Usability evaluation of a mobile phone-based system for remote monitoring and management of chemotherapy-related side effects in Canadian cancer patients

Abstract

Background: Most chemotherapy is administered in the outpatient setting; therefore, patients are required to manage related side effects at home without direct support from health professionals. The Advanced Symptom Management System (ASyMS) has been developed to facilitate the remote monitoring and management of chemotherapy-related toxicity in patients with cancer, using standardized patient-reported outcomes (PRO) questionnaires.

Objectives: Our goal was to evaluate usability of this mobile phone-based technology from the perspective of Canadian cancer patients receiving chemotherapy where the objectives were to elicit their views, experiences and satisfaction with ASyMS and identify existing design, functionality, and usability issues.

Methods: A mixed-method approach to data collection with user-based testing, think aloud technique, semi-structured interviews, and short answer questionnaires was used with 10 cancer patients. Patients attended usability testing sessions at the Centre for Global eHealth Innovation, UHN. Participants performed specific tasks on the ASyMS device. The test was video recorded and each task was timed during the test. After the usability sessions, patients completed the post-test questionnaire and participated in a semi-structured interview. Thematic analysis was used to code and categorize the identified issues according to the type and frequency of occurrence. Also, a set of variables related to the participant’s performance including the number of errors each participant made, requests for help, the time taken to complete the task, participant feedback, and reviewing the videos was used to identify a list of usability issues.

Results: The thematic analysis generated three over-arching themes: (1) ASyMS user-friendliness, (2) Usefulness of the ASyMS (content quality & richness), and (3) Intention to use. Results from the post-test questionnaire indicate that 80% of participants (n=8) had great motivation to use the ASyMS, 70% (n=7) had positive perceptions of the successful use of the ASyMS, and all (n=10) had positive attitude towards using the ASyMS in future. Most identified design and functionality issues are related to the navigation of the ASyMS, using more advanced and attractive design with better functionality and features.

Conclusions: The ASyMS has shown positive perceptions by patients; however, evaluation of the ASyMS through a trial is needed.

Keywords
Introduction

Systematic chemotherapy continues to be a main treatment modality for almost all major cancers [1]. Chemotherapy is associated with a myriad of symptoms and adverse treatment side effects that can range from mild to life threatening, severe and disabling [2]. Most contemporary chemotherapy is administered in the outpatient setting thus patients who experience these symptoms and treatment side effects, do so at home between visits to the cancer clinic without the direct supervision of health care providers [3]. Therefore, early recognition and effective management of these symptoms by both clinicians and patients is critical to reduce physical and psychological treatment sequelae [2]. Poorly managed symptoms is not only a safety issue but is costly to the health system as evidenced in high rates of emergency department use and hospitalization [4-6].

Mobile technology may be an effective way of providing care and preventive management support to reduce the adverse effects of chemotherapy, facilitate behavior change, and improve health outcomes [7]. Evolving technical capabilities of mobile devices enable the provision of health services in all phases of the care delivery process (i.e. supporting prevention, diagnosis, decision, treatment, and follow-up [8]. It also enables patients to access these services at their convenience by shifting care from the acute hospital setting to the home [9, 10]. Mobile interventions using smartphone platforms for self-management in chronic diseases (i.e. chronic heart failure, asthma and diabetes) are shown to be effective on clinical outcomes and increased cost savings [11-14]. It is also shown that web-based symptom reporting for patients with advanced cancer resulted in better Health-Related Quality of Life (HRQoL), reductions in the rate of hospitalizations, fewer emergency room visits, a longer duration of palliative chemotherapy, and superior quality-adjusted survival [15]. Mobile communication technology is emerging as a solution to improve home-based, pro-active “real time” symptom monitoring and management and specifically for providing self-care advice to facilitate patient self-management [16, 17].

The delivery of health care services through mobile technologies (mobile phones and other wireless communication devices), is a rising trend and the number of available medical applications (apps) increased to more than 160,000 apps in 2015 [18]. However, most mobile health solutions using smartphones have been developed by start-up companies, seldom developed in line with best-practice usability guidelines, not rigorously tested, and have not
involved end-users such as clinicians or patients in their development [19, 20]. The effective design of mobile health interventions and essential factors that may contribute to effectiveness of the intervention can be achieved by delivering iterative assessments of the device interface by the end users through multiple cycles of design and evaluation to ensure optimal functioning and enhance the design features of the intervention [21, 22].

This study, which was part of a larger project to enhance provision of timely, high-quality, person-centered supportive care, evaluated usability of a mobile phone-based technology, the Advanced Symptom Management System (ASyMS), from the perspective of Canadian cancer patients (colorectal and lymphoma) receiving chemotherapy using a controlled usability testing environment, with potential users of the platform.

Advanced Symptom Management System (ASyMS)

The ASyMS is a mobile phone-based device designed to monitor and manage chemotherapy-related toxicity within the home setting. It enables real-time remote monitoring of cancer symptoms using patient-reported outcome measures (PROMs) [23]. Patients using ASyMS complete an e-symptom questionnaire on a locked mobile android phone and this information is automatically transmitted in real-time to a clinical server, which is password protected. Patients immediately receive evidence-based self-care advice on the mobile phone based on the specific symptoms that they have reported, which facilitates self-management of symptoms. Leveraging evidence-based algorithms, symptoms reported that meet a threshold criteria (i.e. high level of severity) trigger alerts to cancer care clinicians, usually the nurse, who on receipt of an alert, can view the patient’s symptom reports on a secure web page and contact the patient directly at home by telephone, enabling the initiation of proactive clinical interventions [24].

ASyMS was developed in the UK based on extensive patient and clinician engagement and its utility and acceptability has been tested in UK populations [25, 26]. The effects of the ASyMS intervention on patient outcomes is being tested in a large RCT being conducted in multiple sites across European countries (ie, Austria, Greece, Ireland, Norway and the UK) [27]. Utilizing a combination of real-time, symptom assessment and clinical algorithms, this model of care facilitates the early identification of toxicities, early within their trajectory, when they occur [23]. The ASyMS, or similar devices, have not been tested for use with Canadian cancer populations and a formal usability of the device was not originally conducted. Moreover, it cannot be assumed that cancer populations in different health care contexts will view a mobile device in similar ways. Thus, we undertook a pilot study to test the usability of the ASyMS from the perspective of Canadian cancer patients and engaged key informants regarding the implementation issues that would need to be addressed for its uptake into routine clinical care. In this paper, we focus on the results of the usability study.
A preview of ASyMS is shown in Figures 1.

**Figure 1: Patient handset (screenshots of the main menu, self-care advice, and PRO)**

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**Methods**

We used a mixed-method approach (qualitative and quantitative data sources) to increase the depth of evaluation and to support methodological triangulation to improve the reliability and validity of findings [28]. Mixed-methods also allow for a more comprehensive understanding of
patients experience and enable identification of specific usability issues [28, 29]. We performed a usability evaluation study of the ASyMS’s mobile phone device. A usability study evaluates how a specific process or product works for individuals and the extent to which a user can use a product to achieve specific goals (interaction between user and task in a defined environment) [30, 31].

We completed a mixed-methods approach to data collection that combined user-based testing, think aloud technique, semi-structured qualitative interviews based on Sandelowski [32], and short answer quantitative questionnaires. These methods have all been used widely for usability testing [33]. Specifically, think-aloud is a user-related method for assessing usability where users are encouraged to express their perceptions out loud as they interact with the system [34]. Patients’ experiences with the system can also be evaluated through qualitative interviews and questionnaires [35].

Participants and setting

Estimation of the sample size for a usability test depends on several variables including types of test users available, the mission criticality of a system (any factor that is essential for system operation), and problem discovery rate (number of usability issues that can be uncovered by users) [36, 37]. Although, it has been shown that 80% of the usability problems can be detected with four or five participants in a usability testing [38], Faulkner [37] found that the minimum percentage of identified usability issues increased from 55% to 82% and the mean percentage of issues increased from 85% to 95% when the number of participants was increased from five to ten. Therefore, for this study, we aimed to recruit a minimum of 10 patients. We used a purposive sampling method to ensure maximal variation in end-user characteristics, specifically younger (age<50 years old) and older (age >50 years old) adult patients with diverse cancers (colorectal or lymphoma), males and females, and those with and without experience in using mobile technology.

Institutional Review Board Approval (IA) was obtained from University Health Network (UHN) to conduct the study prior to recruitment (#15-9432). Patients were recruited from ambulatory follow-up clinics at Princess Margaret Cancer Center (PM) a cancer research centre, affiliated with the University of Toronto as part of the UHN. Inclusion criteria were that patients received at least one cycle of chemotherapy for treatment of their cancer (colorectal or lymphoma), were age >18 years, and able to participate in usability testing for “think aloud” in English. All participants gave informed written consent for participation in the study.

Data collection

The main goal of user-centered methods is to involve real users, elicit their views and experiences of the intervention to identify usability issues [39, 40]. To meet the aim of the
study, usability sessions were video-recorded from multiple angles, and participants were encouraged to share their thoughts verbally as they progressed through a set of pre-defined tasks (think aloud) [41]. Our aims were to elicit feedback from Canadian cancer patients and identify design, functionality, and usability issues. In addition, participant experiences, thoughts, feelings and satisfaction with ASyMS was assessed by an audiotaped semi-structured face-to-face qualitative interview with participants and completing a short questionnaire (Telehealth Acceptance Measure [TAM]), immediately after usability testing sessions (see Multimedia Appendix 1).

The TAM questionnaire is composed of 10 questions on a Likert scale ranging from 1 to 7; higher scores indicate greater motivation to use telehealth, more favorable perceptions of the successful use of telehealth, greater patients’ belief that significant others would like them to use telehealth, and more positive attitude towards using telehealth. The TAM questionnaire is designed to assess patients’ motivation to use telehealth and includes questions that are derived from the theory of planned behavior, a model that explains the factors that underpin people’s motivation to act [42]. We used this questionnaire to provide an indication of a patient’s overall motivation and readiness to use the ASyMS device, assess the patient’s perceived behavioral control, subjective norms, attitudes towards the device, and the extent to which individuals perceive that significant others want them to use device.

Patients were also asked to participate in an audiotaped, face-to-face qualitative interview to elicit and specify user requirements, identify the problems and their causes, and collect participants’ ideas for improvements [43].

Usability Testing procedure

Patients attended usability testing sessions at the Healthcare Human Factors labs at the Centre for Global eHealth Innovation, UHN. The usability laboratory at the center is composed of several flexible rooms used for performing usability testing studies, and they included a study lab and observation room. There were multiple cameras along the ceiling of study lab, and a one-way mirror observation room with monitors and video-recording equipment. Each participant was advised that the aim was to test the ASyMS device and not the participant. Participants also received written and verbal information regarding the testing procedure, and a brief introduction to ASyMS before usability testing commenced.

Before starting the session, participants completed a demographic questionnaire that asked about their age, gender, education level, and previous experiences with smartphones, computers, and use of the Internet. Participants were given a case scenario and/or a simulated experience they might have for symptoms during one of their chemotherapy cycles. Participants were requested to follow the tasks provided to them on the ASyMS device, representing typical
user goals. Throughout testing, each participant was requested to perform specific tasks that consisted of the following: 1) completing the e-symptom questionnaire on the ASyMS; 2) finding information about side effects and self-care; 3) filling out the anytime patient reported outcome symptom questionnaire; and 4) finding a history of side effects (see Multimedia Appendix 2). A trained moderator guided the participants through the testing procedure but did not intervene or disrupt the thinking aloud process. Also, from the observation room, behind a one-way mirror, two observers watched the interaction, made notes about what was verbalized and observed to inform the analysis, and ensured the entire session was recorded. The test was audio and video taped to create a set of audio/video recordings for later analysis and back up. Each task was timed during the test.

After the usability sessions, participants were requested to complete the post-test questionnaire on their perceptions about the usability of the ASyMS (see Multimedia Appendix 1). They also participated in an audiotaped, semi-structured, face-to-face interview regarding utility and acceptability of the ASyMS in managing chemotherapy symptoms, parts of the content or aspects of the system they liked or disliked, and the reason for their response. The participants were encouraged to discuss their experience working with the ASyMS device, problems they encountered and/or express their concerns and the possible design changes needed to address the identified issues. The complete testing procedure for all the steps averaged approximately two hours, with a range of 1.5–2 hours.

Data Analysis

The audio-and video recordings from the usability and interview sessions were transcribed. Thematic analysis was used to identify all emerging issues and the relations between the themes [44, 45]. The identified issues were coded and categorized according to the type and frequency of occurrence [44]. Two members of the research team reviewed the transcripts to ensure consensus on themes. All qualitative data were coded using NVivo 10 qualitative data analysis software. Also, a set of variables related to the participant’s performance including the number of errors each participant made, requests for help, the time taken to complete the task, participant feedback, observers and moderator’s notes, and reviewing the videos were used to identify a list of usability issues. Descriptive statistics (means, ranges, frequencies/percentages) were used to summarize this data.

Results

Participant characteristics

Characteristics of the study participants are shown in Table 1. Out of the 10 participants, 7 were male and 3 were female, with the average age of 68 (range 18-78). Most participants (n=8) had higher education (college or university). All participants had their own mobile phone, of which
70% (n=7) had a smartphone while 30% (n=3) of participants owned a regular cell phone (not a smartphone). Sixty percent (n=6) of participants mentioned that they are comfortable or very comfortable in using these devices. Moreover, 80% (n=8) of participants were comfortable using the Internet.

**Table1: Participant characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>N (%) (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>Median (range)</td>
<td>68 (18-78)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7 (70%)</td>
</tr>
<tr>
<td>Female</td>
<td>3 (30%)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>2 (20%)</td>
</tr>
<tr>
<td>University/college</td>
<td>5 (50%)</td>
</tr>
<tr>
<td>Post-Graduate Degree (e.g. PhD)</td>
<td>3 (30%)</td>
</tr>
<tr>
<td><strong>Own a phone</strong></td>
<td></td>
</tr>
<tr>
<td>Smartphone</td>
<td>7 (70%)</td>
</tr>
<tr>
<td>Regular cell phone</td>
<td>3 (30%)</td>
</tr>
<tr>
<td><strong>Hours use a computer each week</strong></td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>1-2 hours</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>4-5 hours</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>&gt;7 hours</td>
<td>7 (70%)</td>
</tr>
<tr>
<td><strong>Comfortable using a smartphone</strong></td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>A little comfortable</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>Comfortable</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>Very comfortable</td>
<td>2 (20%)</td>
</tr>
<tr>
<td><strong>Comfortable using a computer</strong></td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>A little comfortable</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>Comfortable using the Internet</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>Not at all</td>
<td>-</td>
</tr>
<tr>
<td>A little comfortable</td>
<td>2(20%)</td>
</tr>
<tr>
<td>Comfortable</td>
<td>4(40%)</td>
</tr>
<tr>
<td>Very comfortable</td>
<td>4(40%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GI</td>
<td>3(30%)</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>7(70%)</td>
</tr>
</tbody>
</table>

Quantitative Results

Using the video analysis, the task completion times, the numbers of errors made by participants while completing tasks, and the number of times they asked for help, are shown in Table 2. In addition, all participants completed a modified version of the TAM with the addition of three questions regarding the acceptance and satisfaction of using the ASyMS device. Eighty percent of participants (n=8) scored more than 4 on Q2, Q4, and Q5 (Mean=5.8), indicating high motivation to use the ASyMS device. Also, 70% of participants (n=7) scored more than 4 on Q3, Q6, and Q7 (Mean= 5.6), indicating they had positive perceptions of the successful use of the ASyMS, and all participants (n=10) scored more than 4 on Q8 and Q9 (Mean= 6.1), showing they believed that significant others would like them to use ASyMS. Also, all participants (n=10) scored 5 or higher on Q10 (Mean= 6.3), demonstrating a positive attitude towards using the ASyMS device in future (Table 3).

**Table 2: Quantitative results (time and standard deviation, errors, and requests for help)**

<table>
<thead>
<tr>
<th>Task</th>
<th>Time (SD), seconds</th>
<th>Errors (SD)</th>
<th>Requests for help (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1 a</td>
<td>846 (135)</td>
<td>2.7 (1.85)</td>
<td>5.2 (3.15)</td>
</tr>
<tr>
<td>Task 2 b</td>
<td>502 (250)</td>
<td>5.7 (2.43)</td>
<td>3.5 (2.18)</td>
</tr>
<tr>
<td>Task 3 c</td>
<td>232 (124)</td>
<td>3.8 (1.9)</td>
<td>4.1 (0.93)</td>
</tr>
<tr>
<td>Task 4 d</td>
<td>257 (70)</td>
<td>3.7 (1.56)</td>
<td>2.9 (1.05)</td>
</tr>
</tbody>
</table>

a: Complete e-symptom questionnaire  
b: Find information about side effects and self-care  
c: Filling out anytime questionnaire  
d: Find history of side effects
Table 3: Telehealth Acceptance Measure: Mean scoring

<table>
<thead>
<tr>
<th>Participants’ ID</th>
<th>Behavioral intention item</th>
<th>Perceived behavioral control item</th>
<th>Subjective norm item</th>
<th>Attitude item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>6.3</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>5.7</td>
<td>4.3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>6.3</td>
<td>5.5</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>5.3</td>
<td>3</td>
<td>6.5</td>
<td>6.3</td>
</tr>
<tr>
<td>6</td>
<td>3.7</td>
<td>7</td>
<td>7</td>
<td>6.7</td>
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<tr>
<td>7</td>
<td>5.3</td>
<td>6</td>
<td>6</td>
<td>5</td>
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<tr>
<td>8</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>3.7</td>
<td>3</td>
<td>5</td>
<td>6.3</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Qualitative Results

The thematic analysis of the interview transcripts and participants' feedback generated three over-arching themes and related sub-themes: (1) ASyMS user-friendliness, with sub-themes of design, navigation, and ease of use of ASyMS, (2) Usefulness of the ASyMS (content quality & richness), with sub-themes of self-care advice and information on the ASyMS, and appropriateness of the ASyMS questions and (3) Intention to use, with sub-themes of acceptance and satisfaction with using the ASyMS in future.

ASyMS User-Friendliness

Both the quantitative and qualitative data from the usability testing identified several design and functionality issues on the ASyMS's device that may negatively impact its efficient use. Each of the recognized issues was mapped to source events (i.e. participant’s feedback, errors, and moderator observation). Moreover, each of the issues was classified in one of eight usability heuristics for mobile devices (i.e. match between system and the real world, ease of input, and screen readability) [46].

Table 4: Identified usability issues

<table>
<thead>
<tr>
<th>Problem</th>
<th>Category (usability heuristics)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction screen not intuitive nor informative enough</td>
<td>Match between system and the real world</td>
<td>Feedback; Errors; Request for help</td>
</tr>
</tbody>
</table>
The identified issues shown in Table 4 mostly relate to the navigation of the ASyMS device. Most of the comments from participants through usability testing and/or the interview were about the need for a more advanced and attractive design with better functionality and features in ASyMS to better address the needs of end-users, as indicated below:

“Finding where everything is, it’s not labelled, so it would be easier if every option was labelled…. I think it needs a higher-level menu, which may have to be categorized, which allows me to navigate around through it easily” (Patient 1).

“...add a search button. Having a search button just kills so much time. You can access the entire database in like 2 seconds. Saves a lot of time... I wish it had a search button” (Patient 5).

Some participants commented that they would prefer to use ASyMS on a device with a larger screen (with larger font size) and a more effective color scheme that better draws the user’s attention towards specific elements on the screen.

“A bigger screen for people who need glasses .... someone like me whose vision is affected needs a bigger screen” (Patient 4).

“It is always nice for someone in my age if got a bigger text... Of course, if you could make it bigger, would be great” (Patient 7).

“I have an iPhone, which the text isn't very much bigger than that, right? Like the text is the same basically. But the screen colors, like this screen colour to me (shows iPhone) is a lot easier to read than this (shows the ASyMS’s handset)” (Patient 3).

As participants were not familiar with the system prior to the usability session and no tutorial of the ASyMS and its functionalities was given, they often felt insecure about their actions and

<table>
<thead>
<tr>
<th>Small screen/font size</th>
<th>Screen readability</th>
<th>Feedback; Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of having an effective color scheme</td>
<td>Screen readability</td>
<td>Feedback; Observations</td>
</tr>
<tr>
<td>Lack of advance options (e.g., search option)</td>
<td>Consistency and mapping</td>
<td>Feedback; Observations</td>
</tr>
<tr>
<td>No option to (send message) chat with clinician</td>
<td>Ease of input</td>
<td>Feedback; Observations</td>
</tr>
<tr>
<td>Problem with editing and no obvious go back option</td>
<td>Ease of input/ Consistency and mapping</td>
<td>Feedback; Errors; Request for help; Observations</td>
</tr>
</tbody>
</table>
asked for assistance and approval before performing tasks. Most participants mentioned that they would need some time to learn and get familiar with the ASyMS device before they could start to use it regularly. By the end of the usability sessions, when participants had gained some experience with using ASyMS, all of the participants agreed that with experience in using ASyMS, they would get familiar with its features and definitely use it more efficiently, as noted in the following participant quote:

“If people use this a few times they will be able to (use and) navigate it easily” (Patient 6).

Usefulness of the ASyMS

Regarding the self-care advice and information provided in the library, almost every participant commented that ASyMS provides a lot of quality information. Two participants suggested that using the information would be easier if information in the device were better categorized.

“The information section, I would rather have that more generalized and categorized. It is easier for the person to use” (Patient 6).

“There is no easy way to find information here. You have to read the entire list to get what you want, and probably read more than once. Categorization would improve that” (Patient 2).

One participant suggested that it would be helpful if the information and/or advice would be customized to the specific therapy that patients receive. He also commented that the self-care information he sought was not covered in the self-care advice as he experienced different treatment toxicities and suggested to modify and enhance the self-care advice.

“It would help if you could customize to the individual … the specific therapy they are receiving…There is one major thing, that is the food. One of the problems in my experience, I went through two different regimens of chemotherapy, different elements of the regimens have different food requirements, some for example do not allow caffeine or alcohol or meat products or spices. None of that is here, that would be helpful if me and my wife are about to contemplate dinner and it tells us can I eat such and such, those answers would be helpful in terms of my chemotherapy. This app tells us about chemotherapy in general, whereas different patients have different regimens of chemotherapy...” (Patient 8).

Intention to Use

All participants mentioned that the ASyMS would be a valuable device to use in future for managing cancer treatment side effects. Results from TAM and the interviews suggested that almost all participants were satisfied and pleased with their experience in using the ASyMS device and this positively influenced their attitude towards use of ASyMS in future. Participants indicated that they are confident that the problem of communication with their health care
provider can be solved (to some extent) by using such a device and it will help patients to manage their symptoms quicker than the other current available options.

"Clinician is typically in a hurry, not using a lot of words, sometimes very technical words... easy to get snowed... I always try to bring my wife or my son or my daughter, so they can hear what the doctor says and also ask questions. The conversation between me and my doctor is brief and complex. If I have any questions later, I cannot reach them...I call their secretary, who asks that clinician, and gets back to me in a few days...makes it impossible to ask follow up questions. There is a problem with the nature of this communication, which a system like ASyMS could improve, if it provided for multiple interactions... I can see value in such a system if it provided that capability" (Patient 10).

"it actually would give you a pretty good history. And probably you would be able to deal with the nasty symptoms quicker than the other options which is trying to contact your doctor or nurse, and its not that easy" (Patient 2).

Discussion

The ASyMS has undergone several years of development [24, 25] to monitor and manage chemotherapy-related toxicity within the home setting. It has been tested in several patient populations and positive perceptions by patients and health professionals have been shown regarding the utility and feasibility of the system and improvements in symptom outcomes [23, 24]. The purpose of this evaluation was to focus upon the usability issues and evaluate how the interface supports end-users when carrying out a set of typical tasks using a think aloud method, performance testing, and question-asking methods with Canadian cancer populations. This usability evaluation study was part of a broader study to understand the potential barriers to implementation of ASyMS in the Canadian health care context and part of the data was used to further customize the ASyMS device prior to conducting a feasibility randomized trial (Registration: Clinicaltrials.gov NCT03335189).

The main general design recommendations (according to usability heuristics) for enhancing features of ASyMS are: (1) enhance readability and glanceability of screen and (2) implement advance options (including: search option, easy identifiable back option, intuitive pop up screen option, and advanced navigation options [eg, swiping screens] for expert users); and (3) support navigation by creating an option to customize main menu features, particularly the self-care advice to make it easier to find rather than reading through lengthy text.

Concerns have been raised in the literature that use of modern technologies such as mobile devices may not be entirely appropriate for use by all cancer populations, since it might be considered difficult to use. For example, older adults may experience difficulties when using technologies such as mobile devices or smartphones [47]. However, there has been a growing
interest in the design of technologies, including innovative health technology design for older adults, who often manage complex health conditions and multiple chronic illnesses, to provide better and more sufficient supportive care services [48]. Our study findings demonstrated that older participants (>65) were interested and had a positive attitude towards using the ASyMS device, although a few of them mentioned that they prefer to use ASyMS on a larger device with larger font size. Also, they mentioned that their performance was affected by age related physical and mental health status. This trend is also shown in previous research that also demonstrated that older adults are interested and capable of using modern technologies for managing health care issues [49-51].

Furthermore, limited experience with aspects of mobile technology did not affect the acceptance of the mobile device in our study. This is also consistent with the result of a recent literature review indicating that mobile devices such as smartphones can be ideal tools for novice users who have very little understanding of how software or a system in general works, as users learn how to use a touchscreen after a few tries [47]. Although none of the participants had previous experience in using the ASyMS device, all of them became proficient during or by the end of usability testing sessions indicating that the training period does not need to be long; nevertheless, incorporation of tutorials and training are important to reduce the time needed by users to learn how to use the system [52, 53]. The training should focus on the system features that are more problematic, challenging, and complex for users [51]; and ensuring that patients feel confident in the use of the system.

Aside from the design issues and problems observed in the usability testing, patients also commented on the content of ASyMS and current availability of resources to self-manage treatment symptoms. Previous research has shown that a higher perception of the content richness in a system has resulted in a higher perception of the usefulness of the system [54]. Content richness is defined as the sufficiently of resources that users can access to improve their activity on a particular technology [55]. As noted by Lee and Lehto [56], content richness is a key significant predictor of perceived usefulness [57]. The results of this study showed that it would be useful to enhance the self-care advice and personalized tailoring to better support patient taking the required actions for symptom self-management. Evidence-based guidelines for symptom management have been developed [58] and best practices in presenting information in an “actionable” format should be considered in future design of the ASyMS device. Additionally, since patients have different learning styles use of an extensive library of written, audio and video information resources and patient education materials and guidelines for symptom self-management would be beneficial.

Although usability takes into consideration a combination of factors (including intuitive design, ease of learning, efficiency of use, memorability, error frequency, and user satisfaction [59, 60]),
one usability evaluation cannot claim to cover all possible and critical usage situations that can possibly occur. In addition, rigorous evaluation of the ASyMS device through a trial is needed where test the system in real-world situations, which are highly variable [51, 61]. We have customized some of the features in the ASyMS device based on the data derived from this study and a feasibility randomized controlled trial (RCT) is now underway (Trial number: NCT03335189) that will identify implementation and context-related issues prior to a larger, multi-site RCT in Canada.

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Conflict of interest

None declared.

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