



Usability and acceptance evaluation of ACESO: a Web-based breast cancer survivorship tool

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Received: 10 August 2017 / Accepted: 13 December 2017
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Abstract

Purpose The specific objective of this research is to design and develop a personalized Web application to support breast cancer survivors after treatment, as they deal with post-treatment challenges, such as comorbidities and side effects of treatment.

Methodology A mixed-methods approach, utilizing a combination of think-aloud analysis, personal interviews, and surveys, was adopted for user acceptance and usability testing among a group of breast cancer survivors. User feedback was gathered on their perceived value of the application, and any user-interface issues that may hinder the overall usability were identified.

Results The application's portability and capability of organizing their entire breast cancer-related medical history as well as tracking various quality of life indicators were perceived to be valuable features. The application had an overall high usability; however, certain sections of the application were not as intuitive to locate. Visual elements of the website were appreciated; however, overall experience would benefit from incorporating more sociable elements that exhibit positive re-enforcement within the end user and provide a friendlier experience.

Conclusion The results of the study showcase the need for more personalized tools and resources to support survivors in self-management. It also demonstrates the ability to integrate breast cancer survivorship care plans from diverse providers and paves the way to add further value-added features in consumer health applications, such as personal decision support.

Implications for Cancer Survivors Using a personal decision support-based tool can serve as a training tool and resource, providing these patients with pertinent information about the various aspects of their long-term health, while educating them about any related side effects and symptoms. It is hoped that making such tools more accessible could help in engaging survivors to play an active role in managing their health and encourage shared decision-making with their providers.

Keywords Breast cancer · Survivorship · Patient engagement · Self-management · Patient reported outcomes

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s11764-017-0670-8>) contains supplementary material, which is available to authorized users.

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Introduction

As many as 230,000 women get diagnosed with breast cancer annually in the USA [1]. With better and improved cancer treatments, the number of breast cancer survivors has also grown exponentially in the past decades. The 5-year survival rate for breast cancer has significantly increased from 75% in 1977 to 91% in 2010 [1]. The American Cancer Society estimates that there are currently around 3.1 million breast cancer survivors [2] in the USA.

Regrettably, availability of adequate resources and tools for breast cancer survivors has not kept up with the rapid advancement in treatment options, resulting in unmet supportive care needs [3–5]. Breast cancer survivors face a number of issues in terms of quality of life such as fatigue [6, 7], weight gain [8, 9], depression [10, 11], sleep quality [12, 13], and

impaired sexual function [14, 15]. Most breast cancer survivors are still eager and willing to play an active role in managing their health condition [16–19]. However, they face several barriers, such as the lack of knowledge and understanding of their medical condition, coupled with the lack of specific tools and resources that enable them to achieve this [20–22].

Moreover, health care providers have done little to provide continuous care, other than request patients to come for follow-up visits and provide some general educational materials at discharge [23]. Upon completion of their cancer treatment, a patient is provided with a document called a survivorship care plan, which contains a summary of their cancer treatment, including diagnosis, procedures, and medications, and a schedule for follow-up care visits [24, 25]. Conventional cancer survivorship care plans exist in the form of a paper document that is handed to the patient before discharge [24, 25], which have been shown to not be very effective towards achieving improved health outcomes [26]. This form of cancer survivorship care plan assumes that the patients are capable enough to not only understand and retain all the terms and instructions contained within that document but also remember to follow the guidelines it contains in the advised timeline [27–30]. Additionally, the information contained in a conventional survivorship care plan is passive, usually in the form of a static paper document, and relies on the patient to proactively check, analyze, and interpret the information it contains at the right time. Patient-driven and managed survivorship care plans that not only aim to educate the patient but also encourage self-efficacy are needed.

Patient-reported outcome measures (PROM) [31] offer a means to measure the patient-perceived quality of life, treatment-related symptoms, and overall functional status after completion of treatment by means of patient self-reporting. In the context of breast cancer, PROM helps understand and quantify the patient's perspective of treatment outcomes, such as treatment-related symptoms [32] and other survivorship issues such as psychosocial well-being [33]. While PROM have been gaining popularity and significance, they still remain greatly underutilized [31].

Additionally, given that breast cancer survivors are required to periodically visit both an oncologist (to check for recurrence and monitor patient recovery) as well as a primary care physician (PCP) (for general health issues and/or comorbidities) [34], their health records are often scattered across multiple health care providers. This distribution can pose a challenge for the patient to maintain and view a comprehensive personal health record [26].

The current study describes the development of an interactive tool intended to address these challenges, called *After Cancer Education and Support Operations* (ACESO—which is also the name of the Greek goddess of healing). ACESO provides an interactive way for patients to manage their

condition using information residing in their personalized survivorship care plan, provided by their medical care provider.

ACESO aims to be an active, intelligent tool that continually monitors the information derived from the patient's personalized survivorship care plan and the patient provided input, looks for periodic updates or changes, analyzes this information in real time, and provides relevant feedback to the patient. This feedback could be in the form of various alerts, triggers, or reminders, as well as related recently published news and journal articles, bringing critical information to the attention of the patient. These alerts, triggers, and reminders are based on a pre-constructed knowledge-based repository, derived from cancer survivor guidelines, as well as the patient's personalized breast cancer survivorship care plan. The repository contains a pre-defined set of rule-based alerts and triggers that can be activated based on the patient's condition, or any adverse event.

Below, the current investigators describe the design and development of a personalized Web application (ACESO) to support breast cancer survivors after treatment (chemotherapy and/or radiation) as they deal with post-treatment challenges, such as comorbidities and side effects of treatment. This Web application was also tested with actual breast cancer patients and the findings are reported.

Method

The current investigators utilized an iterative process in the design and development of ACESO which involved (1) comprehensive literature review and expert panel comprising an oncologist, a nurse practitioner, researchers, and breast cancer survivors to identify needs of breast cancer survivors; (2) comprehensive review of current breast cancer survivorship guidelines and existing paper-based survivorship plans; (3) development of decision rules based on existing National Cancer Institute (NCI) guidelines; (4) curation of decision rules and text of alert messages by expert panel; (5) prototype design and development; (6) collection of target users' feedback by individual interviews; (7) conduct of prototype's usability testing by target users, utilizing task analysis; and (8) revision of prototype based on user feedback and usability testing.

Prototype design and development

An iterative version of the development model, the waterfall model [35] was employed in the development process. Based on the literature review and input from the expert panel, six core functions were identified to be incorporated in the prototype: (1) record quality of life indicators at home, (2) view changes (using visual charts) in quality of life indicators, (3) record user-reported treatment-related symptoms, (4) view breast cancer-related medical history, (5) view schedule of

upcoming follow-up visits, and (6) generate and display customized alerts regarding observed symptoms or detected quality of life issues.

Using the patient's existing breast cancer-related recorded symptoms and quality of life indicators as sources of data, ACESO analyzes the patients' individual information in order to generate customized alerts and reminders for each patient. Each first-time user sets up their account by entering their breast cancer medical history, using their paper-based survivorship plan, given to the patient by their provider. In addition, ACESO actively analyzes any new data being recorded by the patient (symptoms, quality of life assessments); puts it into context with their past breast cancer-related medical history (diagnosis, procedures, tests and medications); processes it into usable, actionable information; and if applicable, finally pushes this information to the patient in the form of an alert message.

ACESO is designed to be a Web application so that it may be accessed independent of operating system platform, from any device (Web-enabled smartphone, tablet, laptop, or desktop) and a variety of Web browsers. The Web-based implementation of ACESO ensures it is available to all users who have a Web-enabled device without the need for installation of any additional software.

The personal decision support provided by ACESO is based on a set of pre-compiled rules, derived from the Breast Cancer Survivorship Care Plan recommendations, outlined by the National Cancer Institute, which formed the underlying knowledge base for the rules. The NCI plan is a comprehensive guideline of various follow-up care tests, recommendations, late effects, and their corresponding interventions. The NCI plan is based on the guidelines issued by the American Society of Clinical Oncology [25].

A set of pre-defined rules and corresponding decision trees were constructed based on the NCI standard survivorship plan. An advantage of using a set of pre-defined rules in this context is that the resulting knowledge base is relatively easy to modify and maintain to keep up with changes in guidelines. For instance, a decision tree has been compiled to help detect and preemptively warn patient about arm lymphedema (Fig. 1).

In this scenario, the system first checks if the patient received axillary dissection, and/or radiation treatments, which are known to be associated with arm lymphedema. Subsequently, the system verifies if the user has recorded any symptoms associated with arm lymphedema (such as upper arm swelling). In this manner, the system will help detect and monitor important observations and alert the patient in a timely manner, often preemptively, thus allowing them to take quick action as well as informing and educating them about what they are experiencing. The bringing together of data from the patient's breast cancer-related medical history, as

well as the patient-reported symptoms and quality of life assessments further enhances the early detection process.

Participants

Participants were recruited via word of mouth, utilizing flyers as well as via an email sent to volunteers at a local breast cancer resource center. Prior approval from the University of Wisconsin-Milwaukee (UWM) Institutional Review Board (IRB) was obtained before conducting any research activities involving participants. A total of 15 eligible women were self-referred to participate in the study. In order to be eligible, participants must (1) have received a breast cancer diagnosis, (2) have completed local and/or systemic adjuvant cancer therapy, (3) be currently considered cancer free, (4) have no prior history of treatment of other cancers, (5) have the ability to read and write eighth grade English, and (6) have no other major disabling medical or psychiatric conditions. All participants received a US\$20 gift card as compensation for their time and input.

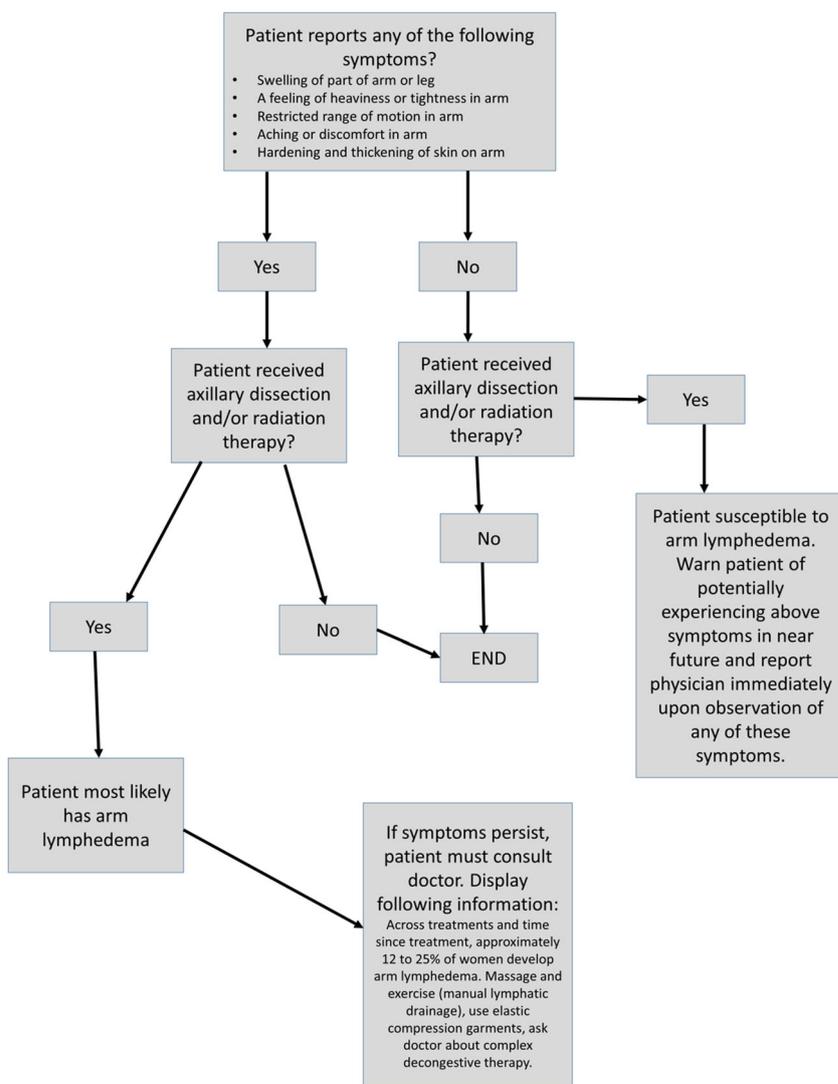
Prototype evaluation

Guided by the Technology Acceptance Model (TAM) proposed by Davis et al. [36], the current investigators evaluated the prototype's acceptance among target users. User acceptance is defined as "the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support" [36]. TAM specifies that actual user acceptance is influenced by two primary predictors: perceived usefulness and perceived ease of use (usability). Perceived usefulness is the extent to which a breast cancer survivor believes that using the system would enhance self-management of their treatment related symptoms. Usability is "the degree to which a person believes that using a particular system would be free from effort" [36]. A good, well-designed, and intuitive user interface will play a large role in improving the system's usability.

TAM has been widely used to conduct usability and acceptance evaluation of several consumer health applications [37, 38]. A review of strategies in the development of consumer health applications urges the utilization of TAM in the consumer health domain [39]. Based on evaluation of other similar consumer health applications [40–45], a mixed-methods approach was adopted, utilizing a combination of semi-structured interviews, task analysis, and self-reported surveys.

The following research questions were investigated: (1) What is the perceived usefulness of an electronic self-management tool among breast cancer survivors? (2) How usable is the current prototype among breast cancer survivors?

Fig. 1 Decision tree to check for arm lymphedema



Procedure

Perceived usefulness

Semi-structured interviews with open-ended questions were employed in order to assess perception of the respondents regarding the perceived usefulness of ACESO. Talking points or open-ended questions for the interviews were derived from the conceptual framework described in the TAM (described in the previous section). All individual sessions were audio-recorded and subsequently transcribed and cross-checked for accuracy.

Users were asked questions, such as: “Do you think having an app would help/have helped you navigate life after breast cancer any better?” and “Do you think more personalized tools (such as apps) to aid breast cancer survivors would be useful? Would you use such an app? Why?” In addition, to determine ACESO’s general acceptance, respondents were

also asked questions to determine their intent in adopting ACESO for use in their daily lives: “How willing would you be to use this app, if it were made available to you for free? Please explain with reasons”.

Usability

The overall usability was measured using three different approaches: task analysis using think-aloud technique [46], semi-structured interviews, and completion of a self-reported online experience survey. Cross-tabulating and comparing results from all three approaches would reveal discrepancies, if any, or the possibility of any bias.

Each participant was instructed to complete a list of tasks using ACESO in order to assess its overall usability. Based on the work of Ericsson and Simon [46], a think-aloud technique was utilized, which allows the capture of one’s cognitive process by having them verbalize it. The number of times each

participant sought help in completing the tasks as well as if they made any errors while completing each task was observed and recorded.

After participants had a chance to use the prototype and get familiar with its features and functions, a second round of one-on-one personal interviews was conducted to gather their individual opinion on the prototype's perceived usability. Participants were also encouraged to offer their suggestions on how to further improve the prototype or any changes they would like to be made. Finally, participants completed the online experience survey in order to assess the respondents' overall experience from using the Web application. The online experience survey used a 7-point semantic differential scale to measure the users' experience on three metrics: usability, sociability, and pragmatic value (or perceived usefulness) of ACESO. These dimensions are derived from research in human psychology, communication science, consumer psychology, and consumer behavior in online environments as well as from human-computer interaction (HCI) and usability research [47, 48]. Respondents rated the system on a scale of 1 (most positive) to 7 (most negative). A score of below 4 is considered to be a favorable user rating.

Analyses

A combination of qualitative and quantitative methods were employed to evaluate the prototype for its perceived usefulness and usability. Thematic analysis was performed to analyze the qualitative data obtained from personal interviews and observation notes. Subsequently, in the unitizing stage, codes (or labels) were then tagged to describe interesting ideas that appeared in a word, phrase, or sentence. Initially, a deductive approach was adopted, based on the two pre-determined high-level themes (perceived usefulness and usability). Inductive analysis was then carried out on the data within these themes, from which a number of sub-themes emerged.

Semantic themes that emerged from the analysis of the text that were representative of the respondents' experiences were identified. This process was repeated to revisit the categories and themes after transcribing each interview, until data saturation (no additional data to develop new categories) was achieved. The NVivo 11 software package was used to perform the thematic analysis.

Quantitative analysis was performed utilizing descriptive statistics and generated using SPSS version 24 to describe and evaluate the sociodemographic characteristics of the study sample, as well as the usability patterns from the task analysis. Responses to the personal interviews were compared and verified with results of the task analysis and the online user experience survey in order to identify any inconsistencies in the findings.

Results

Participant characteristics

Fifteen breast cancer survivors who self-referred to participate comprised the sample for this study. The majority of respondents identified themselves as Caucasian and over the age of 50 and had at least a college degree. Only one respondent did not identify herself as belonging to any of the racial groups listed as options in the online survey (Table 1).

Perceived usefulness

Organization of personal health information

Respondents were asked about their perceived usefulness of a survivorship app, such as ACESO: "How do you think having an app would help/have helped you navigate life after breast cancer any better?" One respondent said "Every time I go to the doctor I leave with so many documents. Look over there (as she pointed to her shelf above her work desk) at that thick binder. I always save everything, but I'm not sure if I ever needed to look for something that I will be able to find it". Respondents revealed their current practices in terms of organizing their medical records and resources and having access to them. While they all had their own way of organizing information (post-it notes, receipts in wallet, binders, etc.), they were not always satisfied with their current practice.

One of the features the respondents seem to find valuable (7/15) was the ability to record and track quality of life observations, such as sleep quality, fatigue, sexual function, mental health, and weight at home, and being able to view them later. As one respondent stated "The visuals and the charts were really nice". Another respondent stated "I like being able to

Table 1 Characteristics of study sample

	Frequency	Percent (%)
Age		
30–39	1	7
40–49	3	20
50–59	4	27
Above 60	7	46
Race/ethnicity		
Caucasian	14	93
Other	1	7
Education (highest level completed)		
High school	2	13
Associates/technical degree	3	20
Bachelor's degree	7	47
Master's degree	3	20

track things at home". Talking about the graphical observation charts, a respondent stated "This could be really helpful. Is this something I can send to my doctor?" Respondents also pointed out that "I like being able to see the past measurements. That way I can tell if it's getting better or worse over time". These responses suggest that even though most respondents had initially stated that they felt prepared after completing their treatment, after getting a chance to view and use the app, they stated they would still like to have access these features, indicating that having ACESO could further improve their preparedness, especially in terms of tracking various quality of life indicators that impact breast cancer survivors.

Online information seeking behavior

Several respondents (6/15), however, were not satisfied with using the Internet as a source of medical information seeking, due to the generic information they find online. These respondents mentioned that they could not always identify what piece of information pertains specifically to them. A respondent mentioned "I use the internet to look up stuff all the time ... I use it a lot, but often end up reading so much, that I think Oh, I could have this and that and it ends up scaring me more". Another respondent stated "I often go to WebMD to do my own research, but I find it hard to understand if what I'm reading applies to me or not." A third respondent stated "You see things in the news online all the time, and a lot of time they are conflicting each other. I just don't know which one to believe". These results indicate the need among survivors for more personalized apps that deliver customized content.

Readability and portability

After getting a chance to view and use the app, respondents were posed the question "What did you like the most about the app?" in order to assess their perceived usefulness of the app. As one respondent stated, "I like that you can see everything in one place". Respondents (8/15) revealed that they find the portability aspect of an app very useful. Having access to a comprehensive online application would mean that they are able to access their own breast cancer survivorship care plan no matter where they might be, especially when traveling.

Respondents were also asked "How willing would you be to use ACESO, if it were made available to you for free? Please explain with reasons". All of the respondents (15/15) stated that they would use ACESO, if it was made available to them free of charge. Some respondents expressed further interest (6/15) in the application by asking "So when does it come out?" or "Is it going to cost any money to use it?" towards the end of the interview session.

These responses from the respondents indicate a high level of acceptability, primarily owing to perceived usefulness and

uniqueness of an app such as ACESO, as well as its ease-of-use.

Usability

Task analysis

Each of the 15 respondents participated in the task analysis. The observations for each task were categorized as *Successful*, *Successful with assistance*, or *Not successful*. None of the respondents had any prior access to the prototype or prior experience with any other online breast cancer survivorship plan. Table 2 shows the list of tasks and their corresponding success rates.

User interface

The prototype demonstrated an overall high usability among lay users. The graphical user interface was found to be intuitive; however, the study identified various issues (Table 3) which would need to be addressed to make the prototype even more easy to use. Issues identified from user feedback and usability testing are listed in Table 3.

It was found that ACESO was fairly easy to use; however, the Observations Reports page was somewhat difficult to find on the website for several participants. Based on the testing results, the research team made significant improvements to the Web program content and incorporated key suggestions into the website. When no further changes were suggested by the user-testing participants, the ACESO website was finalized. Supplemental materials including the screenshots of the ACESO homepage and other webpages for the major domains of the website are included in the [Supplementary material](#).

Positive reinforcement

Respondents were also asked "What suggestions would you have to improve this app?" As one respondent pointed out, "You know, we become very sensitive after everything. Looking at this makes me somewhat anxious". Another respondent stated "I don't mind the alert messages but maybe make them more positive. I can't think of what you would use instead of 'Warning', right now ... hmm ... let me think about what other word would be better". Another respondent suggested "You have these warning messages, but I'd like to also see something positive, like 'Great work, Keep it up!', or something like that ... just makes you feel better, you know?" In particular, the presentation of the alert messages seemed to be the main point of issue. Each alert message appears at the top of the page, prefixed by the word "Warning!" The original intention was to make sure that the user does not miss these important alert messages, therefore they were given prominence on the Web page; however, some respondents (8/15)

Table 2 Task analysis—completion rate

Task	Successful (%)	Successful with assistance (%)	Unsuccessful (%)
1 Log in	15 (100)	0 (0)	0 (0)
2 Record symptom	12 (80)	3 (20)	0 (0)
3 Observe alert message	15 (100)	0 (0)	0 (0)
4 Record fatigue observation	13 (86)	1 (7)	1 (7)
5 Record post-treatment mammography completion date	14 (93)	0 (0)	1 (7)
6 Retrieve chemotherapy dates	15 (100)	0 (0)	0 (0)
7 Retrieve fatigue observation report	6 (40)	6 (40)	3 (20)
8 Find and list one local breast cancer resource	14 (93)	1 (7)	0 (0)
9 Log out	15 (100)	0 (0)	0 (0)

found the use of the word “Warning” to be anxiety-inducing. It must be pointed out that while respondents valued the alert messages function, they did not always agree with the way they were presented. Apart from the alert messages, some respondents also pointed out that while the look and feel of the website is functional and efficient, it felt too clear-cut (3/15). As one respondent said “It looks too clinical.” When further prompted to describe what she meant by “clinical,” she explained “Like something you’d see at the doctor’s office”. When asked about any changes they would like see in the website, another respondent said “Maybe make it more lively and fun.”

A predominant theme that emerged was that applications need to accommodate for the sensitivities of the group of end users. Communicating positive re-enforcement messages via use of more pleasant and sociable language and incorporating more visuals would make the application more sociable for breast cancer survivors.

Online user experience

All 15 respondents completed the anonymous online user experience survey online. Based on their experience with the prototype while performing the tasks, respondents rated their experience with the prototype on the basis of three dimensions: pragmatic, sociable, and usable. The survey utilizes a

7-point semantic differential scale, with a score of 1 being the most positive response and 7 being the most negative response.

Pragmatic

In the pragmatic category, the *informative* dimension was rated most negatively ($\bar{x}^- = 1.64$), while *useful* received the most favorable response ($\bar{x}^- = 1.07$). The participants rated ACESO very favorably in terms of its pragmatic value. These results indicate a high level of perceived usefulness of ACESO, which subsequently contributes to its overall acceptability.

Sociability

In the sociability category, the *social* dimension received the most negative score ($\bar{x}^- = 2.14$), while *inviting* and *friendly* had the most positive scores, as rated by respondents. While participants rated ACESO favorably in terms of sociability, the overall sociability score was lower in comparison to the other dimensions (pragmatic and usability).

Usability

Finally, in the Usability category, the respondents rated the *consistent* and (*not*) *stressful* dimensions most favorably

Table 3 Prototype usability issues identified via usability testing

1	On the Record A Symptom page, make the collapsible menu more intuitive by including a message describing how to access the sub-menu of symptoms
2	Modify the table layout of the Observations Due and the Follow-Up Care due panels, such that the entire cell (not only the text) is an active link, and clickable
3	Change the date format used to record doctor visits from YYYY-MM-DD to MM-DD-YYYY, to make it less confusing and more user friendly
4	Accessing the Observations reports page requires accessing a sub-menu, making it hidden at first glance on the page. Giving this more visibility and prominence on the page will make it more intuitive
5	On the resources page, indicate the definition of “Local” resources as “South-Eastern WI.”

($\bar{x} = 1.21$). Although the *simplicity* dimension still received a very positive score, it was rated most unfavorably ($\bar{x} = 1.47$), in comparison to other dimensions in the category.

Discussion

Overall, the developed prototype demonstrated a high level of acceptance among target users. Our findings are consistent with prior research on how lay people manage their personal health information at home [49], which indicates that several patients develop a style of storing their records in a common place, such as a drawer or file cabinet. The application was perceived to be valuable in its ability to organize and manage breast cancer-related health information in a portable and easy-to-access platform. Users also appreciated the ability to track and record post-treatment-related after effects. While the prototype was found to have overall high usability, it would benefit by incorporating a more sociable interface, including using positive reinforcement in the application's messaging. Areas of the application's user-interface that need modification to make it even more user-friendly were also identified.

With the increasing use of technology in the field of consumer health, various applications have gone beyond what the traditional provider online portal offers and have made self-management of various medical conditions such as cancer and other chronic ailments more accessible [42–45]. The major contribution of this research is the development of an intelligent resource tool, specifically designed for survivors of breast cancer. To the best of the current investigators' knowledge, a tool such as this is the first of its kind. While there do exist generic questionnaire-based systems to generate online survivorship plans, they are a one-size-fits-all solution and are not customized to the specific unique needs of an individual.

Based on the testing results, the research team made significant improvements to the Web program content and incorporated key suggestions into the website. When no further changes were suggested by the user-testing participants, the ACESO website was finalized. Supplemental materials including the screenshots of the final ACESO homepage and other webpages for the major domains of the website are included in the [Supplementary material](#).

Furthermore, ACESO taps a severely underused source of patient data by capturing self-reported quality of life measures [31, 50]; it is hoped that the system will help detect unusual changes in the patient's health and alert them in a timely manner. This could potentially also promote a better understanding of the patient's own medical condition, subsequently leading to better patient-provider communication and shared decision-making.

The developed prototype is unique such a way that it not only incorporates personalized breast cancer survivorship plans but also includes additional value added features, such

as being able to track and record observations at home and personal decision support in the form of timely alerts regarding treatment-related side effects and reminders for follow-up visits.

Breast cancer survivors can expect to experience several treatment-related side effects, several weeks after treatment. By employing a clinical decision support systems approach and incorporating feedback in the form of warnings, alerts, and reminders for the patient, the system explores making the patient experience more interactive for breast cancer survivors. Having easy access to their own personal health information allows the patients to share some responsibility in managing their health condition with their provider. Subsequently, self-management of treatment-related side effects can foster patient empowerment and a sense of being in control of one's own health. Being better informed about their health condition can also lead to a more meaningful interaction with one's physician, thus encouraging shared decision-making [51].

The results of the study hold important implications for clinical practice. By utilizing a personalized tool that incorporates personal decision support, new guidelines for breast cancer survivors can be implemented more efficiently, simply by updating existing decision rules. Additionally, developing a tool that is both usable as well as acceptable could result in higher patient education and engagement, which, in turn, could improve patient-provider communication. Being well informed about their current state of health, patients would be in a position to share decision-making with their provider and ask better, well-informed questions during their clinic/office visits.

This system demonstrates the potential role that more personalized and specialized online tools can play in filling the existing gap in the healthcare industry today. ACESO transforms the passive paper-format of breast cancer survivorship plans into a more interactive, smart, and dynamic tool. As patient engagement continues to become a vital component of Meaningful Use Stage 3, (which is a set of guidelines that providers need to comply with, as part of the HITECH Act [52]), healthcare providers should look at alternative means to more effectively engage patients in taking an active role in managing their health in a more interactive manner.

Limitations

While the present study provides important new insights into the design of a personal decision support-based online self-management tool, there are a few limitations to note. First, the study's sample size is small, thereby limiting overall generalizability; however, Travers [53] indicated that much can be learned from even a small number of respondents if open-ended questions are used in the interview process. This encourages generation of more and richer data, which, in turn

helps in the generation of more codes, categories, and concepts. Moreover, it has been suggested as best practice that usability studies include a minimum of 10 participants and that usability studies discover 80% of usability issues with as few as 4–6 participants [54]. Second, the Web-based intervention is in English, and therefore, all of the participants in the user testing were English-speaking. Third, the volunteer nature of recruitment could imply that the participants had a pre-disposed inclination for using technology in self-management of their health. However, the respondents in this study were similar to other breast cancer survivors in that their voices echoed similar themes found in the literature conveying habits of breast cancer survivors regarding their use of the Internet and technology [55–57]. Fourth, the application was evaluated among participants who were predominantly Caucasian. Further investigation may be needed among other user groups to increase generalizability. Finally, while the study is limited in terms of the ability to generalize the results, the investigators of this study are currently working to evaluate the tool in terms of its impact on survivor perceived quality of life, patient education and communication with their provider. If proven to have impact, the results would warrant further investigation in terms of implementation and dissemination in a broad range of clinical and community settings. Future research also involves investigating the integration of ACESO with the electronic health record and to evaluate its function and added value to both patients and clinicians.

Authors' Contributions AK conceptualized, designed, and developed the intervention, contributed to data collection, analysis, and wrote sections of the manuscript. PN contributed to the study design, interpretation, and analysis of results and wrote sections of the manuscript.

Funding This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sector.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

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