 560 AVR assessments were completed). Challenges in the measurement of medication adherence described above remain a limitation in this study, as well as in many studies of medication adherence. Measuring adherence by self-report is limited by the ability to recall if the medication was taken. Pharmacy dispensing records do not capture all instances of OA dose reductions or temporary stoppages. Medical record audits may be incomplete and may not agree with patient reports. Thus, objective adherence measurement for the sample, as in many medication adherence studies, was challenging.

TM interventions are feasible in cancer patients prescribed OAs for medication adherence and may be effective in helping patients engage in behavior change and improve self-management. Use of cell phones is increasing dramatically, and TMs may be an easy mode of delivering healthcare to large numbers of patients.

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DISCLOSURE STATEMENT

No competing financial interests exist.

Figure Legends

Figure 1. Text message designed using Social Cognitive Theory.

Figure 2. CONSORT flowchart, intent-to-treat; randomization; experimental and control groups.

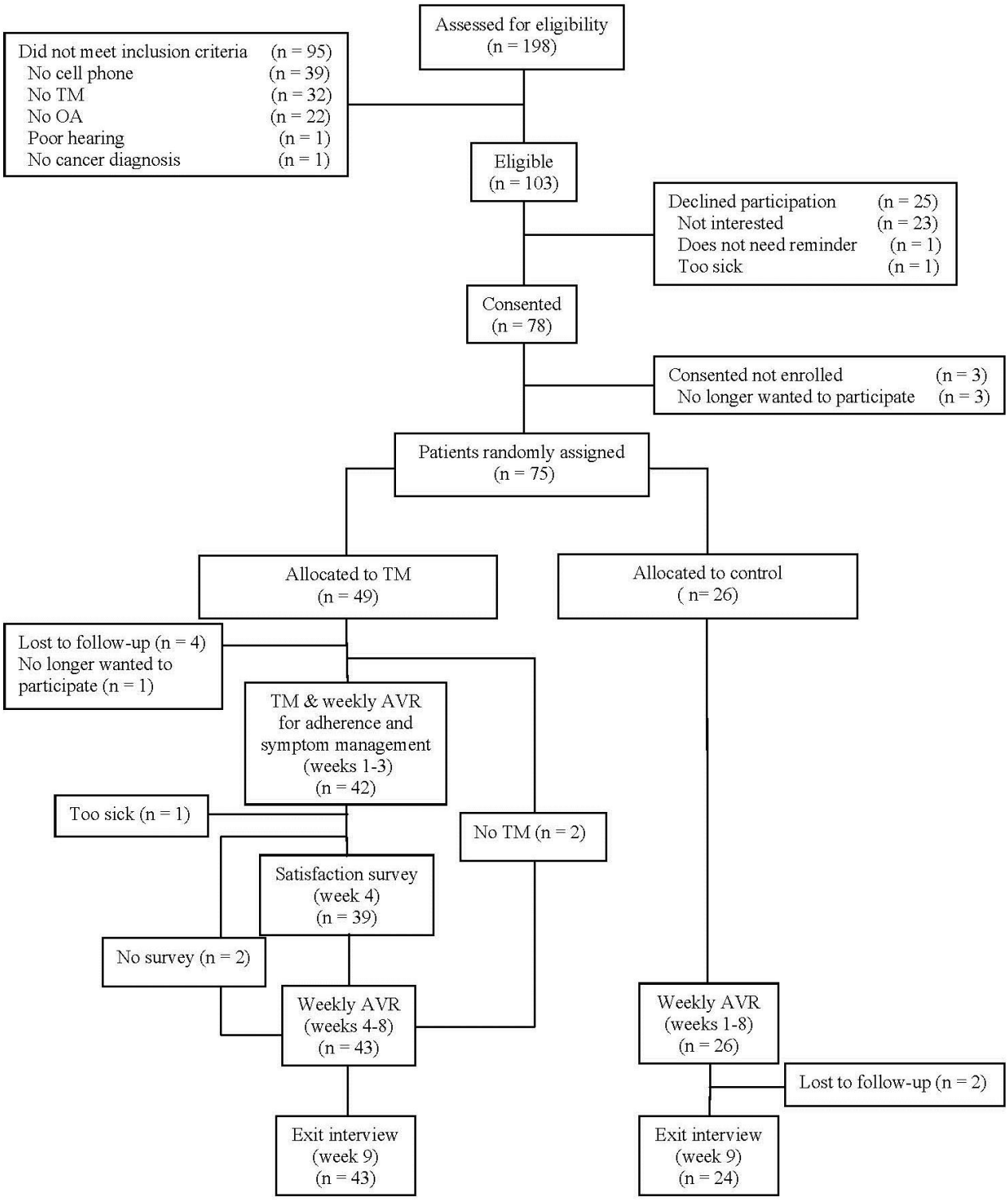
Figures

Fig 1

Timing of message delivery	Text Messages sent to patients in experimental group
Welcome Message	Welcome to the study. For 21 days, you will receive text message reminders to take your cancer pills. Reply “OK” after reading this message.
Adherence Messages (21-days)	A reminder to take your xxx* now. Taking your pill on time is critical in managing your cancer. Reply "Taken" when you've taken it.
	A reminder to take your xxx* now. Doing so is an important step in managing your cancer. Reply "Taken" when you've taken it.
	It's time to take your xxx*. Remember, taking your pill is easy and important in managing your cancer. Reply "Taken" when you've taken it.
	Please take your xxx* now. Reply "Taken" when you've taken it.
	It's time to take your xxx*. You’ve done great all week in taking it on time, so keep at it! Reply "Taken" when you've taken it.
	This is a reminder that it's time to take your XXX*. Find the routine that makes it easiest for you. Reply "Taken" when you've taken it.
Final Message	Our study is over. Remember: it is both easy and important to take your cancer pills as prescribed. If you have questions call your clinician. Thank you.

*** is the brand name of the OA medication to be taken by patient

Fig 2


Assessed for eligibility (n = 198)
Did not meet inclusion criteria (n = 95)
No cell phone (n = 39)
No TM (n = 32)
No OA (n = 22)
Poor hearing (n = 1)
No cancer diagnosis (n = 1)
Eligible (n = 103)
Declined participation (n = 25)
Not interested (n = 23)
Does not need reminder (n = 1)
Too sick (n = 1)
Consented (n = 78)
Consented not enrolled (n = 3)
No longer wanted to participate (n = 3)
Patients randomly assigned (n = 75)
Allocated to TM (n = 49)
Allocated to control (n= 26)
Lost to follow-up (n = 4)
No longer wanted to participate (n = 1)
TM & weekly AVR for adherence and symptom management (weeks 1-3) (n = 42)
Too sick (n = 1)
No TM (n = 2)
Satisfaction survey (week 4) (n = 39)
No survey (n = 2)
Weekly AVR (weeks 4-8) (n = 43)
Weekly AVR (weeks 1-8) (n = 26)
Lost to follow-up (n = 2)
Exit interview (week 9) (n = 43)
Exit interview (week 9) (n = 24)

Tables

Table 1. Baseline Characteristics of Study Participants, According to Study Group

Characteristic	TM (n = 49)	Control (n = 26)	*P*
Age, years			
Mean (SD)	60.1 (10.1)	59.9 (11.2)	.90
Sex, No. (%)			.70
Male	23 (46.9)	11 (42.3)	
Female	26 (53.1)	15 (57.7)	
Race, No. (%)*			.51
White	44 (89.8)	22 (84.6)	
Other	5 (10.2)	4 (15.4)	
Ethnicity, No. (%)			-
Not Hispanic or Latino	49 (100.0)	26 (100.0)	
Education, No. (%)*			.67
Some college/bachelor's degree	27 (55.1)	13 (50.0)	
Other	22 (44.9)	13 (50.0)	
Employment, No. (%)			.74
Employed	17 (34.7)	10 (38.5)	.18
Not employed	32 (65.3)	16 (61.5)	
Comorbidity, No. (%)*			.19
Arthritis	17 (21.5)	11 (33.3)	
Other	62 (78.5)	22 (66.7)	
Total # of comorbidities			
Mean (SD)	1.6 (1.5)	1.3 (1.2)	.33
Site of cancer, No. (%)*			.82
Breast	12 (24.5)	7 (26.9)	-
Other	37 (75.5)	19 (73.1)	
Cancer stage, No. (%)			.82
IV	25 (51.0)	14 (53.9)	
Other	24 (49.0)	12 (46.1)	
Complexity of dosing of oral agent, No. (%)			.39
Simple	17 (35.4)	7 (26.9)	
Complex	31 (64.6)	19 (73.1)	
Symptoms, Mean (SD)			
Total number	4.9 (2.9)	5.7 (3.5)	.32
Summed severity	24.5 (19.6)	31.6 (19.7)	.16
Summed interference	18.8 (17.9)	31.6 (20.9)	.63
PROMIS depression, Mean (SD)	45.5 (7.2)	47.4 (8.4)	.31
PROMIS physical function Mean (SD)	45.0 (7.5)	44.2(8.2)	.65
Cognitive function, Mean (SD)			
Effective action subscale	48.6 (14.2)	46.1 (16.0)	.49
Attentional lapses subscale	23.7 (5.9)	21.8 (7.4)	.23
Interpersonal effectiveness subscale	21.9 (5.8)	20.1 (6.7)	.22
Self-efficacy, Mean (SD)			

BMQ1	10.2 (3.8)	10.5 (4.5)	.78
BMQ2	19.7 (3.7)	15.6 (4.4)	.26
MASES-R	30.2 (4.7)	29.4 (1.2)	.49
Social Support, Mean (SD)	4.6 (3.4)	4.8 (3.2)	.78

*Due to some of the counts being small, p-values reflect group comparisons of proportions in the most prevalent category.

Table 2. Summary of Responses to the Satisfaction Survey by Age Groups and Gender

		Age (years)			Sex	
	All patients	< = 50	51- 64	65+	Male	Female
Question						
How satisfied are you overall with your participation in the study? [a], *No*. (%)						
Not at all	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Somewhat	1 (2.7)	0 (0.0)	1 (10.0)	0 (0.0)	0 (0.0)	1 (4.8)
Very much	13 (35.1)	1 (25.0)	2 (20.0)	10 (43.4)	7 (43.4)	6 (28.6)
Highly	23 (62.2)	3 (75.0)	7 (70.0)	13 (56.6)	9 (56.6)	14 (66.7)
Did you encounter any problems with the text message system? [a]						
No. (%)						
Yes	2 (5.3)	0 (0.0)	1 (10.0)	1 (4.2)	1 (6.3)	1 (4.5)
No	36 (94.7)	4 (100.0)	9 (90)	23 (95.8)	15 (93.7)	21 (95.5)
Overall, for you personally, the text messaging was: [a]						
No. (%)						
Both a burden and helpful	2 (5.4)	1 (25.0)	0 (0.0)	1 (4.3)	0 (0.0)	2 (9.1)
Mostly a burden and helpful	2 (5.4)	0 (0.0)	0 (0.0)	2 (8.7)	1 (6.7)	1 (4.8)
Mostly helpful	33 (89.2)	3 (75)	10 (100.0)	20 (87.0)	14 (93.3)	19 (90.5)
Did the text messages help you take your oral cancer pills on time? [a]						
No. (%)						
Helped	28 (73.7)	4 (100.0)	7 (70.0)	17 (70.1)	10 (62.5)	18 (81.8)
Did not help	2 (5.3)	0 (0.0)	0 (0.0)	2 (8.35)	1 (6.3)	1 (4.5)
Neither	8 (21.0)	0 (0.0)	3 (30.0)	5 (20.8)	5 (31.2)	3 (13.7)
How satisfied were you with text reminders to take your medications? [a]						
No. (%)						
Not at all	1 (2.6)	0 (0.0)	0 (0.0)	1 (4.2)	0 (0.0)	1 (4.5)
Somewhat	2 (5.3)	0 (0.0)	1 (10.0)	1 (4.2)	2 (12.5)	0 (0.0)
Very much	14 (36.9)	1 (25.0)	4 (40.0)	9 (37.5)	7 (43.8)	7 (31.8)
Highly	21 (55.3)	3 (75.0)	5 (50.0)	13 (54.1)	7 (43.8)	14 (63.6)
Did you read the text messages about your cancer pills? [a], No. (%)						
All of the time	30 (78.9)	3 (75.0)	10 (100.0)	17 (70.8)	12 (75.0)	18 (81.8)
Most of the time	7 (18.4)	1 (25.0)	0 (0.0)	6 (25.0)	3 (18.6)	4 (18.2)
Some of the time	1 (2.6)	0 (0.0)	0 (0.0)	1 (4.2)	1 (6.3)	0 (0.0)
None of the time	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Would you recommend text messages as a reminder to take your cancer pills? [a], No. (%)						
Yes	37 (97.4)	4 (100.0)	10 (100.0)	23 (95.8)	15 (93.7)	22 (100.0)
No	1 (2.6)	0 (0.0)	0 (0.0)	1 (4.2)	1 (6.3)	0 (0.0)
Would you recommend text messages as a way for clinicians to monitor if cancer pills were taken? [a], No. (%)						
Yes	36 (100.0)	4 (100.0)	10 (100.0)	22 (100.0)	15 (100.0)	21 (100.0)
No	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

[a] implies that some data are missing.

Table 3. The summary of weekly self-reported adherence

	TM	Control	
Week			*P*
Week 1, No. (%)			.53
Adherent	31 (66.0)	19 (73.1)	
Non-adherent	16 (34.0)	7 (26.9)	
Week 2, No. (%)			.07
Adherent	26 (55.3)	20 (76.9)	
Non-adherent	21 (44.7)	6 (23.1)	
Week 3, No. (%)			.54
Adherent	35 (74.5)	21 (80.8)	
Non-adherent	12 (25.5)	5 (19.2)	
Week 4, No. (%)			.01
Adherent	28 (59.6)	23 (88.5)	
Non-adherent	19 (40.4)	3 (11.5)	
Week 5, No. (%)			.95
Adherent	34 (72.3)	19 (73.1)	
Non-adherent	13 (27.7)	7 (26.9)	
Week 6, No. (%)			.78
Adherent	31 (66.0)	18 (69.2)	
Non-adherent	16 (34.0)	8 (30.8)	
Week 7, No. (%)			.45
Adherent	33 (70.2)	16 (61.5)	
Non-adherent	14 (29.8)	10 (38.5)	
Week 8, No. (%)			.52
Adherent	29 (61.7)	18 (69.2)	
Non-adherent	18 (38.3)	8 (30.8)	
Exit interview, No. (%)			.42
Adherent	39 (86.7)	19 (79.2)	
Non-adherent	6 (13.3)	5 (20.8)	

Table 4. Post-intervention least square (LS) means of outcomes and their standard errors (SE) adjusted for baseline values (except for MARS-M and self-reported adherence)

Measure	TM	Control	*P*	ES
Adherence, Mean (SE)				
Number of weeks adherent	6.5 (0.4)	7.2 (0.5)	.26	0.29
Symptoms, Mean (SE)				
Total number	4.9 (0.4)	5.2 (0.6)	.71	0.09
Summed severity	23.0 (2.7)	26.5 (3.7)	.45	0.21
Summed interference	18.2 (2.7)	21.9 (3.7)	.41	0.22
PROMIS depression				
Mean (SE)	44.6 (1.0)	44.2 (1.3)	.80	0.06
PROMIS physical function			.99	0
Mean (SE)	45.7 (0.9)	45.7 (1.3)		
Cognitive function				
Mean (SE)				
Effective action subscale	49.7 (1.5)	53.4 (2.0)	.15	0.38
Attentional lapses subscale	23.5 (0.7)	24.1 (0.9)	.56	0.15
Interpersonal effectiveness subscale	22.1 (0.7)	23.7 (0.9)	.18	0.35
Self-efficacy				
BMQ1	10.4 (0.6)	10.2 (0.8)	.88	0.04
BMQ2	16.1 (0.5)	15.9 (0.7)	.76	0.08
MASES-R	31.1 (0.3)	31.1 (0.4)	.83	0.06
MARS-M	0.3 (0.1)	0.6 (0.2)	.10	0.44
Social support				
Mean (SE)	3.7 (0.4)	2.4 (0.5)	.04	0.54

Table 5. The summary of self-reported weekly symptom number, severity, and interference with activities of daily living

Week	TM LS	Control LS	*P*
Week 1, Mean (SE)			
Number of symptoms	5.6 (0.5)	6.1 (0.7)	.56
Symptom severity	23.3 (2.5)	23.3 (3.2)	.99
Symptom interference	18.3 (2.6)	21.5 (3.4)	.46
Week 2, Mean (SE)			
Number of symptoms	5.9 (0.5)	5.9 (0.70)	.99
Symptom severity	26.5 (2.4)	21.6 (3.2)	.22
Symptom interference	21.1 (2.6)	18.8 (3.5)	.59
Week 3, Mean (SE)			
Number of symptoms	5.7 (0.5)	6.1 (0.6)	.58
Symptom severity	22.3 (2.4)	22.1 (3.0)	.96
Symptom interference	18.2 (2.6)	17.8 (3.2)	.93
Week 4, Mean (SE)			
Number of symptoms	5.4 (0.5)	5.7 (0.6)	.78
Symptom severity	22.0 (2.4)	21.9 (2.9)	.99
Symptom interference	18 (2.8)	17.3 (3.2)	.87
Week 5, Mean (SE)			
Number of symptoms	5.4 (0.5)	6.0 (0.6)	.47
Symptom severity	22.0 (2.4)	24.6 (3.1)	.50
Symptom interference	19.6 (2.8)	22.2 (3.4)	.56
Week 6, Mean (SE)			
Number of symptoms	5.8 (0.5)	5.7 (0.6)	.86
Symptom severity	23.0 (2.5)	20.8 (2.9)	.56
Symptom interference	20.5 (2.9)	17.9 (3.3)	.56
Week 7, Mean (SE)			
Number of symptoms	6.1 (0.5)	5.2 (0.7)	.29
Symptom severity	23.0 (2.5)	21.5 (3.1)	.70
Symptom interference	21.5 (2.7)	20.2 (3.7)	.77
Week 8, Mean (SE)			
Number of symptoms	5.1 (0.5)	5.4 (0.6)	.70
Symptom severity	20.5 (2.6)	24.0 (3.1)	.38
Symptom interference	17.1 (2.9)	21.9 (3.4)	.29
Exit interview, Mean (SE)			
Number of symptoms	5.0 (0.5)	5.2 (0.6)	.79
Symptom severity	22.1 (2.3)	25.1 (3.0)	.42
Symptom interference	18.3 (2.4)	21.2 (3.1)	.45

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