Feasibility of a Text Messaging Intervention to Promote Self-Management for Patients Prescribed Oral Anticancer Agents

Sandra L. Spoelstra, PhD, RN, Charles W. Given, PhD, Alla Sikorskii, PhD, Constantinos K. Coursaris, PhD, Atreyee Majumder, BS, Tracy DeKoekkoek, RN, Monica Schueller, BA, and Barbara A. Given, PhD, RN, FAAN

Oral anticancer agent (OA) use for cancer treatment is increasing (Soria et al., 2011). With more than 50 OAs on the market, 25% of cancer treatment is expected to be in pill form during the next decade (Bestvina et al., 2014). The therapeutic outcome of cancer treatment for patients taking OAs depends heavily on self-management (Spoelstra et al., 2013a, 2013b). However, research indicates that managing OAs is a significant problem (Bassan et al., 2014; Puts et al., 2013; Streeter, Schwartzberg, Husain, & Johnsrud, 2011).

Reviews of OA studies consistently demonstrate that adherence to regimens is less than 80% (Bassan et al., 2014; Puts et al., 2013). Studies of patients with cancer also indicate that patients interrupted or stopped treatment when symptoms from side effects of treatment became severe (Spoelstra et al., 2013a, 2013b). Difficulty with self-management of OAs has been reported in systematic reviews and further delineated in the National Comprehensive Cancer Network Task Force Report on OAs (Bassan et al., 2014; Puts et al., 2013; Weingart et al., 2008). Factors that seem to influence adherence include age, gender, race, health beliefs, side effects, self-efficacy, comorbidities, depression, cognitive ability, regimen complexity and cost, self-management knowledge, social support, and provider relations. Evidence also shows that, as the complexity of OA regimen increases, adherence decreases (Spoelstra et al., 2013a). Many OA dosing regimens require taking medication multiple times a day, cycling on and off, or taking multiple medications. In addition, 75% of people with cancer have comorbid conditions, which may interfere with the ability to self-manage (Ogle, Swanson, Woods, & Azzouz, 2000). The limited evidence available suggests that managing OAs is a significant problem that

Purpose/Objectives: To determine proof of concept of a mobile health (mHealth) intervention delivering text messages (texts) to self-manage among patients prescribed oral anticancer agents (OAs) and to examine preliminary efficacy on symptoms and medication adherence.

Design: A longitudinal randomized, controlled trial.

Setting: Two community cancer centers in the midwestern United States and a national specialty pharmacy.

Sample: 80 adults with cancer who were newly prescribed OAs.

Methods: Adherence and symptoms were assessed weekly for 10 weeks in both groups. The intervention group received daily texts for adherence and weekly for symptoms for 21–28 days, and satisfaction with the intervention was assessed.

Main Research Variables: Medication adherence and symptom severity.

Findings: Mean age was 58.5 years (SD = 10.7 years), 48 participants were female, and 48 were Caucasian. Fewer symptoms were found in the intervention group with a moderate effect size. Adherence was higher in the text group using medical record and prescription data (n = 26) with greater relative dose intensity of moderate to large effect size. Regarding acceptability, 57% (83 of 145) of eligible participants consented, 39 of 40 participants completed the entire intervention, 30 participants read texts all of the time, and 34 participants were satisfied with the intervention.

Conclusions: Proof of concept and preliminary efficacy of an mHealth intervention using texts to promote self-management for patients prescribed OAs was demonstrated. Patients had high satisfaction with the texts, and adherence and symptoms improved after the intervention.

Implications for Nursing: Texts show promise for patients with cancer who must manage their OAs. Additional research is needed prior to use in practice.

Key Words: text messaging; SMS; mobile phone; mHealth; cancer; medication adherence; oral agent; PROMIS

ONF, 42(6), 647–657. doi: 10.1188/15.ONF.647-657

may affect treatment success (Puts et al., 2013; Spoelstra et al., 2013a, 2013b).

Use of mobile health (mHealth) technology, such as text messages (texts) on mobile phones to promote behavior change, may offer a way to integrate OA self-management into daily life (Burke et al., 2012; Free et al., 2013; Spring et al., 2012). Mobile phones are the most commonly used form of technology worldwide (Smith, 2013). Evidence is emerging on the automated response of texts to motivate behavior change and action (Déglise, Suggs, & Odermatt, 2012; Park, Howie-Esquivel, Chung, & Dracup, 2014; Spring et al., 2012).

Since 2007, research focused on texts to promote self-management, particularly medication adherence, have demonstrated improved outcomes (da Costa et al., 2012; Pop-Eleches et al., 2011; Zolfaghari, Mousavifar, Pedram, & Haghani, 2012). Studies were conducted in HIV, diabetes, coronary heart disease, epilepsy, and chronic conditions. Those studies have used differing text content and intervention dosages, so the ideal content or dose of a text intervention has not been established. In addition, the majority of these studies were in populations aged younger than 50 years. One exception was for the coronary heart disease study, which had a mean age of 59.2 years (Park et al., 2014). However, little is known about the use of texts as an intervention modality in patients with cancer undergoing treatment with OAs, the majority of whom are older aged.

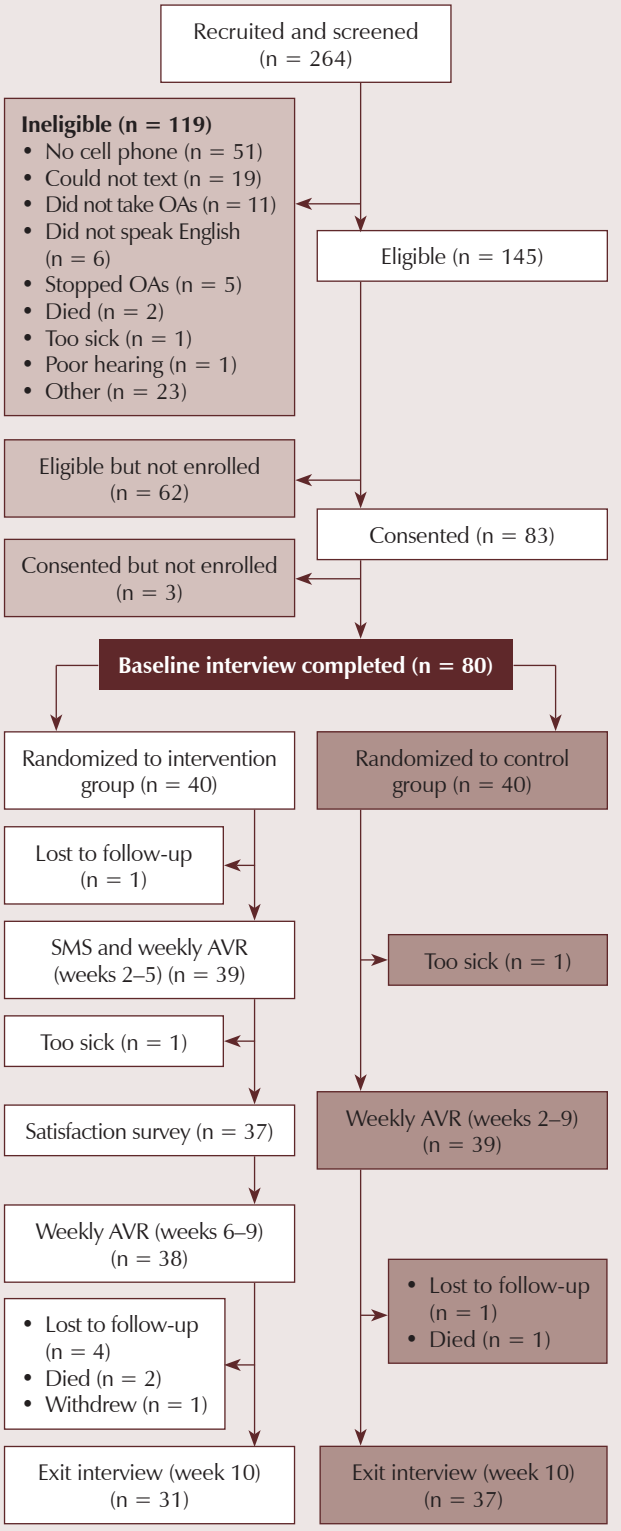
The aim of this study was to determine proof of concept by assessing acceptability, feasibility, and satisfaction with a text intervention among patients with cancer prescribed OAs. The authors also examined preliminary efficacy of texts on self-management by comparing symptom presence, severity, interference, and adherence between patients who received texts for symptom management and adherence in addition to usual care and patients who received usual care.

The Principles of the Self-Efficacy Theory (Bandura, 1977) underpinned the intervention for this study, postulating that belief in capabilities to perform behaviors is influenced by motivation and affective states. Research has shown that 21 days of prompts are needed to form a behavior pattern (DiClemente & Valesquea, 2003; Schlenk, Dunbar-Jacob, & Engberg, 2004). The current authors proposed that engaging patients via texts would heighten self-efficacy and promote OA self-management.

Methods

The design for this study was a 10-week longitudinal two-group randomized, controlled trial. The study was granted approval by the Michigan State University Institutional Review Board in November 2012.

Eighty individuals with cancer were recruited at two community cancer centers in the midwestern United States and a large specialty pharmacy, Diplomat



AVR—automated voice response; CONSORT—Consolidated Standards of Reporting Trials; OA—oral anticancer agent; SMS—text message

Figure 1. CONSORT Chart

Pharmacy, Inc., in Flint, Michigan. The majority of OAs are dispensed by a specialty pharmacy, and the authors wanted to assess whether patients could be accrued at this type of setting in addition to recruiting at cancer clinics. Recruitment occurred from July 2013 to January 2014. Patients were eligible if they were aged 21 years or older, were prescribed an OA, had a personal cell phone, were willing to receive and send texts, and were able to speak and read English. Those with cognitive impairment that limited the ability to understand and answer questions were excluded. Figure 1 shows patients who enrolled and completed each phase of the study.

Recruiters collected data on an enrollment form via patient self-report and medical record review. Trained interviewers at the university collected baseline, satisfaction, and exit data by phone using the web-based Patient Reported Outcomes Measurement Information System ([PROMIS], 2008) Assessment Center Data Collection Platform and an automated voice response (AVR) system. Data were also collected on texts sent and returned.

Measures

Age, gender, race and ethnicity, marital status, education level, employment, and insurance and medication coverage were measured. In addition, data on OA type and regimen and concurrent IV chemotherapy treatment were collected.

Proof-of-concept measures included acceptability, feasibility, and satisfaction. Acceptability of texts was measured by the number of patients who accepted enrollment into the study compared to the number offered to participate and by the proportion who completed the study. Feasibility of texts was measured by the number of texts delivered and replied to during the course of the study. Satisfaction with texts was measured using a tool previously developed by the research team and administered in several previous studies; satisfaction was deemed high for scores exceeding 80% (Spoelstra et al., 2013a).

Adherence was measured by patient report of whether pills were taken as directed in the past seven days during weekly AVR calls and exit interview, as well as by returned texts in the intervention group. Relative dose intensity (RDI), the ratio of delivered dose of OA given over a period of time in relation to what was prescribed as a measure of adherence, was calculated after conducting a pharmacy fill audit from medical or claims records (Amgen, Inc., 2008; Loibl et al., 2011; Raza, Welch, & Younus, 2009). Symptom severity and interference with daily life of 19 symptoms were assessed using the Symptom Experience Inventory (Spoelstra et al., 2013a) at baseline, weekly, and exit. Symptoms were rated "yes" or "no" in relation to their presence in the past week, on a severity scale from 1 (very little) to 9 (worst possible), and in relation to interference with daily life on a scale from 0 (no interference) to 9 (interfered completely).

Secondary outcomes were measured at baseline and exit. Cognition was assessed using the Cimprich Attentional Function Index for cognition assessment for patients with cancer, which is scored from "not at all" to "extremely well" (Cimprich, Visovatti, & Ronis, 2011). The instrument measures three constructs of cognition via subscales (i.e., effective action, attentional lapses, and interpersonal effectiveness), with internal consistency reliability of 0.95. Depression was assessed using the eight-question PROMIS Short-Form 8a, and physical function was assessed using the PROMIS Short-Form 6a, with an alpha coefficient of more than 0.85 as a proxy for frailty (Pilkonis et al., 2011). Self-efficacy was assessed using the Medication Adherence Self-Efficacy Scale (MASES-R) (Ogedegbe, Mancuso, Allegrante, & Charlson, 2003), and the Cronbach alpha was 0.92. For the Medication Adherence Rating Scale (MARS) (Thompson, Kulkarni, & Sergejew, 2000), the Cronbach alpha was 0.66 (acceptable for a five-item scale). For the Brief Medication Questionnaire (BMQ) (Horne, Weinman, & Hankins, 1999), the Cronbach alpha was 0.77. Social support was assessed using the Medication-Specific Social Support (MSSS) tool (Lehavot et al., 2011), and the Cronbach alpha was 0.79.

Procedure

Recruiters approached eligible patients face-to-face at the community cancer centers and via phone or letter from the specialty pharmacy. The recruiters presented the study and obtained consent to participate. Baseline interviews (week 1) were conducted and, once complete, random assignment to the control or intervention group using a minimization algorithm that balanced the groups on age and recruitment location occurred. Patients were informed of group assignment. Both groups used an AVR system to complete eight weekly assessments (weeks 2–9).

All patients were sent a medication and symptom management toolkit (at baseline for the intervention group and at exit for the control group). The toolkit is a bound notebook of evidence-based information that discusses what is needed to manage the OA medication safely, adherence to the regimen, and common side effects from cancer or its treatment. The toolkit has been used to promote symptom management in several studies and is well accepted by patients (Given, Given, & Sikorskii, 2007; Spoelstra et al., 2013a).

Each AVR assessed OA adherence and 19 symptoms (i.e., anxiety, lack of appetite, constipation, cough, diarrhea, disturbed sleep, fatigue, fever, headaches, joint or muscle pain, mouth sores, nausea, numbness and tingling, pain, redness, peeling, or pain in hands or

feet, shortness of breath, skin rashes or sores, swelling in hands or feet, and weakness) and use of the toolkit. AVRs were introduced by Anastasia and Blevins (1997) for symptom management and are commonly used. Intervention satisfaction surveys were conducted one week after completion of the texts (week 4 or 5). Exit interviews were conducted at the end of the study (week 10).

Intervention Protocol

Electronic Medical Office Logistics (EMOL) provided an automated platform that delivered just-in-time, two-way texts and stored data. Patient name, cell phone number, OA medication name, and delivery time for texts (regimen schedule) were entered in EMOL to send tailored, individualized texts.

Texts are 160 characters or less. Brief, theory-based texts were developed: a test text, six medication adherence texts used on a rotating basis, a text that asked patients if they wanted texts for an additional week, a text that confirmed continuation of the intervention for an additional week, a symptom management message, and an end-of-study text (see Figure 2). After randomization, those in the intervention group were sent the test text to ensure that researchers used the correct cell phone number and confirm the patient's ability to text. Adherence texts were delivered for 21 days at the time the OAs were to be taken. For the adherence texts, patients were asked to respond by text if they took the prescribed OAs. Symptom texts were delivered once weekly. After 21 days, patients were asked if they wanted to continue texts for another week. At completion, end-of-study texts were sent. To ensure texts were not provided when patients were not to take the OA, regimen schedules were confirmed with the recruiter and patient, and patients were asked to inform the university if dose modifications (i.e., reductions, interruptions, or stoppage) occurred. Patients were also asked to use a password on their cell phones to ensure privacy.

Statistical Methods

SAS®, version 9.4, was used for analysis. Basic descriptive statistics were computed for variables of interest, which included frequency distributions, measures of central tendency, skewness, and variability. Preliminary analysis was conducted to check the baseline equivalence of groups created by the randomization. Outcome measures at baseline and covariates were compared between groups using chi-square, Fisher's exact test, or t tests. To determine acceptability, feasibility, and satisfaction of texts among patients taking OAs, the proportion of patients who were offered to participate compared to those enrolled, attrition reasons, and characteristics of patients who dropped out of the study were described. The proportions of texts received and returned, as well as satisfaction, were described. General linear modeling was used to determine preliminary efficacy of texts on adherence, symptom severity, symptom interference, secondary outcomes (i.e., depression, physical function, and cognitive function), beliefs about medications,

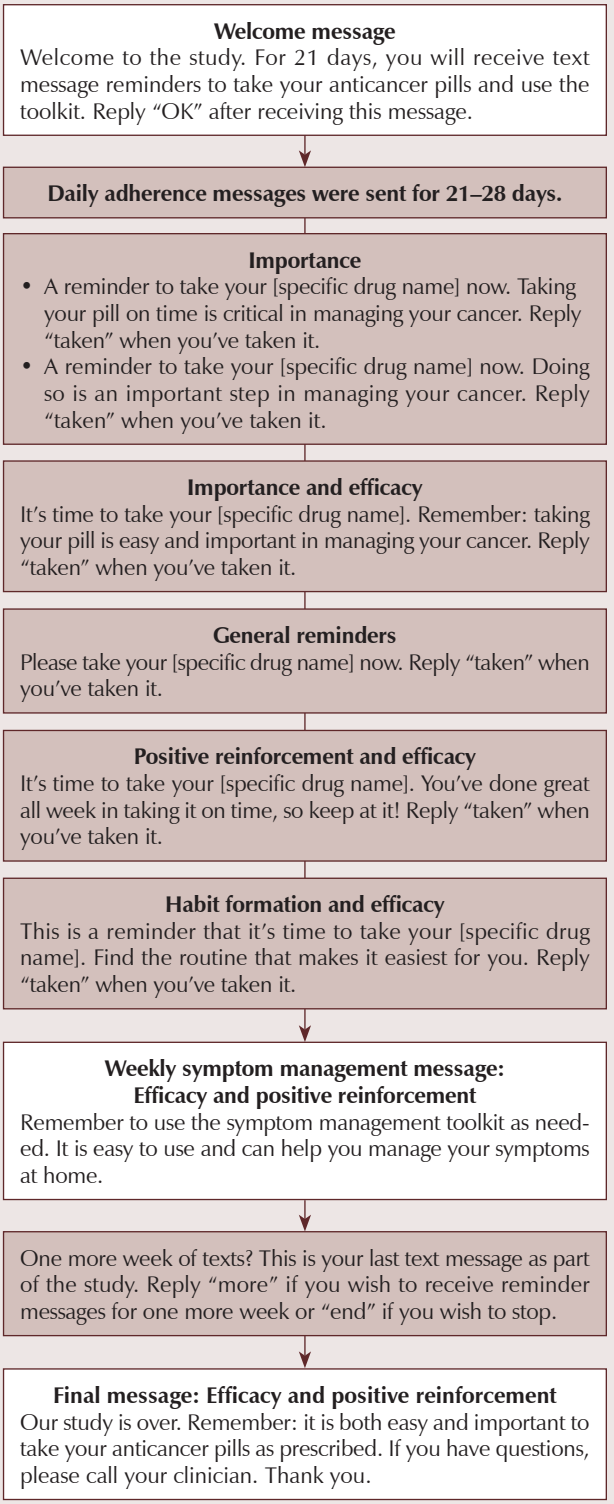


Figure 2. Scripted Text Messages With Theoretical Underpinnings

self-efficacy, and medication-specific social support. The covariates included study group and outcome value at baseline. Value at baseline was not applicable for self-report and RDI adherence measures; therefore, for those outcomes, general linear models included only one explanatory variable, the study group. Because of the exploratory nature of the study and statistical significance, effect sizes were estimated to gauge clinical significance and inform planning of a larger study. Effect sizes were computed as Cohen's d, and the difference between group means were expressed in standard deviation (SD) units. Adjusted effect sizes were computed from the linear models as differences between least square means divided by the adjusted SD (square root of the mean square error) (Cohen, 1992; Kelley & Preacher, 2012).

Findings

Of the 264 patients screened, 83 consented, and 80 completed baseline interviews. Following baseline interview and randomization, 12 patients withdrew, were lost to follow-up, or died (Schulz, Altman, & Moher, 2010).

Table 1 details the sample characteristics. No differences in sociodemographic, clinical, or psychological characteristics were found among groups at baseline, with the exception of more patients with breast cancer in the intervention group (n = 14) than in the control group (n = 5, p = 0.04). Participant mean age was 58.5 years (SD = 10.7, p = 0.96) for the entire group, mean age for the intervention group was 58.6 years (SD = 11.3), and mean age for the control group was 58.4 years (SD = 10.2). Most participants were female, and the majority were Caucasian. Most were educated with at least some college education. Comorbid conditions were found in most participants, with a mean of 1.51 (SD = 1.38). Cancer site varied greatly, with the most common being breast, prostate, lung, colon, and multiple myeloma. Participants used several types of OAs, including capecitabine (Xeloda®) (n = 18), erlotinib (Tarceva®) (n = 10), everolimus (Afinitor®) (n = 10), abiraterone acetate (Zytiga®) (n = 7), lenalidomide (Revlimid®) (n = 5), imatinib (Gleevec®) (n = 5), and letrozole (Femara®) (n = 5). OA regimen complexity was categorized into simple (e.g., once daily) or complex (e.g., requiring multiple medications, medication taken more than once per day, cycling on and off) regimens. Simple daily regimens were found in 47 participants, and 33 used complex regimens. The mean number of symptoms was 5.8 (SD = 3.6) for the 19 symptoms assessed. The summed symptom severity mean was 30.99 (SD = 23.74, range = 0–190), and the summed symptom interference mean was 23.91 (SD = 22.5, range = 0–190). The PROMIS depression mean was 46.93 (SD = 8.41), which was below the mean of the U.S. population of 50 (SD =

Table 1. Baseline Sample Characteristics

Characteristic	Total (N = 80) n	INT (n = 40) n	CON (n = 40) n	p
Gender				0.77
Male	32	17	15	
Female	48	23	25	
Race[a]				
Caucasian	67	31	36	0.54
African American	9	6	3	0.32
Missing data	4	3	1	0.56
Ethnicity				
Hispanic or Latino	6	5	1	0.56
Other	73	34	39	–
Missing data	1	1	–	–
Education[a]				
High school or less	22	12	10	0.67
Some college or bachelor's degree	43	22	21	0.88
Graduate degree	15	6	9	0.44
Employment				
Employed	19	9	10	0.89
Unemployed	61	31	30	–
Dosing complexity				0.88
Simple	47	23	24	
Complex	33	17	16	
Site of cancer[a]				
Breast	19	14	5	0.04
Prostate	9	4	5	0.74
Lung	8	3	5	0.48
Colon	7	1	6	0.06
Multiple myeloma	6	4	2	0.41
Renal	4	2	2	1
Leukemia	4	3	1	0.32
Esophagus	2	1	1	1
Liver	1	–	1	–
Brain	1	–	1	–
Kidney	1	1	–	–
Pancreatic	1	–	1	–
Rectal	1	1	–	–
Melanoma	1	–	1	–
Other	15	6	9	0.44
Stage of cancer[a]				
I	6	3	3	1
II	5	4	1	0.18
III	8	3	5	0.48
IV	33	17	16	0.86
Not staged	15	8	7	0.8
Unknown	13	5	8	0.41
Comorbidity[a]				
Hypertension	28	15	13	0.71
Arthritis	26	14	12	0.69
Depression	24	10	14	0.41
Diabetes	12	7	5	0.56
Heart disease	10	7	3	0.21
Anemia	8	5	3	0.48
Asthma	6	3	3	1
Emphysema or COPD	5	4	1	0.18
Kidney disease	2	2	–	–

[a] Because of small counts, comparisons of proportions for each category were carried out using Fisher's exact test.

CON—control group; COPD—chronic obstructive pulmonary disease; INT—intervention group

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

Question and Response	Total (N = 37)	Age (Years)			Gender	
		0–50 (n = 11)	51–64 (n = 14)	65+ (n = 12)	Male (n = 16)	Female (n = 21)
	n	n	n	n	n	n
How satisfied are you overall with your participation in the study?						
Not at all	–	–	–	–	–	–
Somewhat	2	–	1	1	1	1
Very much	21	5	9	7	8	13
Highly	14	6	4	4	7	7
Did you encounter any problems with the automated voice recording system?						
Yes	7	3	1	3	3	4
No	30	8	13	9	13	17
Did you encounter any problems with the text message system?						
Yes	1	–	1	–	1	–
No	35	11	13	11	15	20
Overall, for you personally, the text messaging was						
Both a burden and helpful.	1	1	–	–	–	15
Mostly a burden and helpful.	1	–	1	–	1	–
Mostly helpful.	34	10	13	11	15	19
Did the text messages help you take your oral cancer pills on time?						
Helped	28	10	12	6	12	16
Did not help	1	–	–	1	1	–
Neither	6	1	2	3	2	4
How satisfied were you with text reminders to take your medications?						
Not at all	1	–	1	–	–	1
Somewhat	4	1	2	1	1	3
Very much	16	3	7	6	7	9
Highly	14	7	4	3	7	7
Did you read the text messages about your anticancer pills?						
All of the time	30	9	12	9	13	17
Most of the time	4	2	2	–	2	2
Some of the time	1	–	–	1	–	1
None of the time	–	–	–	–	–	–
Would you recommend text messages as a reminder to take your anticancer pills?						
Yes	32	11	12	9	15	17
No	5	–	2	3	1	4
Would you recommend text messages as a way for clinicians to monitor if anticancer pills were taken?						
Yes	34	11	13	10	15	19
No	3	–	1	2	1	2
How likely is it that you would recommend the text messages for symptom management to your friend or family member?						
Not at all likely	2	1	–	1	1	1
Somewhat likely	5	1	2	2	2	3
Very likely	11	1	6	4	5	6
Highly likely	18	8	5	5	8	10
How likely is it that you would recommend the text messages for symptom management to your clinician?						
Not at all likely	5	2	2	1	3	2
Somewhat likely	4	1	–	3	1	3
Very likely	11	3	6	2	4	7
Highly likely	16	5	5	6	8	8

Note. Some participants did not respond to all questions, so N may not total 37.

10). PROMIS physical function mean was 44.51 (SD = 8.17), which was also below the mean of the U.S. population. The social support mean score was 4.18 (SD = 3.4).

To demonstrate proof-of-concept, acceptability, feasibility, and satisfaction with the intervention are reported. Regarding acceptability, 57% (83 of 145) of eligible patients consented. Mean age of participants who consented was 58.5 years (range = 39–82), the mean age of eligible participants who did not enroll was 57.24 years (range = 32–92), and the mean age of ineligible participants was 63.6 years (range = 26–82); no difference was found in age according to these categories. Females accounted for 47 of participants who consented, 24 of participants who were eligible but did not enroll, and 54 of participants who were ineligible, with a significant difference in enrollment by gender between consented versus eligible but not enrolled (p = 0.02). Of those who were ineligible, 43% (51 of 119) did not have a cell phone and 35% (42 of 119) did not text. Regarding those who were eligible but chose not to enroll, 31 of 62 were not interested, and 7 of 62 did not need a reminder.

A total of 1,359 texts were sent to patients in this study, which included 1,111 adherence texts (810 sent at the time the OAs were to be taken and 301 repeat texts when the patient did not respond that the OA was taken). One-hundred and sixteen texts were sent regarding symptom management. Fifty-two texts were sent on day 22 to ask patients if they wanted an additional week of the intervention. Ten texts were sent to confirm an additional week of texts. Fifty-three welcome texts and 17 end-of-study texts were also sent.

Of note, in the current sample of patients with cancer, many of whom were on their third or fourth line of treatment, 39 of 40 participants completed the entire text intervention, further confirming acceptability of this intervention. The patient who did not complete the text intervention was lost to follow-up.

Of the 37 patients in the intervention group who completed the text satisfaction survey following completion of the intervention, 30 said that they read the texts all of the time (see Table 2). Thirty-four reported satisfaction with receiving the texts and thought the texts were helpful, but one participant felt the texts were a burden. Of the 36 patients in this sample, 34 patients were likely to recommend texts for symptom management to family or friends, and 31 were likely to recommend texts to their oncologists. In addition, 28 reported that the texts helped them take their OAs on time, and 32 recommended texts as a way to help patients remember to take OAs.

Of the 19 commonly experienced symptoms from side effects assessed, the intervention group had a total number of 3.86 symptoms (standard error [SE] = 0.05), and the control group had 5.26 (SE = 0.46); a significant postintervention difference was found with a moderate effect size of 0.5. The summed symptom severity and interference did not significantly differ by study arm, and the effect sizes were small. Table 3 displays data on the use of the toolkit and symptom severity. Those who used the toolkit had higher symptom severity than those who did not use the toolkit. Of the patients who did not report using the toolkit, the majority said that the reason was that symptoms were not bothersome; less than half of the participants felt there was nothing they could do about their symptoms, and more than two-thirds stated that it was not because they did not find the toolkit helpful.

Of the nine weeks when adherence was examined in the study, the overall mean number of weeks of adherence to OAs in the intervention group was 5.95 (SE = 0.45) compared to 5.95 (SE = 0.46) in the control group (see Table 4). Table 5 provides a detailed weekly

Table 3. Toolkit Use and Symptom Severity During Weeks 2–8 (N = 39)

		SSS (Same Week)				SSS (Previous Week)			
Toolkit Use	**n**	**$\bar{X}$**	**SD**	**p**	**ES**	**$\bar{X}$**	**SD**	**p**	**ES**
Week 2				0.24	**0.43**			0.1	**0.69**
No	21	18.55	15.24			25.95	13.24		
Yes	15	25.38	16.85			36.5	19.96		
Week 3				0.15	**0.6**			**0.04**	**0.83**
No	16	20.5	28.04			12.71	9.93		
Yes	17	34.15	16.56			24.15	16.96		
Week 4				0.47	0.32			0.01	1.19
No	17	20.73	17.66			15.56	14.5		
Yes	13	26.55	19.24			34.77	17.13		
Week 5				0.16	0.6			0.38	0.36
No	20	25.07	18.05			22.38	17.89		
Yes	12	35.8	17.27			28.83	18.23		
Week 6				0.08	0.79			0.25	0.51
No	16	18	17.18			22.62	19.02		
Yes	12	32.5	19.72			31.56	15.08		
Week 7				0.25	0.55			0.05	0.83
No	20	18	13.67			14.38	14.15		
Yes	14	28	20.64			28.67	20.01		
Week 8				0.36	0.41			0.4	0.4
No	15	17.78	19.94			17.75	13.98		
Yes	13	25.83	19.42			25.36	21.63		

ES—effect size; SSS—summed symptom severity

Note. Some participants did not respond to using the toolkit, so N may not total 39.

Note. Bolded values indicate p values less than 0.05 and moderate ES greater than 0.33.

Table 4. Postintervention Least Square Means of Outcomes and Their Standard Errors Adjusted for Baseline Values[a]

Outcome	Intervention (n = 31) LS $\bar{X}$	Intervention (n = 31) SE	Control (n = 37) LS $\bar{X}$	Control (n = 37) SE	p	ES
Number of weeks adherent	5.95	0.45	5.95	0.46	0.99	0
RDI	1.06	0.14	0.74	0.15	0.13	0.62[b]
Total number of symptoms	3.86	0.5	5.26	0.46	0.04	0.5[b]
Summed symptom severity	22.67	3	24.42	2.56	0.66	0.12[c]
Summed symptom interference	17.14	2.34	18.8	2	0.59	0.14[c]
PROMIS						
• Depression	44.69	1.27	44.9	1.16	0.9	0.03
• Physical function	47.56	1.21	44.87	1.09	0.11	0.4[d]
Cognitive function						
• Effective action	49.81	1.86	51.46	1.65	0.51	0.16[c]
• Attentional lapses	23.63	1.04	24.04	0.94	0.77	0.07
• Interpersonal effectiveness	22.6	0.8	23.54	0.72	0.39	0.21[c]
BMQ	26.31	0.82	26.62	0.74	0.78	0.07
MASES-R	30.67	0.3	31.18	0.27	0.22	0.31[d]
MARS	0.65	0.21	0.57	0.19	0.78	0.07
Medication-Specific Social Support	3.48	0.42	3.03	0.38	0.44	0.2[c]

[a] Except for MARS, self-reported adherence, and RDI

[b] Large effect; [c] small effect; [d] medium effect

BMQ—Brief Medication Questionnaire; ES—effect size; LS—least square; MARS—Medication Adherence Rating Scale; MASES-R—Medication Adherence Self-Efficacy Scale; PROMIS—Patient Reported Outcomes Measurement Information System; RDI—relative dose intensity; SE—standard error

summary of self-reported OA adherence in the intervention and control groups for weeks 2–9 and the exit interview. The counts in missing or dose interruptions category correspond to times when patients were not taking OAs because of regimen interruption; therefore, a question about adherence on the entire sample was not applicable. These counts were comparable between the two groups. Weeks 2, 3, 4, 8, and 10 had slightly higher percentages of OA adherence in the intervention group (73% to 63%, 78% to 68%, 65% to 63%, 65% to 50%, and 81% to 76%, respectively); week 4 was similar among groups (60%); and weeks 5, 6, and 8 were slightly higher adherence in the control group (55% to 60%, 55% to 60%, and 50% to 55%, respectively). OA dosage interruptions or missing data ranged from 20%–42% during the 10 weeks in this study. For the subset of patients with the available medical record or prescription data (n = 26), the RDI was greater in the intervention group compared to the control group, with a moderate to large effect size of 0.62. This difference was not statistically significant with the available sample size.

Physical function was better in the intervention group (control: 47.6 [SE = 1.2]; intervention: 44.9 [SE = 1.1]), with a moderate effect size of 0.4. There were no group differences on depression or on the three subscales on cognitive function (i.e., 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 intervention group compared to the control: the BMQ (intervention: 26.3 [SE = 0.9], control: 26.6 [SE = 0.7]; SE = –0.07), the MASES-R (intervention: 30.67 [SE = 0.3], control: 31.2 [SE = 0.3]; SE = –0.31), and the MARS (intervention: 0.65 [SE = 0.2], control: 0.57 [SE = 0.2]; SE = 0.07), which was only done at exit. No group differences were found in social support.

Discussion

This study demonstrated proof of concept and preliminary efficacy of texts to promote self-management of symptoms and adherence for patients prescribed OAs. Among the eligible patients, age was not related to willingness to text, but women were more likely to text. Patients were multimorbid, with many symptoms that interfered with activities of daily life. In this sample of patients with cancer, texts demonstrated feasibility as an intervention, with most patients reading the text. High patient satisfaction was found for symptom management and medication adherence, demonstrating that patients thought texts were positive and effective at improving adherence and managing side effects. Preliminary efficacy of texts as an intervention to produce a reduction in the number of symptoms, higher adherence as measured by RDI, and improvement in physical function were found. The self-reported medication adherence measure did not show higher or sustained adherence rates. Self-report is the most widely used method of assessment medication adherence; however, several shortcomings exist. Self-report has the problem of overestimating adherence, and inaccuracies can also be caused by recall bias, social desirability bias, and errors in self-observation (George, Kong, & Stewart, 2007; Hawkshead & Krousel-Wood, 2007). In addition, the time frame of adherence recollection can affect the accuracy of the recall during self-report (Paterson, Potoski, & Capitano, 2002). 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 (Hawkshead & Krousel-Wood, 2007). When assessing RDI, the authors experienced difficulty obtaining

medical record reviews, and the specialty pharmacy was unable to determine if the oncologist had increased, decreased, or stopped OA dosages unless dose alteration required a new prescription. Therefore, measuring medication adherence remains a challenge for clinicians and scientists. Although the authors did not find differences in measures of self-efficacy in this small sample, the scripted texts based on self-efficacy theory were thought to be encouraging and motivating to patients and began to show promise at engaging behavior change.

Limitations

The majority of these patients were recruited shortly after they were informed of a new cancer diagnosis or after other treatment failure. In either situation, patients may have experienced high levels of stress, which may have led to difficulty completing data collection during weekly assessments; 482 of 632 AVR assessments were completed. Challenges in the measurement of medication adherence 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 because clinicians often forget to document dose modifications. Therefore, limited objective adherence measure existed for the sample in this study.

Table 5. Weekly Self-Reported Oral Anticancer Agent Adherence

Variable	Intervention (n = 40) n	Control (n = 40) n
Week 2		
Adherent	29	25
Nonadherent	2	3
Dose interruption	9	12
Week 3		
Adherent	31	27
Nonadherent	1	2
Dose interruption	8	11
Week 4		
Adherent	26	25
Nonadherent	2	3
Dose interruption	12	12
Week 5		
Adherent	24	24
Nonadherent	1	1
Dose interruption	15	15
Week 6		
Adherent	22	24
Nonadherent	1	3
Dose interruption	17	13
Week 7		
Adherent	22	24
Nonadherent	2	4
Dose interruption	16	12
Week 8		
Adherent	26	20
Nonadherent	2	1
Dose interruption	12	19
Week 9		
Adherent	20	22
Nonadherent	2	2
Dose interruption	18	16
Exit interview		
Adherent	26	29
Nonadherent	5	3
Dose interruption	1	6
Missing data	8	2

Implications for Research and Practice

Future research needs to be conducted on the efficacy of texts in patients with cancer to determine effectiveness of use for self-management. Use of a more precise measure of medication adherence may provide a better understanding of benefits in this mode of intervention delivery. In addition, an effective text dose intervention with frequency and timing must be determined (e.g., whether a text needs to be sent each time the medication is to be taken, once a day, once a week, or once a month). Future work should also focus on scripting the texts to motivate and encourage patients. Two-way texts need to be examined as a measure of adherence, so that clinicians can be notified and take action at the point in time when a patient becomes nonadherent.

Many medication adherence interventions are complex and have not improved adherence. Numerous symptom management interventions for patients with cancer exist; however, best modes of delivery remain open to question as the technology evolves. mHealth interventions are beginning to show promise at changing behavior. Texts are known to improve medication adherence and disease management in asthma (Petrie, Perry, Broadbent, & Weinman, 2012), HIV (Hardy et al., 2011; Horvath, Azman, Kennedy, & Rutherford, 2012; Lewis et al., 2013), and coronary heart disease (Park et al., 2014). For patients with cancer, texts could be individualized and tailored to the medication regimen, making this intervention usable for simple or complex dosing. Likewise, texts could be targeted to symptoms experienced. Delivery of this mHealth intervention on cell phones makes this intervention readily accessible, and texts present an easy-to-use and potentially effective communication modality with patients with cancer.

Conclusion

Text interventions are feasible in patients with cancer prescribed OAs for symptom management and

Knowledge Translation

Patients with cancer prescribed oral anticancer agents (OAs) need to manage medication adherence in the home setting.

Mobile health interventions show promise.

Text messages may assist with managing OA medication adherence and symptoms.

medication adherence and may be effective in helping patients engage in behavior change and improve self-care. Use of cell phones is increasing dramatically, and texts may be an easy mode of delivering health care to large numbers of patients.

The authors gratefully acknowledge the individuals who participated in the study and the clinicians at the specialty pharmacy and cancer centers for their assistance in the research during participant recruitment and their support of the study.

Sandra L. Spoelstra, PhD, RN, is an associate dean for research and scholarship in the College of Nursing at Grand Valley State University in Allendale, MI; and Charles W. Given, PhD, is a professor in the Department of Family Medicine; Alla Sikorskii, PhD, is an associate professor in the Department of Statistics and Probability; Constantinos K. Coursaris, PhD, is an associate chairperson in the Department of Media and Information; Atreyee Majumder, BS, is a research assistant in the Department of Statistics and Probability; and Tracy DeKoekkoek, RN, is a graduate assistant, Monica Schueller, BA, is a project manager, and Barbara A. Given, PhD, RN, FAAN, is a professor, all in the College of Nursing, all at Michigan State University in East Lansing. The study was funded by a grant from the McKesson Foundation, Inc., Mobilizing for Health Grant Program, in San Francisco, CA. Mention of specific products and opinions related to those products do not indicate or imply endorsement by the *Oncology Nursing Forum* or the Oncology Nursing Society. Spoelstra can be reached at spoelsts@gvsu.edu, with copy to editor at ONFEditor@ons.org. (Submitted March 2015. Accepted for publication May 7, 2015.)

References

Amgen, Inc. (2008). *Increasing awareness of relative dose intensity in an evidence-based practice.* http://www.onsedge.com/pdf/amgenEBP.pdf

Anastasia, P.J., & Blevins, M.C. (1997). Outpatient chemotherapy: Telephone triage for symptom management. *Oncology Nursing Forum, 24,* 13–22.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191–215.

Bassan, F., Peter, F., Houbre, B., Brennstuhl, M.J., Costantini, M., Speyer, E., & Tarquinio, C. (2014). Adherence to oral antineoplastic agents by cancer patients: Definition and literature review. *European Journal of Cancer Care, 23,* 22–35. doi:10.1111/ecc.12124

Bestvina, C.M., Zullig, L.L., Rushing, C., Chino, F., Samsa, G.P., Altomare, I., . . . Zafar, S.Y. (2014). Patient-oncologist cost communication, financial distress, and medication adherence. *Journal of Oncology Practice, 10,* 162–167. doi:10.1200/jop.2014.001406

Burke, L.E., Styn, M.A., Sereika, S.M., Conroy, M.B., Ye, L., Glanz, K., . . . Ewing, L.J. (2012). Using mHealth technology to enhance self-monitoring for weight loss: A randomized trial. *American Journal of Preventative Medicine, 43,* 20–26. doi:10.1016/j.amepre.2012.03.016

Cimprich, B., Visovatti, M., & Ronis, D.L. (2011). The Attentional Function Index—A self-report cognitive measure. *Psycho-Oncology, 20,* 194–202. doi:10.1002/pon.1729

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112,* 155–159.

da Costa, T.M., Barbosa, B.J., Gomes e Costa, D.A., Sigulem, D., de Fátima Marin, H., Filho, A.C., & Pisa, I.T. (2012). Results of a randomized controlled trial to assess the effects of a mobile SMS-based intervention on treatment adherence in HIV/AIDS-infected Brazilian women and impressions and satisfaction with respect to incoming messages. *International Journal of Medical Informatics, 81,* 257–269. doi:10.1016/j.ijmedinf.2011.10.002

Déglise, C., Suggs, L.S., & Odermatt, P. (2012). Short message service (SMS) applications for disease prevention in developing countries. *Journal of Medical Internet Research, 14,* E3. doi:10.2196/jmir.1823

DiClemente, C.C., & Velasquea, M.M. (2003). Motivational interviewing and the stages of change. In W.R. Miller & S. Rollnick (Eds.), *Motivational interviewing: Preparing people for change* (pp. 201–216). New York, NY: Guilford Press.

Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., . . . Haines, A. (2013). The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: A systematic review. *PLoS Medicine, 10,* e.1001362. doi:10.1371/journal.pmed.1001362

George, J., Kong, D.C., & Stewart, K. (2007). Adherence to disease management programs in patients with COPD. *International Journal of Chronic Obstructrive Pulmonary Disease, 2,* 253–262.

Given, B., Given, C., & Sikorskii, A. (2007). Deconstruction of a nursing intervention to examine the mechanism of action. *Oncology Nursing Forum, 34,* 199.

Hardy, H., Kumar, V., Doros, G., Farmer, E., Drainoni, M.L., Rybin, D., . . . Skolnik, P.R. (2011). Randomized controlled trial of a personalized cellular phone reminder system to enhance adherence to antiretroviral therapy. *AIDS Patient Care and STDs, 25,* 153–161. doi:10.1089/apc.2010.0006.

Hawkshead, J.J., & Krousel-Wood, M.A. (2007). Techniques for measuring medication adherence in hypertensive patients in outpatient settings. *Disease Management and Health Outcomes, 15,* 109–118. doi:10.2165/00115677-200715020-00006

Horne, R., Weinman, J., & Hankins, M. (1999). The beliefs about medicines questionnaire: The development and evaluation of a new method for assessing the cognitive representation of medication. *Psychology and Health, 14,* 1–24. doi:10.1080/08870449908407311

Horvath, T., Azman, H., Kennedy, G.E., & Rutherford, G.W. (2012). Mobile phone text messaging for promoting adherence to antiretroviral therapy in patients with HIV infection. *Cochrane Database of Systematic Reviews, 3,* CD009756. doi:10.1002/14651858.CD009756

Kelley, K., & Preacher, K.J. (2012). On effect size. *Psychological Methods, 17,* 137–152.

Lehavot, K., Huh, D., Walters, K.L., King, K.M., Andrasik, M.P., & Simoni, J.M. (2011). Buffering effects of general and medication-specific social support on the association between substance use and HIV medication adherence. *AIDS Patient Care and STDs, 25,* 181–189. doi:10.1089/apc.2010.0314

Lewis, M.A., Uhrig, J.D., Bann, C.M., Harris, J.L., Furberg, R.D., Coomes, C., & Kuhns L.M. (2013). Tailored text messaging intervention for HIV adherence: A proof-of-concept study. *Health Psychology, 32,* 248–253. doi:10.1037/a0028109

Loibl, S., Skacel, T., Nekljudova, V., Lück, H.J., Schwenkglenks, M., Brodowicz, T., . . . von Minckwitz, G. (2011). Evaluating the impact of Relative Total Dose Intensity (RTDI) on patients' short and long-term outcome in taxane- and anthracycline-based

chemotherapy of metastatic breast cancer: A pooled analysis. *BMC Cancer, 11,* 131. doi:10.1186/1471-2407-11-131

Ogedegbe, G., Mancuso, C.A., Allegrante, J.P., & Charlson, M.E. (2003). Development and evaluation of a medication adherence self-efficacy scale in hypertensive African-American patients. *Journal of Clinical Epidemiology, 56,* 520–529. doi:10.1016/S0895-4356(03)00053-2

Ogle, K.S., Swanson, G.M., Woods, N., & Azzouz, F. (2000). Cancer and comorbidity: Redefining chronic diseases. *Cancer, 88,* 653–663. doi:10.1002/(SICI)1097-0142(20000201)88:3<653::AID-CNCR24>3.0.CO;2-1

Park, L.G., Howie-Esquivel, J., Chung, M.L., & Dracup, K. (2014). A text messaging intervention to promote medication adherence for patients with coronary heart disease: A randomized controlled trial. *Patient Education and Counseling, 94,* 261–268.

Paterson, D.L., Potoski, B., & Capitano, B. (2002). Measurement of adherence to antiretroviral medications. *Journal of Acquired Immune Deficency Syndromes, 31*(Suppl. 3), S103–S106.

Petrie, K.J., Perry, K., Broadbent, E., & Weinman, J. (2012). A text message programme designed to modify patients' illness and treatment beliefs improves self-reported adherence to asthma preventer medication. *British Journal of Health Psychology, 17,* 74–84. doi:10.1111/j.2044-8287.2011.02033.x

Pilkonis, P.A., Choi, S.W., Reise, S.P., Stover, A.M., Riley, W.T., & Cella, D. (2011). Item banks for measuring emotional distress from the Patient-Reported Outcomes Measurement Information System (PROMIS®): Depression, anxiety, and anger. *Assessment, 18,* 263–283. doi:10.1177/1073191111411667

Pop-Eleches, C., Thirumurthy, H., Habyarimana, J.P., Zivin, J.G., Goldstein, M.P., de Walque, D., . . . Bangsberg, D.R. (2011). Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: A randomized controlled trial of text message reminders. *AIDS, 25,* 825–834. doi:10.1097/QAD.0b013e32834380c1

PROMIS. (2008). PROMIS: Dynamic tools to measure health outcomes from the patient perspective. Retrieved from http://www.nihpromis.org

Puts, M.T., Tu, H.A., Tourangeau, A., Howell, D., Fitch, M., Springall, E., & Alibhai, S.M. (2013). Factors influencing adherence to cancer treatment in older adults with cancer: A systematic review. *Annals of Oncology, 25,* 564–577. doi:10.1093/annonc/mdt433

Raza, S., Welch, S., & Younus, J. (2009). Relative dose intensity delivered to patients with early breast cancer: Canadian experience. *Current Oncology, 16,* 8–12.

Schlenk, E.A., Dunbar-Jacob, J., & Engberg, S. (2004). Medication non-adherence among older adults: A review of strategies and interventions for improvement. *Journal of Gerontological Nursing, 30,* 33–43. doi:10.3928/0098-9134-20040701-08

Schulz, K.F., Altman, D.G., & Moher, D. (2010). CONSORT 2010 Statement: Updated guidelines for reporting parallel group randomized trials. *Annals of Internal Medicine, 152,* 726–732. doi:10.7326/0003-4819-152-11-201006010-00232

Smith, A. (2013). *Smartphone ownership—2013 update.* Retrieved from http://pewrsr.ch/1LJywt8

Soria, J.C., Blay, J., Spano, J.P., Pivot, X., Coscas, Y., & Khayat, D. (2011). Added value of molecular targeted agents in oncology. *Annals of Oncology, 22,* 1703–1716. doi:10.1093/annonc/mdq675

Spoelstra, S.L., Given, B.A., Given, C.W., Grant, M., Sikorskii, A., You, M., & Decker, V. (2013a). An intervention to improve adherence and management of symptoms for patients prescribed oral chemotherapy agents: An exploratory study. *Cancer Nursing, 36,* 18–28. doi:10.1097/NCC.0b013e3182551587

Spoelstra, S.L., Given, B.A., Given, C.W., Grant, M., Sikorskii, A., You, M., & Decker, V. (2013b). Issues related to overadherence to oral chemotherapy or targeted agents. *Clinical Journal of Oncology Nursing, 17,* 604–609. doi:10.1188/13.CJON.17-06AP

Spring, B., Schneider, K., McFadden, H.G., Vaughn, J., Kozak, A.T., Smith, M., Moller, A.C., . . . Lloyd-Jones, D.M. (2012). Multiple behavior changes in diet and activity: A randomized controlled trial using mobile technology. *Archives of Internal Medicine, 172,* 789–796. doi:10.1001/archinternmed.2012.1044.

Streeter, S.B., Schwartzberg, L., Husain, N., & Johnsrud, M. (2011). Patient and plan characteristics affecting abandonment of oral oncolytic prescriptions. *Journal of Oncology Practice, 7*(Suppl.), 46s–51s. doi:10.1200/JOP.2011.000316

Thompson, K., Kulkarni, J., & Sergejew, A.A. (2000). Reliability and validity of a new Medication Adherence Rating Scale (MARS) for the psychoses. *Schizophrenia Research, 42,* 241–247. doi:10.1016/S0920-9964(99)00130-9

Weingart, S.N., Brown, E., Bach, P.B., Eng, K., Johnson, S.A., Kuzel, T.M., . . . Walters. R.S. (2008). NCCN Task force report: Oral chemotherapy. *Journal of the National Comprehensive Cancer Network, 6*(Suppl. 3), S1–S14.

Zolfaghari, M., Mousavifar, S.A., Pedram, S., & Haghani, H. (2012). The impact of nurse short message services and telephone follow-ups on diabetic adherence: Which one is more effective? *Journal of Clinical Nursing, 21,* 1922–1931. doi:10.1111/j.1365-2702.2011.03951.x