Pilot Testing a Web-Based System for the Assessment and Management of Chemotherapy-Induced Peripheral Neuropathy

By: Robert Knoerl, William N. Dudley, Gloria Smith, Celia Bridges, Grace Kanzawa-Lee, and Ellen M. Lavoie Smith.

Knoerl, Robert, Dudley, William N., Smith, Gloria, Bridges, Celia, Kanzawa-Lee, Grace, Smith, Ellen M. Lavoie. (2016). Pilot Test a Web-Based System for the Assessment and Management of Chemotherapy-Induced Peripheral Neuropathy. *CIN: Computers, Informatics, Nursing.*

Made available courtesy of Wolters Kluwer Health, Inc.:
http://dx.doi.org/10.1097/CIN.0000000000000320

Abstract:

Because numerous barriers hinder the assessment and management of chemotherapy-induced peripheral neuropathy in clinical practice, the Carevive Care Planning System, a novel Web-based platform, was developed to address these barriers. It provides patients an opportunity to report their symptoms before their clinic visit and generates customizable care plans composed of evidence-based management strategies. The purpose of this study was to evaluate patient and provider perspectives of feasibility, usability, acceptability, and satisfaction with the Carevive platform. We used a single-arm, pretest/posttest, prospective design and recruited 25 women with breast cancer who were receiving neurotoxic chemotherapy and six advanced practice providers from an academic hospital. At three consecutive clinical visits, patients reported their neuropathy symptoms on a tablet via the Carevive system. The Diffusion of Innovations Theory served as an overarching evaluation framework. The Carevive platform was feasible to use. However, patients had higher ratings of usability, acceptability, and satisfaction with the platform than did the providers, who disliked the amount of time required to use the platform and had difficulty logging into Carevive. If issues regarding provider dissatisfaction can be addressed, the Carevive platform may aid in the screening of neuropathy symptoms and facilitate the use of evidence-based management strategies.

Keywords: Cancer symptom management | Chemotherapy-induced peripheral neuropathy | Peripheral nervous system disease/chemically induced | Technology assessment

Article:

In n the United States, many of the approximately 14.5 million survivors of oncological and hematologic malignancies have been treated with surgery, radiation, or chemotherapy.[1] Treatment-related symptoms are common and include pain, fatigue, neuropathy, dyspnea,

nausea, and vomiting, among others.[2,3] Unmanaged symptom distress can lead to increased hospitalizations, healthcare costs, and mortality; however, many cancer treatment–related symptoms are underreported by patients and underrecognized by providers.[3–6] To improve reporting, assessment, and management of cancer treatment–related adverse effects, Carevive Systems (North Miami, FL) developed a care planning software program. This pilot study evaluated the feasibility (if it was used), usability (how easily a user could interact with the user interface), acceptability (how pleasant it was to use), and satisfaction (how much the user enjoyed it) with the Carevive care planning program, with a focus on chemotherapyinduced peripheral neuropathy (CIPN).[7–9]

A common adverse effect of cancer treatment that occurs in up to 64% of individuals receiving neurotoxic chemotherapy (eg, platinum and taxanes),[10–13] CIPN is characterized by burning, numbness, tingling, and/or shooting sensations in the extremities that can persist transiently or permanently following the completion of chemotherapy.[14,15] The symptoms of CIPN may negatively influence physical functioning and quality of life; CIPN also may be a dose-limiting toxicity necessitating the decrease or cessation of chemotherapy.[13,16]

PATIENT AND PROVIDER BARRIERS TO CIPN ASSESSMENT AND MANAGEMENT

Early detection of CIPN through routine provider assessment may allow for prompt treatment or chemotherapy dose modification to improve physical function and quality of life. However, several barriers to optimal CIPN assessment threaten providers' ability to provide evidence-based care to patients at risk of CIPN-associated complications. More specifically, patients struggle with how to describe the symptoms they are experiencing (eg, numbness, tingling, pain), and providers lack the time, knowledge, and confidence to conduct comprehensive neuropathy assessments.11,[17–20]

The first barrier related to management of CIPN is a lack of effective evidence-based treatments. The American Society of Clinical Oncology identified only one effective treatment in its systematic review of 48 randomized controlled trials testing 22 different pharmacological interventions for CIPN.[11] Second, providers are unable to stay current on the rapidly mounting empirical literature about comprehensive management approaches for physical and psychological symptoms of cancer treatment.[11,21] Also, evidence-based CIPN management guidelines are not quickly translated into clinical practice.[11,16,22,23] Lastly, engaging patients in effective CIPN self-management requires more than disseminating patient resources.[2,24,25] Interventions are needed that will help patients to talk with their care providers and to actively engage in self-management strategies.

The barriers to CIPN assessment and management may be addressed through the use of technology-based interventions that engage patients in their own care and integrate provider- and patient-reported clinical data with evidence-based CIPN management strategies to create comprehensive and tailored treatment plans. Web-based care planning programs that increase communication about symptoms between patients and their providers are emerging as promising catalysts to promote the reporting of cancer treatment– related symptoms.[2,26–29] The Carevive Care Planning System (CPS) is a novel Web-based platform designed to help patients and

providers collaborate to report and manage CIPN symptoms within the clinical visit workflow. The Carevive CPS is used to collect both patient- and provider reported data to create care plans consisting of personalized recommendations based on clinical practice guidelines. This platform addresses patient and provider barriers to CIPN assessment and promotes patient self-management by (1) providing neuropathy self-report measures that allow patients to report their CIPN-related symptoms before their provider visit, (2) supplying providers with information about their patient's key CIPN symptoms, and (3) generating individualized evidence-based CIPN management recommendations to patients and their providers. When used at the start of neurotoxic chemotherapy treatments and prior to each chemotherapy treatment, the Carevive CPS may facilitate better symptom management and improve quality of life by helping patients and providers identify, track, and manage symptoms of CIPN early in the course of treatment.

However, many factors may impede successful integration of a novel technology into clinical practice. An appropriate theoretical framework may help explain these factors and their effects.[30] The Diffusion of Innovations Theory[30] identifies four factors that contribute to the adoption of a new technology in clinical practice: (1) the innovation (eg, relative advantage, complexity, and observability), (2) communication channels, (3) time, and (4) the social system. The object or practice that is perceived as new to the individual is the innovation, which is evaluated in comparison to the previous method (relative advantage), in how complex it is to use (complexity), and how visible the results of the technology are to others (observability). Communication channels refer to the transmission of messages and attitudes regarding the innovation throughout the healthcare team. The time factor pertains to the period during which an individual thinks about whether to adopt the innovation into practice. Lastly, the social system refers to how the innovation meshes with the norms of the healthcare setting.[30] Thus, successful implementation of the Carevive CPS would be predicated on it being viewed by patients and providers as (1) superior to previous methods used at the clinic as a method of assessing CIPN symptoms (relative advantage), (2) easy to use (complexity), (3) increasing communication between patients and providers about CIPN symptoms (communication channel), and (4) aligning with the norms of the healthcare setting (social system).

The purpose of this study was to pilot test the Carevive system as a tool that may foster better CIPN assessment and management. The study aim was to examine patient and provider perspectives of feasibility, usability, acceptability, and satisfaction with the Carevive CPS. If the Carevive CPS demonstrated high patient and provider feasibility, usability, acceptability, and satisfaction, it could be further tested as an intervention to improve patient engagement in CIPN symptom assessment and management and provider adherence to evidence-based practice recommendations in an effort to improve patients' overall quality of life.

METHODS

Design, Sample, and Setting

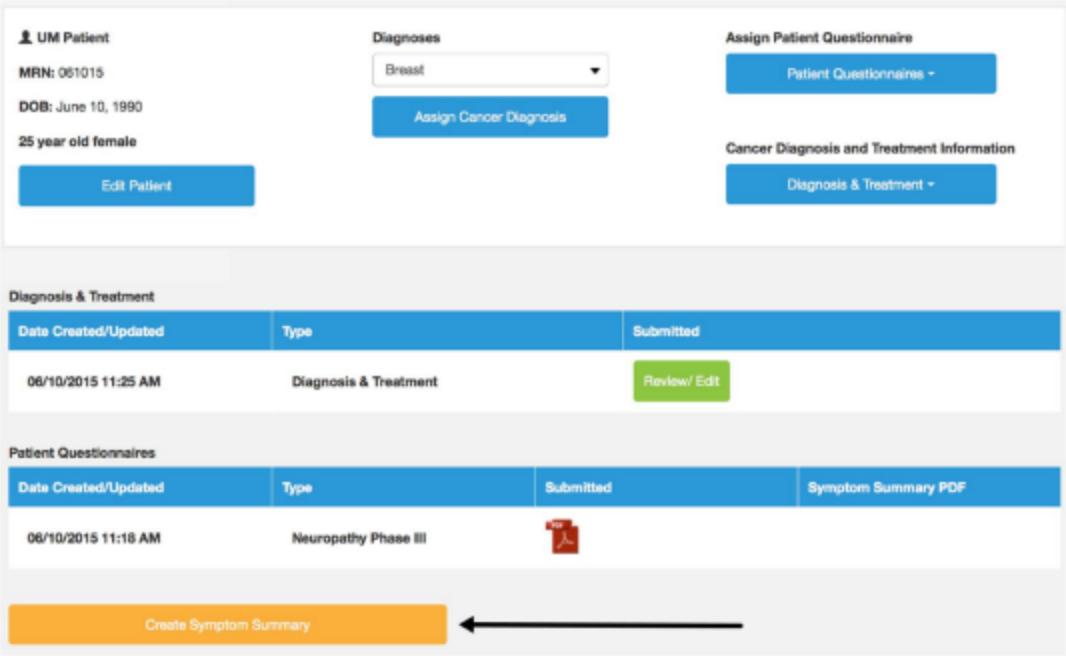
The study aims were addressed via a single-arm, pretest/ posttest, prospective design. Convenience sampling was used to recruit 25 individuals with breast cancer and six providers. To be eligible for the study, patients had to be (1) 18 years or older, (2) able to speak and read English, (3) able to use a computer, (4) receiving neurotoxic chemotherapy (eg, paclitaxel,

docetaxel, cisplatin, carboplatin), and (5) have a diagnosis of breast cancer (any stage). Patients under hospice care and patients with an expected survival of less than 1 month were excluded. Nurse practitioners or physician assistants who provided oncology care for at least one of the patients enrolled in the study were eligible. The study was approved by the study site's institutional review board and was conducted at a comprehensive cancer center outpatient breast cancer clinic from November 21, 2014, to June 4, 2015. All enrolled patients and providers provided signed informed consent.

Carevive Technology

The Web-based Carevive CPS platform is designed to collect patient- and provider-reported data (eg, medical history, cancer treatment history, symptoms) at each clinical visit (see Figure 1 for examples of Carevive interface). Patients report their CIPN symptoms (eg, numbness, tingling, and associated neuropathic pain in hands or feet) via electronic versions of several common neuropathy measures, including the National Cancer Institute's Patient-Reported Outcome Common Terminology Criteria for Adverse Events (PROCTCAE),[31] the European Organisation for Research and Treatment of Cancer's Quality of Life Questionnaire– Chemotherapy-Induced Peripheral Neuropathy Scale (QLQCIPN20),[32] and two CIPN symptom screening questions. The PRO-CTCAE asks patients about the severity of their sensory neuropathy symptoms and how much their CIPN symptoms interfere with their daily activities. The 20 questions of the QLQ-CIPN20 ask participants to rate their symptoms and functional limitations related to CIPN in sensory, motor, and autonomic function domains. Lastly, the CIPN symptom screening questions prompt patients to report the level (0–10) of numbness/tingling they were experiencing in their hands and feet and how much it interfered with their activities The Carevive proprietary rules engine configures the CIPN self-assessment questionnaires, the patient's treatment regimen, and current clinical practice guidelines into automated, customized, and trackable care plans composed of personalized recommendations. These care plans are then reviewed by the patient's provider, who may edit them to further tailor treatment recommendations and referrals. Providers can either accept or reject the recommendations for each symptom and the tasks associated with each recommendation (Figure 2). For example, a Carevive-generated recommendation for mild peripheral neuropathy is for individuals to discuss their CIPN symptoms with their healthcare team; the associated task for the patient is to view a Web site about the signs and symptoms of CIPN. After provider approval, the care plans are delivered electronically; the embedded links (tasks) direct patients to Web sites about self-management strategies and disease and treatment information from national organizations, such as the American Cancer Society (Figures 1 and 2). The CIPN management recommendations generated from this software were selected by an interdisciplinary team of oncology clinicians and scientists based on published literature and evidence-based guidelines.

Provider View of Carevive Care Planning System



Example of Patient Care Plan

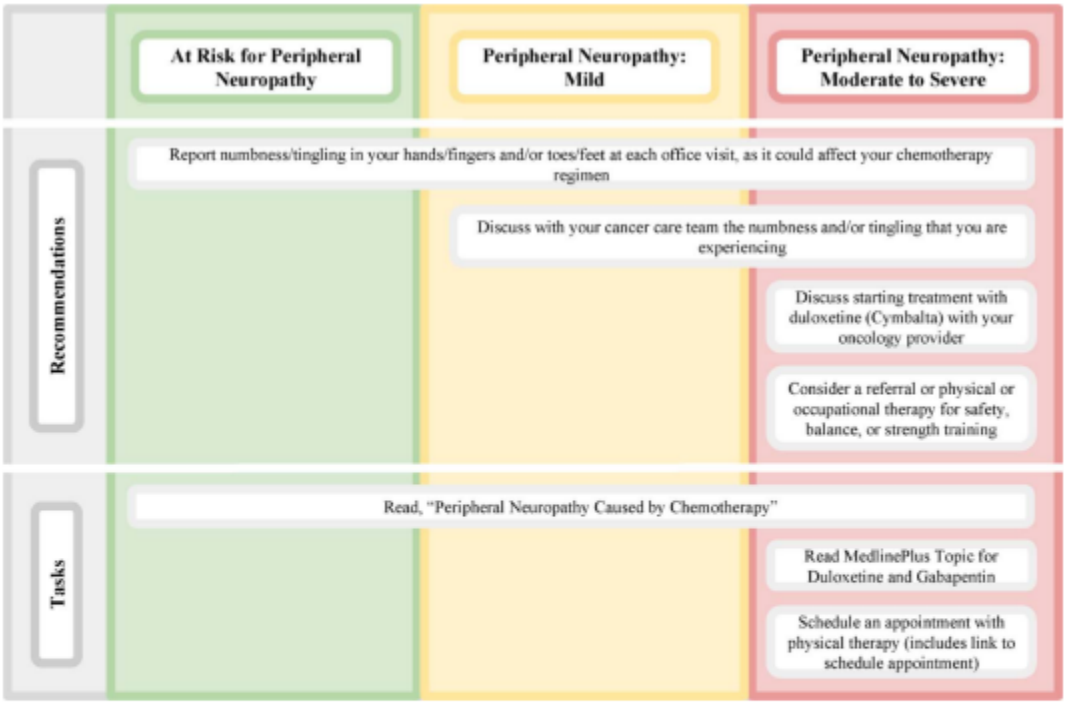
FIGURE 1. Screenshots of the Carevive CPS.

Measures

Feasibility

Patient-related feasibility data were captured automatically within the Carevive CPS using (1) the percentage of participants who created a Carevive account and (2) the percentage of patients who fully completed the Carevive self-assessment questionnaire at each visit. Provider-related feasibility was assessed based on the percentage of (1) providers who created a Carevive account, (2) providers who stated that they reviewed the care plan with their patients (Question 1

of Provider Acceptability Survey), (3) care plans that were finalized, and (4) CIPN care plan recommendations and tasks that were approved for patients by providers.



NOTE: Web links for different CIPN educational material recommended by the Carevive® CPS

1. "Peripheral Neuropathy Caused by Chemotherapy"
   - http://www.cancer.org/treatment/treatmentsandsideeffects/physicalsideeffects/chemotherapyeffects/peripheralneuropathy/peripheral-neuropathy-caused-by-chemotherapy-toc
2. "Read MedlinePlus Topic for Duloxetine and Gabapentin"
   - https://www.nlm.nih.gov/medlineplus/druginfo/meds/a604030.html
   - https://www.nlm.nih.gov/medlineplus/druginfo/meds/a694007.html

FIGURE 2. Examples of care plan recommendations and tasks by CIPN symptom severity.

Usability

Patient-and provider-reported ratings of Carevive CPS usability were measured using the System Usability Scale,[33] which consists of 10 questions and uses a Likert-type response format ranging from 0 to 4 (strongly disagree to strongly agree). The 10 questions are divided into two sets of statements: five positive items and five negative items. The five negative items are reverse scored (4 = strongly disagree, 0 = strongly agree). The total scale is scored from 0 to 40 and then converted to a 0- to 100-point scale (100 represents highest usability). The System Usability Scale has demonstrated satisfactory internal consistency reliability with a Cronbach's α of .91,[34–36] and structural validity has been demonstrated based on factor analysis results.[36]

Acceptability and Satisfaction

Patient-reported ratings of acceptability and satisfaction with the Carevive CPS were measured using the Adapted Acceptability E-Scale,[37] a questionnaire consisting of six items scored on a 1-

to 5-point scale (1 = low rating, 5 = high rating). The Acceptability E-Scale has demonstrated strong internal consistency reliability (Cronbach's α = .76) when used to test an electronic quality-of-life and symptom assessment tool in cancer populations.[37] Furthermore, its validity is supported based on exploratory factor analysis results.[37] The questions of the Acceptability E-Scale were adapted for the purposes of this study and determined by the study team members (eg, oncology clinicians, nurse scientists, PhD students). The Adapted Acceptability E-Scale asked patients how easy and enjoyable the Carevive CPS was to use over the course of the study period.

For providers, acceptability and satisfaction with the Carevive CPS were evaluated through the administration of the Provider Acceptability Survey, a five-item questionnaire created by the study team specifically for use in this study (Cronbach's α = .80). Question 1 asked providers if they reviewed the Carevive-generated care plan with the patient in the examination room (yes/no). Questions 2 through 5, which were scored using 1- to 5-point (1 = least helpful, 5 = most helpful) numeric rating scales, asked how helpful the Carevive CPS was in guiding patient interactions, promoting communication, and identifying areas of need.

Informal Qualitative Feedback

Study staff informally obtained feedback about the Carevive CPS from patients and providers, whose comments were written down and stored in an online database. Study staff also recorded the number of times the study providers reviewed the Carevive-generated care plan with their patients and reasons the providers gave if they did not. The feedback obtained from patients and providers was discussed at study team meetings and was primarily used to improve data collection processes and to identify barriers associated with the use of the Carevive CPS.

Procedures

The research nurse at the clinic explained the study to eligible patients after their provider visit. If the patient was interested, the research nurse obtained written informed consent and enrolled the patient in the study. Before the enrolled patient's next provider visit, a member of the research team extracted baseline disease and cancer treatment information (eg, previous cancer diagnosis, time since current diagnosis, cancer stage) from the patient's electronic medical record and entered it into the Carevive CPS. In the waiting room before each of the next three provider visits, the patient completed self-assessment questionnaires (eg, QLQ-CIPN20, PRO-CTCAE) within the Carevive platform on a tablet computer (screen size = 9.4 x 6.6 inches). In addition, at the first study visit, the patient reported baseline symptom and medical history and demographic information. After the patient completed the questionnaires, the provider generated the patient's care plan by clicking on the "Generate Care Plan" button within the platform and then reviewed the care plan with the patient. After the examination, the care plan was delivered to the patient via e-mail or USB drive. At the final interaction with the Carevive CPS, study Visit 3, the patient also completed the Adapted Acceptability E-Scale and the System Usability Scale. Providers completed the Provider Acceptability Survey and the System Usability Scale electronically after all of the 25 enrolled patients completed the study.

Statistical Analyses

Data obtained from the Carevive CPS and the associated survey databases were exported into Excel (Microsoft, Redmond, WA) and analyzed using R version 3.2.2 (R Foundation for Statistical Computing, Vienna, Austria). Power analyses were not conducted because of the pilot nature of this study. Descriptive statistics for all quantitative data were calculated (mean, SD, and range). Patient-related feasibility was evaluated based on the percentage of Carevive accounts created and self-assessment questionnaires completed over the course of the three study visits. Provider-related feasibility was evaluated based on the percentage of Carevive accounts created and patient care plans finalized by providers. Patient- and provider-related usability was assessed based on System Usability Scale mean scores. Lastly patient-and provider-related acceptability/satisfaction was examined based on Adapted Acceptability E-Scale and Provider Acceptability Survey (Items 2-5) mean scores, respectively. Missing data were handled by imputing sample mean scores for nonmissing items.

RESULTS

Sample Characteristics The majority of the 25 patients enrolled in the study had a positive hormone receptor status (72%) and were HER2/ neu negative (52%). The most common cancer diagnosis was Stage IV breast cancer (36%). All patients were receiving neurotoxic chemotherapy, 64% had undergone cancer surgery, and 48% had completed or had planned radiation therapy. The majority of patients were white (80%), had at least some college education (88%), and had previously used a computer (100%) (Table 1). All of the six providers (five nurse practitioners and one physician assistant) enrolled in the study were female and had earned a master's degree. The mean age was 48.33 years, and the majority were white and non-Hispanic (83%). On average, the providers had 13.66 years of oncology experience and 13.33 years of experience as a nurse practitioner or physician assistant. One patient and one provider did not complete the required Visit 3 surveys pertaining to usability, acceptability, and satisfaction with the Carevive CPS.

Feasibility

Feasibility was high, because most patients were able to complete the Carevive self-assessment questionnaires at each study visit with little help from the study staff. All enrolled patients created a Carevive account (25/25) and completed 74 of 75 Carevive self-assessment questionnaires (98.6%) over the three study visits (Table 2). All providers invited to participate in the study created a Carevive account (6/6); 61 of 75 patient care plans (81.3%) were reviewed and finalized by providers. However, only 20% of the providers who completed all of the outcomes assessments (n = 5) reported that they consistently reviewed the Carevive-generated care plans with their patients (Question 1 of Provider Acceptability Survey) (Table 2). Lastly, although providers accepted 100% of the peripheral neuropathy care plan recommendations, they accepted only 35% of the tasks associated with the recommendations at Visit 1 and 53% of the tasks at Visit 3. Thus, the Carevive CPS demonstrated sufficient ratings of feasibility from both a patient and provider perspective.

Table 1. Baseline Characteristics of Enrolled Patients (n = 25)

Variable	Frequency (%)
Gender	
Female	25 (100)
Race	
American Indian or Alaska Native	1 (4)
Asian	2 (8)
Black or African American	2 (8)
White	20 (80)
Ethnicity	
Hispanic or Latino	1 (4)
Not Hispanic or Latino	24 (96)
Education	
High school or less	3 (12)
Some college	7 (28)
Undergraduate degree	10 (40)
Graduate degree	5 (20)
Employment status	
Employed	12 (48)
Retired	6 (24)
Homemaker	2 (8)
Disabled	5 (20)
Marital status	
Married or partnered	19 (76)
Single	2 (8)
Divorced	4 (16)
Amount of computer use (n = 18)	
I have never used a computer before	0
About once per month	0
About once per week	0
More than once per week	18 (100)
Cancer stage	
I	3 (12)
II	6 (24)
III	5 (20)
IV	9 (36)
Other	2 (8)
Hormone receptor status	
Positive	18 (72)
Negative	7 (28)
HER2/neu status	
Positive	12 (48)
Negative	13 (52)
Surgery	
No surgery	9 (36)
Lumpectomy	6 (24)
Bilateral lumpectomy	1 (4)
Mastectomy	4 (16)
Bilateral mastectomy	5 (20)
Chemotherapy status	
Planned, not started	4 (16)

Usability

Patients rated the usability of the Carevive CPS higher than did providers: the mean patient score on the System Usability Scale was 85.00 (SD, 11.54; range, 62.50–100) (n = 24), whereas for providers it was 33.50 (SD, 17.19; range, 12.50–57.50) (n = 5) (Table 2). Specifically, providers rated the Carevive CPS as awkward to use and had the lowest mean scores on the question that asked if they would like to use the Carevive CPS frequently.

Table 1. Baseline Characteristics of Enrolled Patients (n = 25), Continued

Variable	Frequency (%)
Currently receiving	21 (84)
Radiation therapy status	
Planned, not started	8 (32)
Complete	4 (16)
Not planned or receiving	13 (52)
Hormonal therapy plan	
Yes	9 (32)
No	8 (36)
Not yet determined	8 (32)

Note: n = 18 for the question, "Amount of computer use" because of some participants not fully completing the survey that contained that question.

Acceptability and Satisfaction

Patients' mean scores on the Adapted Acceptability E-Scale ranged from 4.08 (SD, 0.93) to 4.90 (SD, 0.29) (range, 1–5) (n = 24). Mean scores on Questions 2 through 5 of the Provider Acceptability Survey ranged from 1.60 (SD, 0.89) to 3.20 (SD, 0.84) (range, 1–5) (n = 5) (Table 2). Thus, patients exhibited considerably higher ratings of acceptability and satisfaction with the Carevive CPS than providers. In particular, providers did not believe that the Carevive CPS was helpful in guiding clinical interactions with patients (Item 3) or in promoting communication between themselves and their patients (Item 4).

Table 2. Patient (n = 24) and Provider (n = 5) Feasibility, Usability, Acceptability, and Satisfaction Results

Feasibility	Percent		
Patient			
Patient self-assessment questionnaires completed	98.6 (74/75)		
Patient Carevive CPS accounts created[a]	100 (25/25)		
Provider			
Provider Carevive CPS accounts created[a]	100 (6/6)		
Provider care plans finalized	81.3 (61/75)		
Provider neuropathy care plan recommendations accepted	100		
Provider neuropathy care plan tasks accepted—Visit 1	35		
Provider neuropathy care plan tasks accepted—Visit 3	53		
Usability	**Mean**	**SD**	**Range**
Patient System Usability Scale	85.0	11.54	62.5–100
Provider System Usability Scale	33.5	17.19	12.5–57.5
Acceptability and Satisfaction—Patient Adapted Acceptability E-Scale			
(1) How easy was the Carevive CPS for you to use?	4.90	0.29	4–5
(2) How understandable were the questions?	4.75	0.53	3–5
(3) How much did you enjoy using the Carevive CPS?	4.19	0.73	3–5
(4) How helpful was it to complete the Carevive CPS?	4.08	0.93	2–5
(5) Was the amount of time it took to complete the Carevive CPS questions acceptable?	4.58	0.58	3–5
(6) Overall, how would you rate your satisfaction with the Carevive CPS?	4.56	0.65	3–5
Acceptability and Satisfaction—Provider Acceptability Survey			
(1) Did you see your patients' Carevive-generated care plans?[b]	0.20	0.45	0–1
(2) Based on your clinical interview, did the Carevive CPS identify appropriate areas of concern?	3.20	0.84	2–4
(3) Did the Carevive CPS help guide your clinical interactions with these patients?	1.80	1.10	1–3
(4) Was the information in the Carevive CPS helpful in promoting communication between you and these patients?	1.60	0.89	1–3
(5) Was the information in the Carevive CPS helpful in identifying areas of need or symptoms?	2.40	1.14	1–4

Note: One patient and one provider did not complete the final surveys for the usability, acceptability, and satisfaction outcomes.

[a]All patients (n = 25) and providers (n = 6) enrolled at baseline created a Carevive account.

[b]Item scored as yes (1) or no (0) and used to measure feasibility with the Carevive CPS.

Qualitative Feedback

Enrolled patients and providers identified several barriers to the use of the Carevive CPS. Patients questioned the clarity of the neuropathy items on the self-assessment questionnaire. For example, patients were unclear about the difference between "numbness" and "tingling" on a question that stated, "What was the severity of your numbness or tingling in your hands or feet at its worst in the past 7 days?" Patients also reported that some of the questions did not clearly state the time period over which they were to recall their symptoms. In addition, some patients did not receive the finalized care plan because (1) their e-mail address was inactive, (2) they did not regularly check their e-mail, or (3) they did not routinely bring their USB drive back to the clinic for each study visit if they had chosen that delivery option.

Providers reported that they had trouble logging into the Carevive CPS on their clinic computers because they forgot their passwords or opened the Carevive CPS in the wrong Internet browser (Internet Explorer instead of Google Chrome). One provider stated, "As you know, I had repeated problems with the password, which undoubtedly colored my perception of this program. There is just no time to fiddle with a password in the middle of a busy clinic." Furthermore, because of time constraints within the clinic workflow, the participating providers were sometimes unable to examine the study patients (a physician may have already seen the patient) or review the patient's Carevive care plan. In fact, study staff documented that providers

reviewed the care plan with the patient in the examination room only 61% of the time (28/46 recorded observations).

Providers felt that the recommendations provided by the Carevive CPS were similar to what they already reviewed with patients regarding CIPN symptom management. For example, for patients with minimal CIPN (eg, mild numbness and tingling in the hands and feet that do not interfere with activities of daily living), the Carevive-generated recommendation is to monitor symptoms closely and to contact the healthcare team if symptoms worsen. However, this recommendation would not add significant value beyond a verbal discussion with the patient. Providers also stated they would be more likely to use the Carevive CPS if they knew it was benefiting their patients. Lastly, study staff also frequently observed providers voicing their displeasure with the Carevive CPS to other clinicians.

DISCUSSION

This single-arm, pretest/posttest, prospective pilot study examined patients' and providers' perspectives of feasibility, usability, acceptability, and satisfaction with the Carevive CPS, a Web-based platform designed to improve the assessment and management of CIPN in clinical practice. While this study demonstrated that the Carevive CPS was feasible for both patients and providers to use, patients reported higher mean rates of usability, acceptability, and satisfaction with the Carevive CPS than did providers. Consistent with the results of this current study, recent evidence suggests that patients report high ratings of feasibility, usability, acceptability, and satisfaction with computerized oncology care planning programs.[38–41] For example, in one study, patients with lung cancer reported their cancer treatment–related symptoms (eg, pain, dyspnea, anxiety, depression, constipation, insomnia) using a Web-based Symptom Assessment and Management Intervention (computer tablet) in the waiting room.[38] Results demonstrated that provider adherence to the algorithm-generated recommendations was 57%, whereas the patient symptom assessment questionnaire completion rate was 84%, similar to the findings of the current study. These results suggest that further research is needed to explore why providers may have difficulty using computerized oncology care planning programs.

The implementation of any new technology into clinical practice is challenging. Specifically, providers reported a greater number of challenges and complaints with the Carevive CPS use than patients. Providers' unfavorable ratings of usability, acceptability, and satisfaction with the Carevive CPS may have been influenced by a number of challenges that can be understood in the context of the Diffusion of Innovations Theory.[30] In terms of the relative advantage of the innovation itself, providers did not perceive the recommendations generated by the Carevive CPS to be more useful than the recommendations they were already providing in cases of minimal CIPN. However, because patients and providers often need more assistance and information to effectively manage more severe or complex symptoms, use of the Carevive CPS to assess and manage patients with more severe CIPN symptoms would perhaps be viewed more favorably.

Providers also faced challenges related to the complexity of the innovation as demonstrated by the trouble they had logging into the platform. Related to observability, providers may not have adopted the Carevive CPS because they were unable to determine if their patients benefited from

using the Carevive CPS during the study. Providers also faced challenges related to the communication channel. Because they frequently communicated their displeasure with the Carevive CPS to one another during the study period, an overall negative attitude toward Carevive CPS usage may have been amplified among providers. In terms of time, because the providers interacted with the Carevive CPS over only a few months, they may have had too little time to troubleshoot the challenges they encountered to determine if they could adopt the Carevive CPS into their daily clinical practice. Lastly, related to the social system, it is possible that the Carevive CPS simply did not align with the norms and values of this particular breast cancer clinic.

Overall, the difficulties experienced by providers may have contributed to a low rate of adoption and lower ratings of usability, acceptability, and satisfaction. Provider ratings of usability may have been lower because the version of the Carevive CPS used in this study focused solely on CIPN. The Carevive CPS has received high ratings of patient- and provider-related usability and acceptability when used to assess multiple cancer symptoms (eg, sleep problems, anxiety/ depression, fatigue, pain, nausea).[42] Specifically, providers stated that the platform helped to identify symptoms that patients otherwise would not tell them about, allowing them to direct the clinical visit to the patients' needs and goals of care.[42] Our findings may have been similar had we used the Carevive CPS to assess other cancer treatment–related symptoms in addition to CIPN. Nevertheless, this study identified several challenges associated with the implementation of this technology into clinical practice. Future modifications of the Carevive CPS may increase its usability for providers by addressing their challenges and complaints.

In fact, based on the results of this study, Carevive is planning several modifications to the CPS to increase patient and provider usability. First, to aid in provider login, a "Forgot Password" button has been added on the login screen of the Carevive CPS. Second, a "Symptom Summary" page, which displays a summary of the patient's answers to the Carevive self-assessment questionnaire, was added. This summary will allow the provider to focus on the most important cancer treatment–related symptoms and severity scores reported by the patients. Third, patients' responses to individual symptom questions will be graphed to track symptom progression over time. A revised version of the Carevive CPS that incorporates these changes is being tested in a second phase to reevaluate patient and provider perceptions of the platform in a larger sample. Lastly, although it was not yet integrated in this current study, Carevive has incorporated the CPS into the patient's electronic medical record and "patient portal." This allows providers to simultaneously view the patient's Carevive care plan and medical record in the examination room without the need to open a separate Internet browser. Furthermore, patients can complete the Carevive CPS self-assessment questionnaire at home before their examination and have access to their care plans online. The Carevive CPS may be further explored as a tool to increase patient engagement in CIPN symptom assessment and management and to improve provider adherence to CIPN quality standards. Evidence suggests that individuals who are highly engaged in their medical care have better treatment outcomes and lower costs of care.[43]

The Carevive CPS may promote patient engagement in self-care by providing patients with personalized care plans composed of CIPN educational materials and self-management strategies that they can discuss with their healthcare provider. Furthermore, although documentation of CIPN symptom assessment is a crucial component of quality care per Joint Commission

requirements,[18] documentation of CIPN symptom assessment and management varies widely by provider and institution. The Carevive CPS may increase provider adherence to quality standards by generating individualized patient care plans that remind providers to assess for symptoms of CIPN (eg, numbness, tingling, pain). Personalized Carevive-generated care plans may increase both patient engagement in self-care and provider adherence to CIPN quality standards, which may improve the assessment and management of CIPN.

Lastly, the use of the Carevive CPS in clinical practice may increase the availability of standardized patient self-report measures of neuropathy (eg, PRO-CTCAE, QLQ-CIPN20). The sufficient ratings of feasibility, usability, acceptability, and satisfaction with patients demonstrated in this study support the delivery of electronic self-report neuropathy measures. Providing patients an opportunity to report their neuropathy symptoms (versus physician report alone) is critical because evidence has demonstrated that providers consistently miss approximately half of the symptoms reported by patients with cancer.[44–46] Furthermore, physician-graded neuropathy severity has not been shown to correlate highly with patient-reported neuropathy severity.[47] Thus, the Carevive CPS may improve the assessment of CIPN by providing patients an opportunity to report their CIPN symptoms electronically. Overall quality of life may also improve. A study by Basch et al[48] randomly assigned 766 patients receiving outpatient chemotherapy either to receive usual care (symptom monitoring per clinician) or to report their cancer symptoms using tablet computers (nurses received e-mails when symptoms worsened). Results demonstrated that individuals reporting their cancer symptoms via tablet had greater increases in quality of life in comparison to the group reporting their cancer symptoms to their physician alone ($P < .001$).[48] Although this outcome has not yet been tested, the Carevive CPS may increase patients' overall quality of life by promoting the discussion of CIPN symptoms between patients and providers, which may lead to earlier treatment interventions.

Limitations

This study was conducted in a homogeneous patient population at a single outpatient clinic; thus, the results may not be generalizable to cancer populations other than women with breast cancer receiving care at a comprehensive cancer center. Also, the sample size for the number of patients and providers enrolled in this study was small. Moreover, because of the numerous barriers associated with provider-related Carevive CPS use, research staff frequently assisted providers in the technological aspects of accessing and completing the Carevive-generated care plans. Study staff assistance may have increased the providers' perceptions of usability with the Carevive CPS and decreased opportunities for the providers to work through the barriers with the platform on their own. Lastly, because qualitative feedback was obtained informally, it is possible that not all of the participants had the opportunity to provide feedback about the Carevive CPS. Despite these limitations, this study contributes to the growing body of literature supporting the notion that computerized oncology care planning programs are highly rated by patients and have important implications for the identification and treatment of CIPN.

Implications for Nursing

Unmanaged cancer treatment–related symptoms can lead to decreased quality of life and poorer treatment outcomes.4 Beginning routine screening for symptoms early in cancer treatment will

enable nurses to provide interventions that reduce the likelihood of adverse treatment outcomes and improve patients' health-related quality of life.[48–50] Symptom screening technologies such as the Carevive CPS may be used to increase nurse-patient communication about cancer treatment–related symptoms and subsequently promote the early identification of cancer treatment–related adverse effects. Furthermore, nurses can use this technology in their practice to facilitate the use of evidence-based assessment and management CIPN strategies.

Conclusions

This pilot study examined patient- and provider-related feasibility, acceptability, usability, and satisfaction with the novel computerized Carevive CPS. While patients and providers both had high ratings of feasibility of the Carevive CPS, patients had higher ratings of acceptability, usability, and satisfaction than did providers. Additional research is needed to test a revised Carevive platform that addresses adoption barriers and to evaluate Carevive-based effects on CIPN symptom severity, patients' engagement in their care, and provider adherence to evidence-based practice recommendations.

Acknowledgments

The authors thank Jill Hayden, RN, and Shraddha Pardesi, MS, BPharm, for patient accrual; James P. Kelly IV, BS, Deborah Lee, MSN, FNP, ACNP-BC, and Kelsey Kippe, BSN, RN, for data collection; and Rylie Haupt for her help in creating the figures for this article.

References

1. American Cancer Society. Cancer facts and figures: 2014. http://www.cancer.org/acs/groups/content/@editorial/documents/document/acspc-044552.pdf. Published 2015. Accessed May 3, 2016.

2. Cooley ME, Lobach DF, Johns E, et al. Creating computable algorithms for symptom management in an outpatient thoracic oncology setting. J Pain Symptom Manage. 2013;46(6): 911–924.e1.

3. Mayer DK, Travers D, Wyss A, Leak A, Waller A. Why do patients with cancer visit emergency departments? Results of a 2008 population study in North Carolina. J Clin Oncol. 2011;29(19): 2683–2688.

4. Brown KW, Levy AR, Rosberger Z, Edgar L. Psychological distress and cancer survival: a follow-up 10 years after diagnosis. Psychosom Med. 2003; 65(4): 636–643.

5. Massie MJ. Prevalence of depression in patients with cancer. J Natl Cancer Inst Monogr. 2004;32(32): 57–71.

6. Watson M, Haviland JS, Greer S, Davidson J, Bliss JM. Influence of psychological response on survival in breast cancer: a population-based cohort study. Lancet (London, England). 1999;354(9187): 1331–1336.

7. Merriam-Webster.comFeasible. http://www.merriam-webster.com/dictionary/feasible. Accessed June 6, 2016.

8. Nielsen J. Usability 101: introduction to usability. https://www.nngroup.com/articles/usability-101-introduction-to-usability/. Published 2012. Accessed May 3, 2016.

9. Usability.gov. Glossary. https://www.usability.gov/what-and-why/glossary/u/index.html. Accessed June 6, 2016.

10. Cavaletti G, Cornblath DR, Merkies IS, et al. The chemotherapy-induced peripheral neuropathy outcome measures standardization study: from consensus to the first validity and reliability findings. Ann Oncol. 2013; 24(2): 454–462.

11. Hershman DL, Lacchetti C, Dworkin RH, et al. Prevention and management of chemotherapy-induced peripheral neuropathy in survivors of adult cancers: American Society of Clinical Oncology clinical practice guideline. J Clin Oncol. 2014;32(18): 1941–1967.

12. Kautio AL, Haanpaa M, Kautiainen H, Kalso E, Saarto T. Burden of chemotherapy-induced neuropathy—a cross-sectional study. Support Care Cancer. 2011;19(12): 1991–1996.

13. Mols F, Beijers T, Vreugdenhil G, van de Poll-Franse L. Chemotherapy-induced peripheral neuropathy and its association with quality of life: a systematic review. Support Care Cancer. 2014;22(8): 2261–2269.

14. Saif MW, Reardon J. Management of oxaliplatin-induced peripheral neuropathy. Ther Clin Risk Manag. 2005;1(4): 249–258.

15. Smith EM, Bridges CM, Kanzawa G, et al. Cancer treatment–related neuropathic pain syndromes—epidemiology and treatment: an update. Curr Pain Headache Rep. 2014;18(11): 457–459.

16. Stubblefield MD, Burstein HJ, Burton AW, et al. NCCN task force report: management of neuropathy in cancer. J Natl Compr Cancer Netw. 2009;7(suppl 5): S1-NaN-8.

17. Binner M, Ross D, Browner I. Chemotherapy-induced peripheral neuropathy: assessment of oncology nurses' knowledge and practice. Oncol Nurs Forum. 2011;38(4): 448–454.

18. Smith EML, Bakitas MA, Homel P, et al. Using quality improvement methodology to improve neuropathic pain screening and assessment in patients with cancer. J Cancer Educ. 2009;24(2): 135–140.

19. Smith EML, Barton DL, Qin R, Steen PD, Aaronson NK, Loprinzi CL. Assessing patient reported peripheral neuropathy: the reliability and validity of the European Organization for Research and Treatment of Cancer QLQ-CIPN20 Questionnaire. Qual Life Res. 2013;22(10): 2787–2799.

20. Tanay MAL, Armes J, Ream E. The experience of chemotherapy-induced peripheral neuropathy in adult cancer patients: a qualitative thematic synthesis [published online ahead of print January 20, 2016]. Eur J Cancer Care (Engl). 2016.

21. Network NCC. Distress management. Clinical practice guidelines. J Natl Compr Cancer Netw. 2003;1(3): 344–374.

22. Davis DA, Taylor-Vaisey A. Translating guidelines into practice: a systematic review of theoretic concepts, practical experience and research evidence in the adoption of clinical practice guidelines. Can Med Assoc J. 1997; 157(4): 408–416.

23. Grol R. Successes and failures in the implementation of evidence-based guidelines for clinical practice. Med Care. 2001;39(8 suppl 2): II46–II54.

24. Kinnane N, Thompson L. Evaluation of the addition of video-based education for patients receiving standard pre-chemotherapy education. Eur J Cancer Care (Engl). 2008;17(4): 328–339.

25. Williams SA, Schreier AM. The role of education in managing fatigue, anxiety, and sleep disorders in women undergoing chemotherapy for breast cancer. Appl Nurs Res. 2005;18(3): 138–147.

26. Aktas A, Hullihen B, Shrotriya S, Thomas S, Walsh D, Estfan B. Connected health: cancer symptom and quality-of-life assessment using a tablet computer: a pilot study. Am J Hosp Palliat Care. 2015;32(2): 189–197.

27. Berry DL, Hong F, Halpenny B, et al. Electronic self-report assessment for cancer and self-care support: results of a multicenter randomized trial. J Clin Oncol. 2014;32(3): 199–205.

28. Kolb N, Smith A, Singleton J, et al. A novel evidence based phone system reduces symptoms of chemotherapy induced neuropathy (P7.095). Neurology. 2015;84(14 supplement).

29. Maguire R, Ream E, Richardson A, et al. Development of a novel remote patient monitoring system: the advanced symptom management system for radiotherapy to improve the symptom experience of patients with lung cancer receiving radiotherapy. Cancer Nurs. 2015;38(2): E37–E47.

30. Rogers E. Diffusion of Innovations. 5th ed. New York, NY: Free Press; 2003.

31. Basch E, Reeve BB, Mitchell SA, et al. Development of the National Cancer Institute's Patient-Reported Outcomes Version of the Common Terminology Criteria for Adverse Events (PRO-CTCAE). J Natl Cancer Inst. 2014;106(9).

32. Postma TJ, Aaronson NK, Heimans JJ, et al. The development of an EORTC quality of life questionnaire to assess chemotherapy-induced peripheral neuropathy: the QLQ-CIPN20. Eur J Cancer. 2005;41(8): 1135–1139.

33. Brooke J. SUS—a quick and dirty usability scale. Usability Evaluation in Industry. 1996;189(194): 4–7.

34. Ahmed A, Ouzzani M. Development and assessment of an interactive Web-based breastfeeding monitoring system (LACTOR). Matern Child Health J. 2013;17(5): 809–815.

35. Ahmed AH, Ouzzani M. Interactive Web-based breastfeeding monitoring: feasibility, usability, and acceptability. J Hum Lact. 2012;28(4): 468–475.

36. Lewis J, Sauro J. The factor structure of the System Usability Scale. In: Kurosu M, ed. International Conference on Human Centered Design. Vol 5619. Berlin, Germany: Springer; 2009: 94–103.

37. Tariman JD, Berry DL, Halpenny B, Wolpin S, Schepp K. Validation and testing of the Acceptability E-Scale for Web-based patient-reported outcomes in cancer care. Appl Nurs Res. 2011;24(1): 53–58.

38. Cooley ME, Blonquist TM, Catalano PJ, et al. Feasibility of using algorithm-based clinical decision support for symptom assessment and management in lung cancer. J Pain Symptom Manage. 2015;49(1): 13–26.

39. Abernethy AP, Hendon JE 2nd, Wheeler JL, et al. Feasibility and acceptability to patients of a longitudinal system for evaluating cancer-related symptoms and quality of life: pilot study of an e/Tablet data-collection system in academic oncology. J Pain Symptom Manage. 2009;37(6): 1027–1038.

40. Montemurro F, Mittica G, Cagnazzo C, et al. Self-evaluation of adjuvant chemotherapy-related adverse effects by patients with breast cancer. JAMA Oncol. 2016;2(4): 445–452.

41. Wood WA, Deal AM, Abernethy A, et al. Feasibility of frequent patient-reported outcome surveillance in patients undergoing hematopoietic cell transplantation. Biol Blood Marrow Transplant. 2013;19(3): 450–459.

42. Stevens E, Bottsford-Miller J, Miller J, et al. Supportive care plans: Linking patient-reported outcomes to evidence-based supportive care across the cancer continuum. In: 2016 Society of Gynecologic Oncology Annual Meeting on Women's Cancer; March 19–22, 2016; San Diego, CA. Abstract # 319.

43. Greene J, Hibbard JH, Sacks R, Overton V. When seeing the same physician, highly activated patients have better care experiences than less activated patients. Health Aff (Millwood). 2013;32(7): 1299–1305.

44. Fromme EK, Eilers KM, Mori M, Hsieh Y-C, Beer TM. How accurate is clinician reporting of chemotherapy adverse effects? A comparison with patient-reported symptoms from the Quality-of-Life Questionnaire C30. J Clin Oncol. 2004;22(17): 3485–3490.

45. Laugsand EA, Sprangers MAG, Bjordal K, Skorpen F, Kaasa S, Klepstad P. Health care providers underestimate symptom intensities of cancer patients: a multicenter European study. Health Qual Life Outcomes. 2010;8: 104.

46. Atkinson TM, Li Y, Coffey CW, et al. Reliability of adverse symptom event reporting by clinicians. Qual Life Res. 2012;21(7): 1159–1164.

47. Alberti P, Rossi E, Cornblath DR, et al. Physician-assessed and patient-reported outcome measures in chemotherapy-induced sensory peripheral neurotoxicity: two sides of the same coin. Ann Oncol. 2014;25(1): 257–264.

48. Basch E, Deal AM, Kris MG, et al. Symptom monitoring with patient-reported outcomes during routine cancer treatment: a randomized controlled trial. J Clin Oncol. 2016;34(6): 557–565.

49. Ruland CM, Andersen T, Jeneson A, et al. Effects of an internet support system to assist cancer patients in reducing symptom distress: a randomized controlled trial. Cancer Nurs. 2013;36(1): 6–17.

50. Kroenke K, Theobald D, Wu J, et al. Effect of telecare management on pain and depression in patients with cancer: a randomized trial. JAMA. 2010; 304(2): 163–171.