

Feasibility and Experiences of Using Virtual Reality in a Rehabilitation Program for Breast Cancer Patients: A Phenomenological Study

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Submitted to: JMIR Serious Games
on: November 03, 2022

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Feasibility and Experiences of Using Virtual Reality in a Rehabilitation Program for Breast Cancer Patients: A Phenomenological Study

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Abstract

Background: Surgery is an essential treatment for early breast cancer. However, the management of side effects after breast cancer surgery, such as arm dysfunction and lymphedema, remains a cause for concern. Rehabilitation exercises for such side effects should be initiated within 24 hours after surgery. Virtual reality (VR) can assist the process of rehabilitation; however, the feasibility and experiences of applying VR for rehabilitation must be explored.

Objective: This study aimed to determine the feasibility of developing a VR rehabilitation system for patients with breast cancer and the potential accessibility of such a system. In addition, this study explored patients' attitudes toward and experiences of using VR for their rehabilitation.

Methods: A phenomenological qualitative study was conducted from September to December 2021. Eighteen patients with breast cancer who had undergone surgical treatment were interviewed using open-ended questions. Colaizzi's seven-step procedure for phenomenological analysis was employed for data analysis. To ensure high study reliability, this study followed Guba and Lincoln's quality criteria for trustworthiness.

Results: Four themes were identified: (1) increased recognition on rehabilitation exercises, (2) positive support through real-time interaction, (3) Inspired motivation to engage in early rehabilitation exercises, and (4) challenges of extensive VR use to be overcome. Most of the interviewed patients reported positive experiences using VR for rehabilitation. Specifically, they were able to understand appropriate motion and angle limits while exercising, and they reported perceiving moral support and enjoying good company when using the system. In addition, the gamified nature of the system apparently made VR-based rehabilitation more engaging than traditional rehabilitation. However, the high cost of VR equipment makes VR-based rehabilitation difficult to perform at home.

Conclusions: The interviewed patients with breast cancer had positive experiences in using VR for rehabilitation. High costs of both VR equipment and software development present an application challenge for VR-based rehabilitation.

(JMIR Preprints 03/11/2022:44025)

DOI: <https://doi.org/10.2196/preprints.44025>

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Original Manuscript

Original Paper

Feasibility and Experiences of Using Virtual Reality in a Rehabilitation Program for Breast Cancer Patients: A Phenomenological Study

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Abstract

Background: Surgery is an essential treatment for early-stage breast cancer. However, various side effects due to breast cancer surgery, such as arm dysfunction and lymphedema, remain causes for concern. Rehabilitation exercises to prevent such side effects should be initiated within 24 hours after surgery. Virtual reality (VR) can assist the process of rehabilitation; however, the feasibility and experiences of applying VR for rehabilitation must be explored.

Objective: This study explored patients' attitudes toward and experiences of using VR for their rehabilitation to determine the feasibility of such VR use and to identify potential barriers.

Methods: A phenomenological qualitative study was conducted from September to December 2021. Eighteen patients with breast cancer who had undergone surgical treatment were interviewed using open-ended questions. Colaizzi's seven-step procedure for phenomenological analysis was employed for data analysis. To ensure high study reliability, this study followed Guba and Lincoln's quality criteria for trustworthiness.

Results: Three themes were identified: (1) VR was powerful in facilitating rehabilitation, (2) early and repetitive upper limb movements: advantage to VR rehabilitation, and (3) challenges of extensive VR use to be overcome. Most of the interviewed patients reported positive experiences of using VR for rehabilitation. Specifically, VR helped these patients identify appropriate motion and angle limits while exercising; in other words, knowledge gained through VR can play a key role in the rehabilitation process. In addition, the patients reported that the use of VR provided them company, similar to when a physiotherapist is present. Finally, the gamified nature of the VR system seemed to make VR-based rehabilitation more engaging than traditional rehabilitation, particularly with respect to early rehabilitation; however, the high cost of VR equipment makes VR-based rehabilitation difficult to implement at home.

Conclusions: The interviewed patients with breast cancer had positive experiences in using VR for rehabilitation. High costs of both VR equipment and software development present an application challenge for VR-based rehabilitation.

Keywords: breast cancer; rehabilitation; virtual reality

Introduction

Breast cancer is a major global health problem. In Taiwan, more than 10,000 women were diagnosed with breast cancer every year; approximately 80% of these diagnoses were early-stage breast cancer, and most required surgical treatment[1]. More than one in five women who were breast cancer survivors might eventually suffer from upper limb lymphedema[2]. In addition, the life expectancy of patients with stage 0 to stage 3 breast cancer is 20–32 years [3]. Breast cancer treatments include surgery, radiation therapy, chemotherapy, endocrine therapy, and targeted therapy. Because of advancements in diagnosis and treatment in recent years, the 5-year relative survival rate of breast cancer is now higher than 80% [4]. However, both ancillary dissection and axillary radiation are known to increase the incidence of lymphedema and axillary web syndrome [5], and associated symptoms include pain, upper extremity weakness, paresthesia, and limited range of motion (ROM), each of which can not only delay the commencement of radiation therapy but also lead to an inability of patients to perform basic self-care tasks. This is a problem because less mobile patients are more likely to experience side effects after surgery; for example, a frozen shoulder is a side effect that commonly occurs in the short term as a result of immobility after surgery [6]. These associated symptoms may persist for up to 1.5 years after surgery and therefore predispose patients to depression and other mental health conditions that can become long-term health problems [7,8].

Studies have suggested that the early commencement of postoperative rehabilitation exercises, including upper extremity abduction and flexion exercises, can reduce the risks of upper extremity pain and dysfunction [9,10]. Although the optimal time to start ROM exercises remains unclear, one study suggested that activity recovery tends to be more successful following earlier rehabilitation [11]. Typically, rehabilitation is recommended to be commenced within the first 7 days after surgery, with shoulder ROM be limited to 90° initially [12]. Hence, a patient's willingness to undergo rehabilitation after surgery to prevent their arms from becoming motionless is essential. However, after surgery, a patient's motivation to undergo physical rehabilitation tends to be low because of wound pain and fear of movement [13,14].

Virtual reality (VR) can reduce fear of movement and improve motivation to engage in rehabilitation. In addition, VR can promote compliance and rehabilitation success among patients [15-17]. Furthermore, VR appears to be effective in increasing shoulder ROM compared with standard physiotherapy for postoperative rehabilitation in patients with breast cancer [18]. The use of VR for rehabilitation is not new; however, feasibility studies that provide individualized, progressive practice of arm movements after surgery for breast cancer patients by using VR remain scarce. Feasibility research is often conducted prior to a randomized controlled trial [19]. In recent years, most studies investigating VR for rehabilitation in patients with breast cancer have used randomized controlled design and have been prospective, adequately powered, and methodologically rigorous. Nevertheless, according to core recommendations related to VR [20], the development of new VR content should include three phases of VR1 to VR3. VR1 provides guidance for the development of new VR content; VR2 constitutes early testing related to the feasibility, acceptability, tolerability, and initial clinical efficacy of VR; and VR3 is conducted to evaluate the efficacy of VR in comparison with control trials. Bypassing feasibility and accessibility tests to jump immediately to clinical trials

may lead to a gap between program development and bedside application, and cause barriers to practice reality. Even though VR is effective in improving rehabilitation effects in breast cancer patients with sound evidence, VR is not currently used in many clinical settings. According to Brennan, et al. [21], barriers to the implementation of VR include usability problems, cognitive limitations, cost, a lack of patient safety, low patient motivation, and negative patient responses. In addition, VR's unfamiliarity to many patients may dampen their willingness to use VR [22]; thus, patients' attitudes, experiences, and opinions related to VR must be understood. Further explorations of feasibility and accessibility are recommended for the use of VR in health care [23,24].

To the best of our knowledge, most studies regarding postoperative rehabilitation in patients with breast cancer were clinical trials as VR3 that evaluated only treatment effects, such as pain, grip power, muscle power, or ROM. A VR2 study is skipped. This study employed a phenomenological approach to investigate the feasibility and experiences of this VR rehabilitation program (VR2) in patients with breast cancer. Therefore, the present study was conducted to answer the following questions: (1) What are their lived experiences of using virtual reality for arm rehabilitation, and (2) how do they perceive the process? In doing so, this study determined the clinical effectiveness of and barriers to VR rehabilitation as a prelude to a definitive randomized controlled trial.

Methods

Design and Development of the VR System

The VR system in this study was designed and developed in accordance with the VR-CORE-VR1 guidelines [20]. The present VR design team was a multidisciplinary team comprising users and technicians. The rehabilitation program was developed in three stages, which are described as follows. The first stage was based on inspiration gained through empathy. Specifically, interviews were held with two patients who were invited to share their rehabilitation experiences and express their perspectives and opinions to facilitate the design of an effective VR-based treatment program. The interview questions of this stage considered (1) Smart device usage behavior (2) Willingness/acceptability of using VR rehabilitation systems. The second stage involved ideation through team collaboration. Specifically, our team comprised experts in surgery, rehabilitative physicians, software engineering, and a case manager. Innovative ideas were generated through methods such as brainstorming and collective ideation, and the ideas that were most suitable for prototyping were then compiled. The third stage involved prototyping based on user feedback. Specifically, further discussions were held with the aforementioned two patients to obtain further information. Our team then built prototypes to test three VR rehabilitation exercises prior to implementation (Table 1). Ultimately, we extracted three key sets of limb motions that are described as follows. The first was a whack a mole-like motion that involved the abduction of the shoulder (no more than 90°). The second motion was akin to wiping a table that involved external forearm rotation. The third motion was akin to combing one's hair that involved flexion of the shoulder (no more than 90°) (Figures 1–3). This study used the PC-based Oculus Quest 2 head-mounted display (HMD) to provide the most immersive VR experience possible.



Figure 1. Integration workflow of My Health Bank software development kit and mobile app.

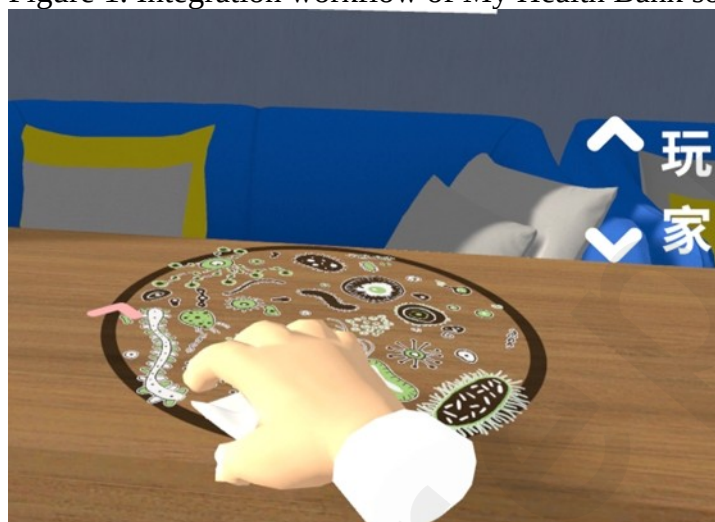


Figure 2. Identity verification process of My Health Bank software development kit for accessing My Health Bank services (left panel); third-party statements relating to use of My Health Bank data (right panel).



Figure 3. Downloaded My Health Bank data in XML format.

Table 1. Summary of our design principles and strategies based upon the recommendation from the best practices for VR1 [20].

Design principles and strategies	Our practices
Inspiration through empathy <i>Recruitment</i> <i>Observation</i> <i>Patient interviews</i> <i>Expert interviews</i>	Two patients with breast cancer who had experienced axillary web syndrome were invited for individual interviews regarding their relevant needs, experiences, fears, and expectations; a group discussion was then conducted to determine the patient's needs.
Ideation through team collaboration <i>Sharing stories and notes</i> <i>Generating ideas</i>	We analyzed, aggregated, and discussed the stories and data obtained in the previous phase. Our team then formulated 10 ideas for rehabilitation actions. After considering the restrictions on drainage tube indwelling the day after surgery (shoulder joint movement must not exceed 90°), we extracted three motions. These motions were named as follows: (1) Whac-A-Mole: abduction of the shoulder; (2) Wiping the table: external forearm rotation; and (3) Combing hair: flexion of the shoulder.
Prototyping through continuous feedback <i>Building a prototype</i> <i>Repeatedly testing the prototype</i>	Draw the height of a mallet on the wall and place a picture of a gopher on the table to simulate a Whac-A-Mole game. For wiping the table and combing hair, use the table and a comb to perform these actions, and then collect feedback from patients after their first use. Our team found that the Whac-A-Mole game was difficult to perform owing to the different heights of the patients and seats (e.g., a patient may need to raise their shoulder angle excessively to obtain the mallet, leading to pain and an inability to pick up the mallet, forcing the exercise to be abandoned). Thus, the software engineer adjusted the heights of the controllable mallet and the adjustable gopher table to meet the need of each individual patient.

Figure 1-3. Breast cancer VR rehabilitation system

Study Design

This qualitative study was guided by the phenomenological methodology to focus on investing the perceived experience of using VR rehabilitation and then using the inductive approaches and Colaizzi interview data analysis method [26] to identify themes from the VR rehabilitation experiences. Ethical approval for this study was granted by the Human Trials Ethics Committee of Chang Gung Memorial Hospital, Taiwan (Institutional Review Board number: 202001617A3C501). All the participants provided written informed consent to participate in this study.

Setting

This study was conducted at a medical center in Taiwan that receives up to 20 new patients with breast cancer per month.

Participants and Recruitment

The criteria for the participant in this study were as follows: (1) new diagnosis of breast cancer and hospitalized for surgical treatment, (2) aged 20–65 years, (3) able to read and speak Mandarin Chinese or Taiwanese, (4) willing to use a wearable VR head-mounted display (HMD) and have sufficient cognitive abilities to understand and follow instructions, as well as to interact with the VR environment, (5) have sufficient physical abilities (self-reported) to use the VR equipment in the VR rehabilitation program, (6) willing to be interviewed. After surgical treatment for breast cancer, patients were invited to a rehabilitation consultation to ask about their willingness for VR rehabilitation and recruited to participate in this study. The recruitment period ran from September to December 2021, with 18 patients interviewed.

Data Collection

First, the participants filled out the questionnaires of demographic data (including age, gender, and type of breast surgery), the Distress Thermometer (DT) and the Chinese Health Questionnaire-12 (CHQ-12) (Table 2). The DT is a visual analog scale for routinely screening for distress in all cancer patients, whose scores range from 0 (indicating no distress) to 10 (indicating extreme distress); a cutoff score of ≥ 7 is optimal for distress in patients with new diagnoses [28]. The CHQ-12 was modified from the GHQ-12, a universally used psychometric test for screening mental problems, with a score of ≥ 4 as having psychological distress [29].

After completing the questionnaires, a face-to-face interview was conducted for each participant for approximately 30 minutes. The interview guides were developed by the researcher team (an expert in qualitative study, a breast cancer clinical nurse specialist). After the content of the first interview was analyzed, the interview questions were discussed and modified with the research team (appendix 1).

During the interview process, the researcher actively listened and continuously clarified any perspectives and meanings that the participants wanted to express. Participants were allowed to freely express their views. All interviews were audio-recorded. After the data analysis, the researcher would revisit the patients to ensure the accuracy and completeness of the data.

Inductive Content Analysis

According to Kyngäs [25], inductive approaches, which are common in qualitative research, should be employed when no prior research has addressed a specific phenomenon or if existing knowledge is fragmented. Because prior studies had not investigated the experiences of patients with breast cancer to evaluate the effectiveness of VR-based rehabilitation, our study used inductive approaches of content analysis, that involved data reduction, data grouping, and, finally, concept formation. The content was analyzed by using Colaizzi's phenomenological analysis method [26] which involved a seven-step procedure for content analysis. Specifically, three researchers analyzed the data and grouped them into themes to enhance comprehension. First, the interview transcript was read to obtain an idea of its overall meaning. Second, a researcher extracted significant statements relevant to the purpose of this study. Third, each statement considered meaningful was recorded for accurate representation of the research data. Fourth, the researcher classified significant statements into categories based on their meanings. Fifth, the researcher grouped similar categories together and organized them into themes. Sixth, all themes presented were combined to produce an exhaustive description. Seventh, the results were presented to each participant for feedback and to verify their accuracy.

Trustworthiness

To enhance the trustworthiness of our study, we referred to the Guba and Lincoln's quality criteria of credibility, transferability, dependability, and confirmability.

To establish confidence in the credibility of the findings, triangulation was used to examine the consistency of the data. Researchers presented their summaries of the categories and themes from data analysis and discussed any uncertainty about any category or theme by replaying and reanalyzing the interview recording.

High transferability was ensured through the interview process, including the stability of observations and the interrater reliability. Researcher as an interviewer was attentive to interviewee's experience and not lead to bias from her values and beliefs. The interviewer was conscious about avoiding misperceptions about what the interviewees was saying to ensure the stability of observations was established. There was only one interviewer hence no interrater reliability was performed.

The study had high dependability as the data collecting procedures were approved by an expert in qualitative methodology and emerged themes and subthemes were consistent after coding and recoding procedure during the data analysis by all researchers.

Finally, during the data analysis stage, three researchers who were not part of the study team confirmed the collected data by distinguishing between the units of the main themes and subthemes to verify the main themes' theoretical saturation and thus achieve confirmability.

Results

Characteristics of participants

Table 2 shows the participants' characteristics. The mean age (standard deviation) of the participants was 46.66 years (8.05). Seventeen of the participants were female (95%), and 1 was male (5%); 11 were married (61%); 11 (61%) were full-time workers; and 7 (39%) were housekeepers or had no formal employment. Regarding the types of surgery received, nine participants (50%) underwent mastectomy and sentinel lymph node biopsy (SLNB), four (23%) underwent mastectomy and axillary lymph node dissection (ALND), two (11%) underwent mastectomy and reconstruction, and three (16%) underwent modified radical mastectomy. All participants had DT scores less than 7, indicating no distress. In the CHQ-12 items, some participants reported having been suffering from shaking or numbness of limbs (17%), lost much sleep because of worry (22%), and losing confidence in themselves (22%), (items 4, 5, and 8). However, all participants had the CHQ-12 scores less than 4, indicating no mental problems. Finally, 7 (39%) and 11 (61%) of the participants reported moderate (4-6) and mild (1-3) wound pain by using the Numeric Rating Scale for Pain, respectively.

Table 2. Distribution of sociodemographic variables of participants.

Variable	n	(%)
Sex		
Female	17	95%
Male	1	5%
Age (years)		
35–44	6	33%

45–54	8	44%
55–64	4	3%
Educational level		
Senior high school	9	50%
College	9	50%
Distress		
Yes (DT $\geq$ 7)	0	0%
No (DT $\leq$ 7)	10	100%
Mental problems		
Yes (CHQ-12 $\leq$ 4)	0	0%
No (CHQ-12 $\geq$ 4)	18	100%
Numerical Rating Scale for Pain		
1-3	11	61%
4-6	7	39%
Marital status		
Married or domestic partnership	11	61%
Single	5	28%
Separated or divorced	2	11%
Employment status		
Employed	11	61%
Unable to work	7	39%
Type of breast surgery		
Mastectomy + SLNB	9	50%
Mastectomy + ALND	4	23%
Mastectomy + reconstruction	2	11%
Modified radical mastectomy	3	16%

Themes

The following three themes were inductively extracted from the interview data, namely: (1) VR was powerful in facilitating rehabilitation, (2) early and repetitive upper limb movements: advantage to VR rehabilitation, and (3) challenges of extensive VR use to be overcome. Tables 3–5 present these themes in greater detail alongside their subthemes and interviewee statements.

VR was Powerful in Facilitating Rehabilitation

A key concept of this inductive theme was “power” obtained from knowledge and companionship. Related subthemes and interviewee statements are presented in Table 3.

Obtaining knowledge

Seventy percent of the participants described how the VR content helped them learn the most helpful rehabilitation movements and the angular limitations of their exercises and thus enabled them to perform these exercises relatively early and safely in the rehabilitation process.

Companionship

Most of the participants stated that playing games enabled them to feel as though they were interacting with health-care professionals and experiencing companionship and support. Related subthemes and interviewee statements are presented in Table 3.

Early and Repetitive Upper Limb Movements: Advantage to VR Rehabilitation

After surgical treatment for breast cancer, rehabilitative exercises must be performed early. In this study, wound pain and discomfort during such exercises were the main concerns of the participants, leading to fear of movement. Related subthemes and interviewee statements are presented in Table 4.

Reduced Fear of Movement

Eighty percent of the participants stated that the gamified design of VR rehabilitation made it more interesting than traditional rehabilitation; seven of the patients experienced moderate pain after surgery; however, during the use of VR for rehabilitation, these patients reported no wound pain or discomfort. In addition, their willingness to rehabilitate was enhanced by the second day after surgery

Enhanced Motivation to Engage in Rehabilitation

Most of the participants described an immersive virtual environment that facilitated the performance of early rehabilitative exercises. In addition, the participants were subsequently able to continue performing the aforementioned three rehabilitation movements at home without VR.

Challenges of Extensive VR Use to be Overcome

Most of the patients had safety concerns, mainly because while wearing the VR HMD, they were unable to pay attention to the environment around them. Consequently, some of the patients initially felt apprehensive, fearing collisions with nearby objects. In addition, high equipment costs limited the accessibility of the equipment for home use, and many of the patients expressed disappointment that they were able to use the system only in hospital. Related subthemes and interviewee statements are presented in Table 5.

Safety of the Real-World Environment

While the patients were wearing the VR HMD and engaging in VR-based exercise, they were unable to pay attention to the environment around them. Thus, patients had the not unfounded fear that they may collide with nearby objects and were initially apprehensive. Therefore, patients should be in a clutter-free environment when engaging in VR rehabilitation.

Furthermore, the cost of VR equipment for rehabilitation is high, making it relatively inaccessible for home use. Each new technology faces the problem of high equipment cost in its initial stage, and similarly, the main problem for most of the participants in this study was that they wanted to continue using the rehabilitation equipment at home. They indicated that they thought it was a pity that the system could be used only in hospitals.

Motion Sickness

Three of the participants reported the side effect of motion sickness after performing the wiping table exercise.

Table 3. Subthemes and interviewee statements related to theme (1): VR was powerful in facilitating rehabilitation.

Subthemes	Quotations
Obtaining	It turns out that some actions are unsuitable (because of the drainage tube); after

knowledge	use, I have a better idea of the angle of movement. 02 After practicing with this system (VR) and being discharged from the hospital, I know that some actions are not suitable for me to do, so I will not do them randomly. 03 I was anxious, thinking that not moving my arms was suitable for wound healing. 13 I can adjust my range of motion according to my tolerance, and I will not feel frustrated. 17
Enjoying good company	This way of rehabilitation (VR) is like a kind of support for me when exercising because the physiotherapist does not always accompany me. 9 The usage process is very simple. I think it is well executed in the hospital and I can concentrate on practicing. 05 The physiotherapist was very busy and left after teaching me the rehabilitation movement, so I had to do it independently. 11 I didn't understand what this was at first, and I was a little scared, but it turned out that I was doing rehabilitation while playing games. 01

Table 4. Subthemes, and quotations related to theme (2): early and repetitive upper limb movements: advantage to VR rehabilitation.

Subthemes	Quotations
Reduced fear of movement	The VR rehab game method is more fun than the traditional rehab method because it lets me know I need to do rehab exercises; I think I can do it a few more times. 1 My time in the hospital was short, and it was a pity that I didn't do VR many times. 6 I experienced no pain or discomfort during the VR rehab; I want to do it a few more times. 7 After playing Whac-A-Mole, I attempted to move my arm. While using it, I temporarily forgot that I had surgery. 14 Initially, I was terrified of moving my arms, but now, I'm having so much fun that I don't realize I'm doing rehab. 18
Enhanced motivation to engage in rehabilitation	The VR program can be performed as soon as possible; I have been performing VR for seven days since surgery. In the execution of the Whac-A-Mole and wiping the table exercises, I did not have too much discomfort or pain, and I am doing better and better. 15 Although there is no VR at home, I can continue to do the VR movements, and I will not worry about my arm's limited range of motion in the future. 16 After using VR for rehabilitation, I found that my condition was not as bad as I thought. 7

Table 5. Subthemes, and quotations related to theme (3): challenges of extensive VR use to be overcome.

Subthemes	Quotations
Safety of the real-world environment	I was initially scared because I had never used VR. 4 Wearing a VR HMD, I can't see the outside world, so I'm worried about hitting something. 5
Cost of VR rehabilitation equipment is too high to extend to home use	VR rehabilitation equipment is too expensive to buy and can only be used in hospitals. 5 Without equipment, there is no way to use VR for rehabilitation. 8 VR rehabilitation can only be used in hospitals; at home, we use traditional rehabilitation methods. 17 I hope to rent VR equipment for my home so I can use it anytime. 18 Although there is the Switch, finding a suitable sports game for rehabilitation is difficult. 9
Motion sickness	After wiping the table, I felt a little dizzy. 10 My eyes constantly roll when wiping the table, which is a little uncomfortable. 9

Discussion

Principal Findings

To the best of our knowledge, this study is the first phenomenological study to investigate the feasibility of an immersive VR experience for facilitating postoperative rehabilitation in breast cancer patients. Through inductive thematic analysis, our study found VR to be an effective and suitable intervention for the present patient population. Tables 3 and 4 address feasibility in relation to two of the three inductive themes of this study, namely "VR was powerful in facilitating rehabilitation" and "early and repetitive upper limb movements: advantage to VR rehabilitation." Table 5 reveals the key finding that the high costs of VR hardware and software limit at-home use. These results further support the recommendation of VR-CORE [20]. However, high cost of VR equipment remains concern.

VR Was Powerful in Facilitating Rehabilitation

This study found "power" to be an essential concept and that power was cultivated through knowledge and companionship. One key finding related to this inductive theme was the knowledge obtained by the individual. In our study, most of the participants were skeptical about their early postoperative rehabilitation, and some had no idea how to proceed with it; however, through VR, these patients gained information about rehabilitation, which then led to behavioral changes. A previous study noted the importance of people's need to know which approach they should adopt to improve their health [30]. In addition, most patients with breast cancer desire information concerning recovery details; in particular, they want real-time, transparent information regarding appropriate rehabilitative measures [21]. Our findings were consistent with those of the aforementioned two studies. Another present finding was related to companionship; specifically, the participants reported

that they felt as if a medical care team was with them in their rehabilitation in the VR world. This finding is notable because not every patient with breast cancer receives a rehabilitation exercise consultation after surgery. Our interactive VR system provides clear information regarding the commencement and completion of rehabilitation exercises, and its prompts align with how the clinical rehabilitation program operates (e.g., 20 prompts for each motion). The literature notes that an ideal user experience must include interaction with VR applications in order to encourage and support users to complete clinical activities; this assertion is consistent with our findings [31].

Early and Repetitive Upper Limb Movements: Advantage to VR Rehabilitation

The VR elicited engagement in early postoperative rehabilitation in most of the present patients, seemingly stemming from their reduced fear of movement and their enhanced motivation. Early postoperative rehabilitation in patients who have undergone breast cancer surgery aims to improve shoulder and/or arm mobility. VR is believed to be as effective as conventional physiotherapy in improving upper limb function to facilitate the maintenance of activities of daily living [32]. Some of the participants in the present study were initially apprehensive to undertake postoperative rehabilitation primarily because of fear related to insufficient knowledge of the appropriate degree of movement. Nevertheless, our VR rehabilitation system was based on the concept of gamification; the participants who used the system were attracted to the game screen, and consequently, their negative feelings—including fear, pain, and discomfort—were temporarily alleviated. In this manner, the VR system considerably enhanced the participants' motivation to engage in rehabilitation; this finding was consistent with those of previous studies [18,33]. In addition, the game design can be adjusted according to the needs of the patient to prevent patients from giving up on movements that are either difficult or so simple that the desired training outcomes cannot be achieved by performing them.

Challenges of Extensive VR Use to be Overcome

The participants in this study were required to wear HMDs, and thus, they could not see their surroundings during rehabilitation. Related studies that have recommended VR have stated that when using such technology, a space of at least 5 square feet is required; however, in our study, the participants took a seated position to minimize the risk of tripping and thus needed only to heed whether the seat back was affecting exercise safety. Although research has shown that the cost of HMDs has fallen in recent years [15], VR devices remain unaffordable for many people in Taiwan. Therefore, even if patients with breast cancer are interested in using this emerging technology for rehabilitation, doing so without an HMD is difficult. In addition, the development and maintenance costs of VR applications software and hardware are high, and thus, the cost of VR equipment remains a challenge for large-scale implementation in postoperative rehabilitation.

Motion sickness (MS) is a common physiological response to VR immersion [34]. Previous studies have shown that behavioral and dietary strategies and physical therapy, such as listening to music or chewing gum [35], are effective in alleviating MS symptoms. Although each movement in our VR rehabilitation system was accompanied by music with a brisk tempo, three of the patients in this study still experienced MS due to unsuitable seat height. A previous study demonstrated that positive emotions can relieve MS [36]; we found that most patients have positive emotions while using VR for rehabilitation. Accordingly, this paper suggests that the use of VR should be combined with emotional assessments to effectively prevent MS. With regard to feasibility, we found that the present VR system met the patients' needs, conformed to their values, and satisfied their expectations and also provided an engaging and interactive rehabilitation environment that stimulated the patients' motivation to engage in early and continuous rehabilitation and, in turn, reduced their risk of developing defensive functional impairments. Nevertheless, the accessibility of VR proved to be a challenge because of the difficulty of using VR technology at home. Thus, such interventions tend to be limited to in-hospital use because not every patient can afford to purchase VR equipment and

software.

Conclusion

Feasibility research related to health care is crucial for generating novel ideas and improvements to provide more effective care for patients. From the perspective of the present study, rehabilitation is a reiterative, active, and educational process of problem-solving that must focus on a patient's behavior. VR technology was effective in facilitating rehabilitation by providing knowledge and companionship to participants. It helped reduce fear of movement and enabled early and repetitive upper limb movements. However, safety concerns, high equipment costs, and potential side effects like motion sickness were reported as challenges to extensive VR use.

Study Limitations

This study has some limitations. First, this study did not conduct a pilot study of the interview guide. However, after the content of the first interview was analyzed, the interview questions were discussed and modified with the research team to identify and address any potential issues in the data collection methods. It may be recommended to incorporate a pilot study in future research to ensure the validity and robustness of the study. Second, the development of VR technology to facilitate postoperative rehabilitation in breast cancer patients is still in its infancy. In this study, only three rehabilitation exercises were developed and clinically tested. The facilitators of and barriers to rehabilitation were investigated. To determine the clinical efficacy of the proposed VR system, a large-scale randomized controlled trial is needed.

Acknowledgments

This research was partially supported by the Kaohsiung Chang Gung Memorial Hospital, part of the Chang Gung Medical Foundation, Taiwan (Grant Number: CMRPG8L0081), and this manuscript was edited by Wallace Academic Editing.

Conflicts of Interest

None declared.

Abbreviations

ALND: axillary lymph node dissection
CHQ: Chinese Health Questionnaire-12
DT: Distress Thermometer
HMD: head-mounted display
MS: motion Sickness
SLNB: sentinel lymph node biopsy
VR: virtual reality

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Supplementary Files

Untitled.

URL: <http://asset.jmir.pub/assets/32b44edd55b599d21eb06f1b7b77b676.docx>

Figures

Integration workflow of My Health Bank software development kit and mobile app.



Identity verification process of My Health Bank software development kit for accessing My Health Bank services (left panel); third-party statements relating to use of My Health Bank data (right panel).



Downloaded My Health Bank data in XML format.

