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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Abstract

Introduction: This multisite, randomized controlled trial assigned 75 adult cancer patients prescribed an oral anticancer 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 (Weeks 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 patients consented, 88% (n = 37 of 42) receiving text messages read them most or all of the time, and 90% (n = 38) were satisfied. The differences 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. Furthermore, perceived social support was higher ($p=0.04$;

$ES=0.54$) in the experimental group. **Conclusions:** Proof of concept and preliminary efficacy of a mobile health intervention using text messages to promote adherence for patients prescribed oral anticancer agents were 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.

Key words: behavioral health, mobile health, technology, teleoncology

Introduction

With more than 50 oral anticancer agents (OAs) on the market, it is projected that within the next decade, 25% of cancer treatment will be in pill form.¹ Recent reviews on OAs indicate adherence rates are often less than 80%.^{2,3} OAs often come with side effects, which in turn may lead to adverse events and non-adherence.³ OA treatment requires patients to self-manage side effects from treatment and adherence in the home setting.⁴ Most cancer patients are older and also have comorbid conditions and take multiple medications, which likely make symptoms more severe, as well as adherence more difficult.⁵ Other known factors that may influence adherence include medication frequency and complexity, adverse effects of the medication, forgetfulness, beliefs about importance of taking the medication, or inability to pay.⁶ The available evidence suggests self-management of OAs is a significant clinical problem that may impact treatment success or failure.^{7,8}

Cell phones have been widely adopted and are rapidly evolving as a cost-effective mode of delivering tailored behavioral interventions.^{9,10} There are more than 285 million cell phone subscribers in the United States,¹¹ and it is estimated 81% of users send and receive text messages (TMs).¹² Evidence is beginning to show that TMs built on Social Cognitive Theory¹³ increase self-efficacy and improve health outcomes.¹⁴ TMs have also improved medication adherence in multiple diseases,⁶ with one trial finding more correct medication doses taken on time.¹⁵

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 the 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 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 previously.¹⁶

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria were being 21 years of age or older, having been newly prescribed an OA within the past 30 days, owning a personal cell phone, and being willing and able to receive and send TMs. Patients with cognitive impairment that limited their 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 the patient was willing to participate. Recruiters also called on the phone, explained the study, and obtained informed consent via an electronic e-mail signature. All recruiters recorded the number of patients who were contacted and the subsequent accrual rates.

PROCEDURES

After consents to participate were obtained, baseline interviews (Week 0) were conducted by phone. An automated voice response system was used to complete weekly assessments (Weeks 1–8) 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 version 9.4 software (SAS Institute, Cary, NC). The minimization balanced the groups on age (<50 or ≥50 years) and recruitment site. The intervention began at the time the patient started the OA prescription or within 7 days of random assignment if patients had already started the OA.

INTERVENTION

Theory-based TMs were developed according to Social Cognitive Theory using 160 characters or less (*Fig. 1*). This included a welcome and test TM (e.g., “Welcome to the study. For 21 days, you will receive text message reminders to take your cancer pills. Reply ‘OK’ after reading this message”), six medication adherence TMs used on a rotating basis (e.g., “A reminder to take your [drug name] now. Doing so is an important step in managing your cancer. Reply ‘Taken’ when you’ve taken it”), and an end-of-study TM (e.g., “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”). An automated platform delivered the TMs and stored associated 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.

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.

Fig. 1. Text message designed using Social Cognitive Theory. xxx* represents the brand name of the oral anticancer agent to be taken by the patient.

USUAL CARE

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

MEASURES

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

Disease parameters and treatment. Record reviews were conducted to determine cancer type and stage of disease, as well as 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, as well as by the percentage of patients who 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.^{17,18} Satisfaction was deemed high for scores exceeding 80%.

PRIMARY OUTCOME MEASURES

Adherence was measured by report by patients 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, an additional measure of adherence that is determined by the ratio of delivered dose of OA given

over a period of time in relation to what was prescribed, was evaluated.^{19–21}

Severity and interference with daily life of 19 symptoms were assessed using the Symptom Inventory^{22,23} 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.²⁴ Patient Reported Outcomes Measurement Information System (PROMIS) tools were used to assess depression (8a) and physical function (6a).²⁵ Self-efficacy was assessed using the Medication Adherence Self-Efficacy Scale,²⁶ the Self Efficacy Adherence Medications,²⁷ and the Brief Medication Questionnaire (Specific).²⁸ Social support was assessed using the Medication Specific Social Support tool.²⁹

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-squared, Fisher's exact, or *t* tests. To determine acceptability, feasibility, and satisfaction of TMs among patients on OAs,

the proportions 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, as was 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-reported 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.^{30,31} SAS version 9.4 software (SAS Institute, Cary, NC) was used for the data analysis.

Results

The flow of participants is depicted in *Figure 2*. In total, 1,356 TMs were sent to patients in this study. This included 1,189 TMs for adherence: 741 TMs were sent at the time the OAs were to be taken, and 448 repeat TMs were sent when the patient did not reply with the correct response text. In addition, 49 test TMs and 49 end-of-study TMs were sent. Patients replied via 1,036 TMs, 87.1% of the time (1,036 of 1,189).

PARTICIPANTS

Of the 198 patients screened, 78 consented, and 75 of them 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 socio-demographic, 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 automated voice response 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. No difference in age was found according to eligi-

bility and consent, but a significant difference was observed in enrollment by sex between consented versus eligible but not enrolled ($p=0.02$) (*Table 1*). Of those who were ineligible, 41.1% (39 of 95) did not have a cell phone, 33.7% (32 of 95) did not use TMs, 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 (*Table 2*), 39 completed the survey. It is notable that, 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 1–8 and the exit interview. The control group started with a higher percentage of OA adherence in Week 1 (73.1%, $n=19$) compared with the experimental group (66%, $n=31$), and as shown in *Table 3*, Weeks 2–6 and 8 had higher percentages of OA adherence in the control group. The control group had declining adherence over time, whereas the experimental group had increasing OA adherence over time. Week 7 and exit had higher adherence in the experimental group (70.2% versus 61.5% and 86.7% versus 79.2%, respectively). The mean number of weeks of adherence to OAs in the experimental group was 6.5 (standard error=0.4) compared with 7.2 (standard error=0.5) in the control group ($p=0.26$), with an ES of -0.29 (*Table 4*). This difference was not statistically significant with the available sample size. We were unable to calculate relative dose intensity 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, of 59 patients with no dose changes documented in the medical records, 5 (8%) said the dose was changed; 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 (*Table 5*). *Table 4* reports on group differences postintervention. Although not significant, the experimental group had fewer total number of symptoms (ES=0.09), lower summed

Fig. 2. Modified Consolidated Standards of Reporting Trials flowchart, showing intent-to-treat and randomization for the experimental and control groups. AVR, automated voice response; OA, oral anticancer agent; TM, text message.

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)	0.90
Sex [n (%)]			0.70
Male	23 (46.9)	11 (42.3)	
Female	26 (53.1)	15 (57.7)	
Race [n (%)] ^a			0.51
White	44 (89.8)	22 (84.6)	
Other	5 (10.2)	4 (15.4)	
Ethnicity [n (%)]			—
Not Hispanic or Latino	49 (100.0)	26 (100.0)	
Education [n (%)] ^a			0.67
Some college/bachelor's degree	27 (55.1)	13 (50.0)	
Other	22 (44.9)	13 (50.0)	
Employment [n (%)]			0.74
Employed	17 (34.7)	10 (38.5)	0.18
Not employed	32 (65.3)	16 (61.5)	
Comorbidity [n (%)] ^a			0.19
Arthritis	17 (21.5)	11 (33.3)	
Other	62 (78.5)	22 (66.7)	
Comorbidities (total number) [mean (SD)]	1.6 (1.5)	1.3 (1.2)	0.33
Site of cancer [n (%)] ^a			0.82
Breast	12 (24.5)	7 (26.9)	—
Other	37 (75.5)	19 (73.1)	
Cancer stage [n (%)]			0.82
IV	25 (51.0)	14 (53.9)	
Other	24 (49.0)	12 (46.1)	
Complexity of dosing of oral agent [n (%)]			0.39
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)	0.32
Summed severity	24.5 (19.6)	31.6 (19.7)	0.16
Summed interference	18.8 (17.9)	31.6 (20.9)	0.63
PROMIS [mean (SD)]			
Depression	45.5 (7.2)	47.4 (8.4)	0.31
Physical function	45.0 (7.5)	44.2 (8.2)	0.65

continued →

Table 1. continued

CHARACTERISTIC	TM (N= 49)	CONTROL (N= 26)	P
Cognitive function [mean (SD)]			
Effective action subscale	48.6 (14.2)	46.1 (16.0)	0.49
Attentional lapses subscale	23.7 (5.9)	21.8 (7.4)	0.23
Interpersonal effectiveness subscale	21.9 (5.8)	20.1 (6.7)	0.22
Self-efficacy [mean (SD)]			
BMQ1	10.2 (3.8)	10.5 (4.5)	0.78
BMQ2	19.7 (3.7)	15.6 (4.4)	0.26
MASES-R	30.2 (4.7)	29.4 (1.2)	0.49
Social support [mean (SD)]	4.6 (3.4)	4.8 (3.2)	0.78

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

BMQ, Brief Medication Questionnaire; MASES-R, Medication Adherence Self-Efficacy Scale; PROMIS, Patient Reported Outcomes Measurement Information System; TM, text message.

symptom severity (ES = 0.21), and lower summed interference (ES = 0.22), all having small ES.

SECONDARY OUTCOMES

There were no group differences on physical function (ES = −0.06) or on the three subscales on cognitive function (effective action, attentional lapses, and interpersonal effectiveness), and the ES for group differences were small. Similarly, the three self-efficacy measures demonstrated small ES differences in the experimental group compared with the control: the Brief Medication Questionnaire-1 (ES = 0.04), the Brief Medication Questionnaire-2 (ES = 0.08), the Medication Adherence Self-Efficacy Scale (ES = −0.06), and the Self Efficacy Adherence Medications (ES = −0.44) (the last was only done at exit). The experimental group differed significantly from the control group 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 send/receive TMs, whereas females were more likely to send/receive TMs. Patients were multimorbid, 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.

TEXT MESSAGES TO IMPROVE CANCER MEDICATION ADHERENCE

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

QUESTION	ALL PATIENTS	AGE (YEARS)			SEX	
		≤50	51–64	65+	MALE	FEMALE
How satisfied are you overall with your participation in the study? ^a						
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						
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						
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						
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						
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						
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						
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						
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)

Data are number (%).

^aSome data are missing.

Table 3. Summary of Weekly Self-Reported Adherence

WEEK	TM	CONTROL	P
Week 1			0.53
Adherent	31 (66.0)	19 (73.1)	
Nonadherent	16 (34.0)	7 (26.9)	
Week 2			0.07
Adherent	26 (55.3)	20 (76.9)	
Nonadherent	21 (44.7)	6 (23.1)	
Week 3			0.54
Adherent	35 (74.5)	21 (80.8)	
Nonadherent	12 (25.5)	5 (19.2)	
Week 4			0.01
Adherent	28 (59.6)	23 (88.5)	
Nonadherent	19 (40.4)	3 (11.5)	
Week 5			0.95
Adherent	34 (72.3)	19 (73.1)	
Nonadherent	13 (27.7)	7 (26.9)	
Week 6			0.78
Adherent	31 (66.0)	18 (69.2)	
Nonadherent	16 (34.0)	8 (30.8)	
Week 7			0.45
Adherent	33 (70.2)	16 (61.5)	
Nonadherent	14 (29.8)	10 (38.5)	
Week 8			0.52
Adherent	29 (61.7)	18 (69.2)	
Nonadherent	18 (38.3)	8 (30.8)	
Exit interview			0.42
Adherent	39 (86.7)	19 (79.2)	
Nonadherent	6 (13.3)	5 (20.8)	

Data are number (%).

TM, text message.

The self-reported medication adherence measure showed improving adherence rates in the experimental group at later weeks, suggesting that a patient may start with good adherence but may need the 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 overestimating adherence; inaccuracies can also be caused by recall bias, social desirability bias, and errors in self-observation.^{32,33}

Table 4. Postintervention Least Square Means of Outcomes and Their Standard Errors Adjusted for Baseline Values (Except for Self Efficacy Adherence Medications and Self-Reported Adherence)

Measure	TM	Control	P	ES
Adherence				
Number of weeks adherent	6.5 (0.4)	7.2 (0.5)	0.26	0.29
Symptoms				
Total number	4.9 (0.4)	5.2 (0.6)	0.71	0.09
Summed severity	23.0 (2.7)	26.5 (3.7)	0.45	0.21
Summed interference	18.2 (2.7)	21.9 (3.7)	0.41	0.22
PROMIS				
Depression	44.6 (1.0)	44.2 (1.3)	0.80	0.06
Physical function	45.7 (0.9)	45.7 (1.3)	0.99	0
Cognitive function				
Effective action subscale	49.7 (1.5)	53.4 (2.0)	0.15	0.38
Attentional lapses subscale	23.5 (0.7)	24.1 (0.9)	0.56	0.15
Interpersonal effectiveness subscale	22.1 (0.7)	23.7 (0.9)	0.18	0.35
Self-efficacy				
BMQ1	10.4 (0.6)	10.2 (0.8)	0.88	0.04
BMQ2	16.1 (0.5)	15.9 (0.7)	0.76	0.08
MASES-R	31.1 (0.3)	31.1 (0.4)	0.83	0.06
MARS-M	0.3 (0.1)	0.6 (0.2)	0.10	0.44
Social support	3.7 (0.4)	2.4 (0.5)	0.04	0.54

Data are mean (standard error) values.

BMQ, Brief Medication Questionnaire; MARS-M, Self Efficacy Adherence Medications; MASES-R, Medication Adherence Self-Efficacy Scale; PROMIS, Patient Reported Outcomes Measurement Information System.

Furthermore, the time frame of adherence recollection can affect the accuracy of the recall during self-report.³⁴ TM reminders may sensitize patients to missed doses, and they may be more likely to report missed doses compared with 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 relative dose intensity, 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.

Table 5. Summary of Self-Reported Weekly Symptom Number, Symptom Severity, and Interference with Activities of Daily Living

WEEK, FACTOR EVALUATED	TM LS	CONTROL LS	P
Week 1			
Number of symptoms	5.6 (0.5)	6.1 (0.7)	0.56
Symptom severity	23.3 (2.5)	23.3 (3.2)	0.99
Symptom interference	18.3 (2.6)	21.5 (3.4)	0.46
Week 2			
Number of symptoms	5.9 (0.5)	5.9 (0.70)	0.99
Symptom severity	26.5 (2.4)	21.6 (3.2)	0.22
Symptom interference	21.1 (2.6)	18.8 (3.5)	0.59
Week 3			
Number of symptoms	5.7 (0.5)	6.1 (0.6)	0.58
Symptom severity	22.3 (2.4)	22.1 (3.0)	0.96
Symptom interference	18.2 (2.6)	17.8 (3.2)	0.93
Week 4			
Number of symptoms	5.4 (0.5)	5.7 (0.6)	0.78
Symptom severity	22.0 (2.4)	21.9 (2.9)	0.99
Symptom interference	18 (2.8)	17.3 (3.2)	0.87
Week 5			
Number of symptoms	5.4 (0.5)	6.0 (0.6)	0.47
Symptom severity	22.0 (2.4)	24.6 (3.1)	0.50
Symptom interference	19.6 (2.8)	22.2 (3.4)	0.56
Week 6			
Number of symptoms	5.8 (0.5)	5.7 (0.6)	0.86
Symptom severity	23.0 (2.5)	20.8 (2.9)	0.56
Symptom interference	20.5 (2.9)	17.9 (3.3)	0.56
Week 7			
Number of symptoms	6.1 (0.5)	5.2 (0.7)	0.29
Symptom severity	23.0 (2.5)	21.5 (3.1)	0.70
Symptom interference	21.5 (2.7)	20.2 (3.7)	0.77
Week 8			
Number of symptoms	5.1 (0.5)	5.4 (0.6)	0.70
Symptom severity	20.5 (2.6)	24.0 (3.1)	0.38
Symptom interference	17.1 (2.9)	21.9 (3.4)	0.29
Exit interview			
Number of symptoms	5.0 (0.5)	5.2 (0.6)	0.79
Symptom severity	22.1 (2.3)	25.1 (3.0)	0.42
Symptom interference	18.3 (2.4)	21.2 (3.1)	0.45

Data are mean (standard error) values.
LS, least squares.

Finally, although we did not find differences in measures of self-efficacy in this small sample, the scripted TMs based on Social Cognitive Theory were thought to be encouraging and motivating to patients, as shown in patient remarks in satisfaction surveys, and began to show promise at engaging behavior change in the form of improved adherence over the course of the study toward the later weeks.

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 a difficulty with completing data collection during our weekly assessments (78.9%, or 442 of 560, automated voice response assessments were completed). This study was not powered to detect differences between groups on the secondary outcome measures but to compute ES for a larger study. 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. Future work is needed to examine the efficacy of TMs at improving medication adherence in larger clinical trials across multiple disease conditions and age groups, in particular with technology-based interventions of different types such as TMs, automated voice response, and applications.

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