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Towards a Patient-Centered Design of a Cancer Telerehabilitation System

Irena PARVANOVA[a.1], and Joseph FINKELSTEIN[a]
[a]Icahn School of Medicine at Mount Sinai, New York, NY, USA
ORCiD ID: Irena Parvanova https://orcid.org/0000-0002-1861-193X, Joseph Finkelstein https://orcid.org/0000-0002-8084-7441

Abstract. Successful implementation of telehealth platforms requires a detailed understanding of patient's needs, preferences, and attitudes toward a home-based platform. The goal of this study was to identify patient-centered characteristics of a cancer rehabilitation system based on cognitive evaluation of user interface and semi-structured qualitative interviews. Quantitative and qualitative feedback from 29 patients with metastatic urogenital cancer was collected after using a cancer telerehabilitation system. Heuristic evaluation, cognitive walkthrough, and analysis of qualitative interviews demonstrated a high level of support for the concept of home-based cancer telerehabilitation by cancer patients. Post-task surveys demonstrated sufficient usability and satisfaction scores from the participants. The patients provided valuable and insightful comments on how to further improve the functionality and interface of the platform. Further improvement of the system usability, consistency, and accessibility based on the patient-centered design principles will significantly facilitate the implementation of cancer telerehabilitation in clinical practice.

Keywords. Telerehabilitation, usability, patient-centered design, cancer.

1. Introduction

Cancer rehabilitation has been shown effective in cancer survivors for attenuating their symptoms, reducing inactivity and disability, and improving clinical outcomes and quality of life [1]. Telehealth approaches can broaden access to rehabilitation programs [2-3]. However, their successful implementation requires a detailed understanding of patients' needs, preferences, and attitudes toward a home-based telerehabilitation system [4-5]. In our previous work, user-centered specifications were identified for telerehabilitation in patients with cardiopulmonary [6-7] and neurodegenerative conditions [8-9] and demonstrated high acceptance of telerehabilitation by patients with chronic health conditions and older adults [10-11]. The goal of this study was to identify patient-centered characteristics of a cancer rehabilitation system based on cognitive evaluation of user interface and semi-structured qualitative interviews.

[1] Corresponding Author: Irena Parvanova, Irena.Parvanova@mountsinai.org.

2. Methods

Twenty-nine patients diagnosed with metastatic urogenital cancer and receiving outpatient oncology care at the Mount Sinai Health System were enrolled in the study. They were asked to review the system's functionality using a touchscreen tablet, complete three representative tasks, and then provide open-ended feedback in a qualitative interview. The cognitive assessment of the user interface comprised a heuristic evaluation and cognitive walkthrough. 22 out of the 29 patients tested the cancer telerehabilitation platform during an outpatient chemotherapy session, while 7 patients evaluated the platform after an office visit with their oncologist. The study subjects used Home Automated Telemanagement (HAT) system [12] adopted for cancer telerehabilitation to support individualized exercise as previously described [13].

Once introduced to the process, participants were instructed to complete baseline surveys which included a sociodemographic questionnaire and the Rapid Estimate of Adult Literacy in Medicine (REALM). For the cognitive assessment, the subjects were instructed to use the cancer rehabilitation system to complete three representative tasks. The three tasks were as follows: (1) log into the system; (2) complete symptom survey; (3) review, perform and complete an exercise. After completing each task, the participants were asked to fill in a post-task survey rating their experience (Table 1). After completing all three tasks, the participants were asked to complete a heuristic evaluation survey, a system usability survey (SUS), and a semi-structured qualitative exit interview.

Table 1. Analysis of post-task patients' surveys.

Task	N	Mean	SD
Task1 Content Easy/Difficult	29	4.8	0.4
Task1 Questions Easy/Difficult	29	4.8	0.4
Task1 Satisfaction	29	4.7	0.7
Task1 Amount of Time	29	4.7	0.9
Task1 Visually Appealing	29	4.4	1
Task1 Easy to Navigate	29	4.5	0.9
Average	**29**	**4.7**	**0.7**
Task2 Content Easy/Difficult	29	4.7	0.5
Task2 Questions Easy/Difficult	29	4.7	0.5
Task2 Satisfaction	29	4.7	0.7
Task2 Amount of Time	29	4.5	0.9
Task2 Visually Appealing	29	4.6	0.7
Task2 Easy to Navigate	29	4.7	0.6
Average	**29**	**4.7**	**0.7**
Task3 Satisfaction	28	4.7	0.5
Task3 Amount of Time	28	4.5	0.7
Task3 Visually Appealing	28	4.5	0.7
Task3 Easy to Navigate	28	4.6	0.6
Average	**28**	**4.6**	**0.6**

Post-task surveys (Table 1) asked participants to rank each task on a Likert-like scale of 1 (very difficult) to 5 (very easy). Survey questions for Tasks 1 and 2 included: 1) How difficult or easy was it to review the content and finish the sections? 2) How difficult or easy was it to answer the questions? 3) How satisfied are you with using this system to complete this task? 4) How would you rate the amount of time it took to complete this task? 5) Is the system visually appealing? 6) Is the system easy to navigate?

These questions were followed by two open-ended questions that asked the participants to describe any problems and offer additional feedback. Task 3 asked patients to rank their satisfaction, and time spent testing the system, visual appeal, and ability to navigate the system. Survey questions for Task 3 included: 1) How satisfied are you with using the system to complete this task (very unsatisfied = 1) to (very satisfied = 5)? 2) How would you rate the amount of time to complete this task (too much time = 1) to (very little time = 5)? 3) Is the system visually appealing (strongly disagree = 1) to (strongly agree = 5)? 4) Is the system easy to navigate (strongly disagree = 1) to (strongly agree = 5)? They were followed by two open-ended questions for patients to share additional comments.

3. Results

We collected data from 29 cancer patients who provided their feedback on the characteristics, functionality, and usability of a cancer rehabilitation system. The mean patient age was 64.8±11.6 (45 to 85 years old). 79% of the subjects were males. 17% of the participants were Blacks, and 79% were Whites, a race of one person was not identified. 76% of the patients tested the platform during chemotherapy treatment, while 24% of the patients evaluated the system after an office visit with their oncologist.

Task self-assessment results are presented in Table 1 as averages, with a score of 5 indicating the highest satisfaction. The content difficulty for Task 1 was found to be 4.8. The question's difficulty was found to be 4.8. Satisfaction and amount of time spent on exercise scored at 4.7. Visual appeal was found to be 4.4, while Ease of navigating was found to be 4.5.

Content difficulty and Question difficulty for Tasks 2 scored at 4.7, Amount of time spent – at 4.5, Visual appeal rated at 4.6, and Easy to navigate was 4.6.

Satisfaction for Task 3 was found to be 4.7, while the Amount of time spent, and Visual appeal scored at 4.5. Finally, Easy to navigate was rated at 4.6 (Table 1).

The heuristic evaluation's highest mean score was 4.7 for 'Match (between system and real world)', 'Buttons to go back or move forward (control/ freedom)', and 'Consistency', whereas the lowest mean score of 4.3 was ascribed to 'Error prevention' (Table 2).

Table 2. Heuristic evaluation assessment.

Heuristics	N	MEAN	SD
1. The system shows you what's going on and gives you feedback (visibility)	29	4.5	0.9
2. Language and words make sense (match between system and real world	29	4.7	0.6
3. There are clearly marked 'exits', buttons to go back or move forward (control/freedom)	29	4.7	0.6
4. Words, situations, and actions mean the same thing as elsewhere (consistency)	29	4.7	0.5
5. There are very few errors, and minimal error-prone conditions (error prevention)	29	4.3	1.1
6. Instructions are obvious, no need to remember how things work (recognition, not recall)	29	4.5	0.7
7. The system works for both new and expert users (flexibility, efficiency of use)	29	4.5	0.8
8. Information is streamlined and relevant (aesthetic / minimalist design)	29	4.4	0.9
9. Error messages are clear and in plain language (recognize, recover from errors)	28	4.5	0.6
10. Help is available, searchable, and relevant(help and documentation)	28	4.4	0.8

The mean System Usability Scale (SUS) score was 86.3, which corresponds to 'above average' usability rating placing this system at greater than the 90th percentile for usability (Table 3). The semi-structured qualitative interviews (QI) captured changes that the patients recommended to occur in order to further improve the platform.

Table 3. SUS score results (N=29).

Average of the SUS Score (N=29)					
N	**Mean**	**Std Dev**	**Minimum**	**Median**	**Maximum**
29	86.3	16.1	50	95	100

The qualitative interviews focused on content, interface, and process for the cancer rehab system, where patients discussed the following topics: individuality and setup, system and clarity, and accessibility and overview. Some of the recommended changes included adjustment of the volume of the system, correcting misspellings, requests for additional assistance with the touchscreen, and a suggestion for a text message from the system to remind patients to exercise (Table 4).

Table 4: Concept map of recommended changes based on patient feedback.

RECOMMENDED CHANGES					
CONTENT		**INTERFACE**		**PROCESS**	
Individuality	**Setup**	**System**	**Clarity**	**Accessibility**	**Overview**
Volume needs to be increased	Issues with entering answers into the surveys	Demonstration is required for touchscreen during the initial use	Issue using the touchscreen to re-size and scroll through the menu	Both audio and visual along with substitles are required for patients' with hearing problems	Interface design is primitive and not polished
Number of required sets to appear first, followed by number of completed sets (left to right to avoid confusion)	Misspellings	Assistance is required of how to use the system	Lack of comfort using the tablet and navigating the interface	Preference for both audio and visual exercise prompts and counts	Remove the word "Cancer"
Video, background, and instructor are distracting	Instructor's accent is difficult to understand	Minor assistance is needed	For questions requiring a numerical answer - have the numbers appear	An option is requested to exercise without the tablet to avoid additional steps navigating the sensitive touchscreen	Send reminder text messages to patients to complete the guided exercises

4. Discussion

Twenty-nine patients with metastatic urogenital cancer were able to successfully complete all representative tasks when they used the cancer telerehabilitation system. The cognitive evaluation of the platform revealed that patients were highly interested in using a cancer telerehabilitation system at their homes. The high scores of the post-task

surveys showed that the system is easy to operate, the interface is easy to navigate, and the overall experience was satisfactory. Low post-task scores revealed gaps in the visual appeal of the system. The heuristic evaluation confirmed high acceptance of the system content, interface navigation, and workflow consistency. The users pointed out minor misspellings and inconsistencies which can be easily addressed. The mean of the system usability survey (SUS) was 86.3, which placed the platform at >90th percentile for usability. The changes recommended by the patients will facilitate further improvement of the system by implementing a patient-centered design tailored to their individual needs, preferences, and attitudes.

5. Conclusions

Overall, the patients demonstrated high acceptance of a cancer telerehabilitation system. A concept map reflecting patient needs, preferences, and expectations for a cancer telerehabilitation system has been constructed. Further improvement of the system's usability, consistency, and accessibility based on the patient-centered design principles will facilitate the implementation of cancer telerehabilitation in routine clinical care.

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