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Perceptions and Experiences of Commercial Virtual Reality Games in Early Postoperative Rehabilitation among Cardiac Surgical Patients: A Qualitative Study

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Abstract

Background: Although numerous studies in China and abroad have focused on the outcomes of virtual reality games for early postoperative rehabilitation in cardiac surgical patients, research on these patients' perceptions and experiences with virtual reality games has been limited.

Objectives: The aim of this study was to provide insights into the perceptions and experiences of cardiac surgical patients in using commercial virtual reality games during early postoperative rehabilitation.

Methods: Twelve patients underwent early postoperative rehabilitation at the cardiac surgery center of a tertiary hospital in Nanjing, China, between January 2023 and December 2023. The patients utilized Oculus Quest 2 head-mounted virtual reality to experience commercial system virtual reality games for three sessions (30-45 minutes each session). Data were collected through individual in-depth interviews and then analyzed using Colaizzi's phenomenological method.

Results: Two themes emerged from the interviews: (1) the benefits of virtual reality games for rehabilitation, including (i) enhancing enthusiasm for rehabilitation, (ii) helping patients to focus attention, (iii) increasing individual exercise, (iv) providing enjoyment, and (v) regulating negative emotions; (2) shortcomings in the use of virtual reality games, including (i) producing stress, (ii) insufficient operating space, (iii) discomfort while wearing, (iv) difficulty in mastering the application, and (v) individualized needs.

Conclusion: Cardiac patients believed that the use of commercial virtual reality games during early postoperative rehabilitation was beneficial to rehabilitation, but they highlighted some shortcomings that require improvement. The results of this study provide a certain theoretical basis for the further promotion and application of commercial virtual reality games in clinical practice in the future.

Keywords: Virtual reality; Cardiac Surgery; Rehabilitation; Experience; Qualitative study.

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Introduction

Cardiac surgery remains the standard treatment option for a wide range of heart diseases, and despite decades of medical advances, there is still a high rate of complications following cardiac surgery [1]. Studies [2] have shown that even after these patients are discharged from the intensive care unit, 50%-75% exhibit persistent cognitive dysfunction, physical weakness, and post-traumatic symptoms. Therefore, rehabilitation is important for patients who have undergone cardiac surgery. Currently, cardiac rehabilitation programs [3] include exercise therapy, secondary prevention medication, nutritional support, psychological management, and cognitive interventions. These programs are mostly led by healthcare professionals, with varying results owing to a lack of active participation and immersion of patients [4,5].

Virtual Reality (VR) technology allows participants to be immersed in a virtual world of three-dimensional dynamic views and physical behavioral interactions through the use of head-mounted displays, headsets, motion-tracking systems, and interactive devices. The technology has been applied to cardiac patients to enhance their motivation and engagement [6,7]. Over the past few years, there has been a growing adoption of VR games in clinical settings, both those available commercially and those developed by healthcare systems. Studies have indicated that these VR games can significantly benefit patients' rehabilitation, leading to improved outcomes, reduced physical decline, enhanced cognitive function, better sleep quality, pain alleviation, and other positive effects [8-10]. However, there are some weaknesses in the use of VR in the field of rehabilitation, such as potential side effects on patients and cost-effectiveness issues associated with developing VR technology. These factors have hindered the widespread implementation of VR in most rehabilitation centers [11]. In recent years, the actual clinical implementation has not been satisfactory [12].

In contrast to commercial VR systems focused on entertainment and high-quality user experiences, VR rehabilitation games are typically tailored to individual patient needs [13-16]. Nonetheless, as commercial VR games advance, offering diverse difficulty levels and customizable features, they are becoming more appealing for clinical use, with lower costs and improved technical capabilities [13,17]. Studies have shown that Oculus and HTC commercial VR systems are feasible alternatives for VR-based health applications. These systems not only fulfill the needs of patients for gaming, exploration, and exercise rehabilitation in VR space but also exhibit minimal side effects [18,19].

Presently, domestic and international studies on the use of VR technology for patients with cardiac disease primarily focus on the observation of endpoints. Studies on patients' actual cognition and experience of VR games are few. As little research has been conducted on this topic, this study utilized qualitative interviews to comprehend the real-life experiences and perceptions of post-cardiac surgical patients regarding the application of commercial VR games in their rehabilitation. The aim is to provide a theoretical foundation for enhancing VR technology intervention programs in rehabilitation and to promote the integration of commercially available VR technology into clinical rehabilitation settings.

Methods

Study design

This qualitative study employed Colaizzi's phenomenological method [20] to explore the real experiences of post-cardiac surgical patients following their engagement with commercial VR games. Colaizzi's method of analysis is centered on comprehending the fundamental structure and significance of human experiences [20], with the aim of extracting the shared attributes of participant experiences as a whole, rather than focusing solely on individual characteristics. Therefore, this method is valuable for analyzing participant experiences without introducing distortions. The scientific approach ensures the authenticity of the collected experiences of the participants and adheres to scientific standards. The findings of this study were reported following the guidelines outlined by the Consolidated Criteria for Reporting Qualitative Research (COREQ) [21].

Setting

Participants were recruited between January 2023 and December 2023 from a cardiac surgery center at a tertiary hospital in Nanjing, China. This center serves patients requiring cardiac surgical treatment.

Inclusion and exclusion criteria

Twelve patients were selected for the study from the cardiac surgery center of a tertiary hospital in Nanjing, China, all of whom had used the same VR game. Training was conducted using a commercial head-mounted VR system (Oculus Quest 2), which offers fully immersive virtual 3D room-scale tracking and interaction with the virtual environment via a headset and haptic hand controls. Each participant was presented with five games: Beat Saber, Angry Birds, Fruit Ninja, Dart Wars, and VoctoR PsydMind. The inclusion criteria were as follows: (1) patients who had used the Oculus Quest 2 commercial VR head-mounted system to experience VR games for at least three sessions (30-45 minutes each time); (2) patients who voluntarily participated in the experiment; (3) patients aged 18 years or older; (4) patients with a clear mental state and the ability to communicate normally. Exclusion criteria: (1) Richmond Agitation Sedation Scale (RASS) score less than -1 point; (2) the presence of delirium; (3) the presence of mental or cognitive impairment or mental retardation; (4) patients with unstable vital signs, such as fatal arrhythmia, hemodynamic instability, or hypoxemia. Additionally, patients who dropped out for any reason were excluded.

All participants signed an informed consent form, and the study was approved by the ethics committee of our hospital. The investigators were all nurses working in the cardiac surgery center. We invited the patients face-to-face to inquire whether they were willing to be interviewed about their experience with VR gaming applications. After explaining the purpose and significance of the study, they all agreed to participate. This study employed purposive sampling to recruit patients of various genders, ages, education levels, and employment statuses, among other factors. The general information of the patients is presented in Table 1, and recruitment continued until theoretical saturation was reached and no new topics emerged. A total of 12 patients were included in this study.

Interview outline

We developed the interview outline by reviewing relevant literature and consulting experts in the field. The main interview questions were as follows: (1) How do you feel about using virtual reality games during your postoperative rehabilitation? (2) What aspects of virtual reality games do you enjoy? (3) Have you encountered any difficulties while using them? (4) Did you experience any discomfort during the use of VR games? (5) Would you be interested in continuing to use these VR games if given the opportunity? Finally, an open-ended question was posed: "Do you have any other suggestions or ideas regarding the use of virtual reality games?"

Data collection

Data were collected through face-to-face individual in-depth interviews. The interviews were scheduled during the patient's free time, and they occurred at the patient's bedside. When interviewing patients who were not in a single-room ward, we pulled the curtain to prevent interference. Each interview lasted for 30-40 minutes, and each patient received 1-2 interviews depending on the data collection situation. The researcher typically interviewed patients on the same day that they met the inclusion criteria, with a maximum interval of no more than 3 days. All interview conversations were recorded, and the recordings included non-verbal cues such as laughter, silence, and sighs. The audio recordings were transcribed verbatim within 24 hours of the interviews and subsequently reviewed by the interviewer to ensure the accuracy of the transcripts. The researchers endeavored to reflect on participant experiences and thoughts without distorting them with their own biases. They maintained a neutral perspective throughout the study to avoid influencing the results.

Data analysis

Data were analyzed through the phenomenological method proposed by Colaizzi [20]. The feelings and experiences of each participant were examined holistically by reading the interview transcripts several times to grasp the conveyed meanings. Statements related to the experience were extracted, and overarching meanings were constructed to form general statements, each reflecting similar content. Theme clusters were formed through the grouping of similar themes together. The researchers offered a detailed description of each theme generated by clustering and included exemplary original statements from the participants. Similar themes and their descriptions were grouped for iterative comparisons to identify and extract shared views. Brief phrases were then formulated to represent each theme. To ensure that these themes accurately reflected the participants' original experiences as conveyed, they were repeatedly cross-checked against the patient transcripts. We thoroughly reviewed all steps of the analysis procedure to confirm that they adequately captured the essential structure of the participants' experiences. The interviews, original transcripts, and data analyses were conducted in the Chinese language. The theme categories and quotations were established through consensus among the team during discussions. All quotes were translated into English and then back into Chinese by two researchers to ensure the preservation of the original meaning.

Trustworthiness

The findings of this study were evaluated according to the following four criteria: credibility, transferability, dependability, and confirmability [22]. Credibility was ensured by allowing participants to review the interview descriptions to verify that the transcripts accurately conveyed their intended meaning. Transferability was ensured through reflection on all the steps involved in the research process and the procedure used for data transformation. Dependability and confirmability were supported through the documentation of the logic underpinning the research process, allowing two reviewers to trace the data and their sources and understand the final interpretations.

Ethics approval

This study was approved by the Institutional Review Board of the researchers' hospital (No. KY20220713-02). Prior to conducting the formal interviews, the researchers informed the participants of their identities and provided details about the main content and process of the study. Subsequently, the patients were allowed to decide whether to participate in the interview. In accordance with the International Council of Nurses (ICN) Code of Ethics for Nurses, [23] we assured the participants that their personal information would not be disclosed to any additional persons while in the hospital, as the interviewers were already staff members working in the Cardiac Surgery Unit. This approach fostered a safe and trusting environment, allowing patients to express themselves openly and critically without concerns about personal consequences or privacy violations. All participants provided their informed oral consent before the interviews were conducted, and all dialogue was audio-recorded. Participants were assured of the confidentiality of their responses, which was ensured by using numbers instead of names. The data were utilized solely for academic research purposes. Participants were informed that their participation was voluntary. Furthermore, the interviewers assured the participants that they had the option to withdraw from the study at any time if they felt it was necessary owing to their physical condition, fatigue, or stress.

Results

All participants completed the interviews, and none withdrew during the study period. The mean age of participants was 39.5 years, and 41.6% were female. Only one participant had previously used head-mounted VR gaming. Most participants had a high school degree or above. Participants had experienced the VR game at least three times, with each session lasting between 30 and 45 minutes. The general information of the respondents is shown in Table 1 (Table 1), and two themes and nine sub-themes were extracted (Table 2).

Perceived benefits of virtual reality games for rehabilitation

Enhancing the enthusiasm for rehabilitation: Participants interviewed had a positive attitude toward the use of VR games, which they found helpful in their recovery from surgery. Although only one of the interviewees had prior experience using VR games, most participants expressed willingness to try them. After using the applications, they found the VR games very interesting and expressed a desire to try them again.

N1: I have never experienced a game like this before, the graphics were very three-dimensional, as if I was transported to another dimension.

N5: Although I don't like to play computer games, I think this [VR game] is a bit of fun, it makes me happy and allows my arms to get some exercise!

N6: I want to play that Angry Birds game again!

Helping to focus: Although these VR games mainly focused on exercising patients' upper limb abilities, participants also expressed perceived benefits in other areas. For example, they noted that the VR games effectively captured their attention. Participants reported feeling sleepy before, but their attention became instantly focused, and their cognitive engagement increased when using the VR games.

N2: Originally, I was drowsy, but when I played it, I felt that I was not sleepy at once, and I found the three-dimensional picture particularly attractive.

N7: When playing, I felt that I forgot my worries, became deeply engrossed in the images in front of me, and felt my mind racing.

N11: It felt like time passed quickly, the game was over in a flash, I was foggy in the head before but I was refreshed all of a sudden, I didn't feel tired at all while playing, I was completely immersed in the VR games.

Increasing individual exercise: Some participants indicated that playing VR games significantly increased their activity levels compared with their usual exercise methods, such as bedside seating and bedside walking.

N2: I feel that my activity volume has increased by using the VR equipment, and I exercise more than I did yesterday when I was not playing it.

N3: I think it can not only increase my brain's reaction speed but also increase the amount of motion of my upper limbs, which I have never experienced before.

N4: My hands and arms keep moving, and I get a bit sweaty when playing.

Providing enjoyment: When playing games, almost all patients had also engaged in other forms of exercise rehabilitation, including the use of exercise equipment such as grippers and bicycles. Participants found that using VR games made them feel happier than the traditional exercise methods.

N3: I feel like it's more interesting than mobile phone games, and it feels immersive.

N6: My favorite game is "Angry Birds." Every time I shoot a bird, I feel a special sense of achievement.

N8: It's my first time experiencing this kind of equipment, and it feels very novel and especially interesting.

N12: Wow, this picture is so realistic. It feels like I'm really holding a sword in my hand. It's so interesting!

Regulating negative emotions: Participants reported that VR games made them feel happy. When they focused on earning rewards in the game, seeing themselves advance provided a sense of accomplishment and served as a positive incentive to momentarily distract them from their worries.

N5: I felt so much fun that it took my mind off my troubles.

N1: It was so rewarding to advance in the game, I would like to play again if I have the chance. Can you extend the time for me next time? I would like to continue to pass the level!

N8: After playing the game, I feel that my mood has changed, and I will recall the images of the game.

Shortcomings of VR gaming applications

Producing stress: In addition to their strong interest in VR technology, patients may also encounter negative emotions, such as stress induced by the fear of making mistakes or not being able to learn how to use the technology.

N5: At first, the nurse taught me how to use it, but when I operated it independently, I still felt a bit nervous.

N8: When I first learned it, I was a bit worried that I would be disliked if I didn't operate it in the right way.

N12: Fear of damaging hospital equipment if I operate it incorrectly and having to be careful.

Insufficient operating space: Upon the introduction of VR games in the ward, patients commonly observed the limited operating space. Furthermore, some patients suggested that playing VR games while lying in bed could help conserve their stamina.

N7: It would be nice if VR games could be played while lying on the hospital bed; it would feel more comfortable and save strength.

N4: When applying the equipment, I need to move my upper limbs to cooperate, and I feel that the operating space is a bit small when I sit on the bedside, and I can't stretch out, which sometimes leads to operating errors.

N9: When operating the equipment, I was a little worried that my limbs would touch the tables and chairs around me because I couldn't see the surrounding reality.

Discomfort in wearing the device: The discomfort experienced during VR gaming, as expressed by most patients, primarily included the heaviness of the head-mounted device, which led to fatigue. Additionally, some patients reported feeling tired after VR gaming and needed to rest for a while afterward.

N4: It would be nice if this machine could be a bit lighter, I find it a bit heavy.

N7: I feel a bit tired after wearing it on my head for a long time, and post-surgical patients are easily fatigued because they don't have much stamina.

N9: I don't feel tired when I play, but I feel fatigued after I finish it, and I fall asleep when I go to bed.

Difficulty in mastering the application: Although the participants included in the interviews were patients who had undergone the entire VR training, they still expressed difficulty in mastering the use of the equipment or feeling unskilled in its operation.

N1: I have not come into contact with VR equipment in my normal life, and I rarely even play computer games, so it was difficult to learn, and although I could operate it in the end, it did not feel very smooth.

N2: The whole process involves playing several games, each with a different method of operation; fortunately, I am a young person with a strong learning ability.

N8: Although I used to use computer or mobile phone games a lot, I felt that I was slower to learn and get used to them as I had just recently had surgery.

N9: It would be nice to have an instructional video on how to use it, I wasn't quite able to operate the handle proficiently at first.

Individualized needs: Participants described that although VR games are very interesting, not all of them are their favorite games. They noted that only when they find the right game and the appropriate level can they experience a corresponding sense of achievement.

N2: My favorite game is Rhythm Lightsaber, which is not only easy to operate but also exercises my hand-eye coordination.

N6: I prefer fruit-cutting games, but I can only play the beginner's level, and I keep failing when the level is upgraded.

N9: When I am more tired, I still like to experience games that don't require much strenuous activity, like that 3D animation with music that relaxes my mind and body.

Table 1: General information of the participants (n=12).

Code	Gender	Age	Education level	Occupational status	Whether having experiences of VR games	Cumulative time of VR games (minutes)
N1	Male	45	High school	Working	NO	90
N2	Male	39	College	Working	NO	120
N3	Female	51	High school	Working	NO	90
N4	Male	25	University	Working	NO	125
N5	Female	24	University	Working	NO	95
N6	Male	38	College	Working	NO	180
N7	Female	53	High school	Not working	NO	140
N8	Male	48	High school	Not working	NO	100
N9	Male	59	High school	Not working	NO	90
N10	Female	34	College	Not working	NO	200
N11	Female	39	College	Working	NO	95
N12	Male	20	University	Not working	YES	160

Table 2: Overview of themes and subthemes.

Themes	Subthemes
The benefits of virtual reality games for rehabilitation	Enhancing enthusiasm for rehabilitation
	Helping patients to focus attention
	Increasing individual exercise
	Providing enjoyment
	Regulating negative emotions
Shortcomings in the use of virtual reality games	Producing stress
	Insufficient operating space
	Discomfort while wearing
	Difficulty in mastering the application
	Individualized needs

Discussion

Some studies [24] have indicated that Oculus and HTC commercial VR systems are viable options for VR-based health applications. These systems not only fulfill patients' needs for gaming, exploration, and exercise in VR for rehabilitation but also have no significant side effects. Consistent with the results of the current study, VR gaming on commercial systems can enhance the motivation of post-cardiac patients for rehabilitation, increase the amount of exercise, and improve adverse emotions. However, it is also crucial to select the patient's favorite games and appropriate difficulty levels according to their individual condition. In future clinical applications, patients can explore the resource library independently and choose their favorite VR games for repeated use. Additionally, considering that commercially available VR games offer extensive resources and are regularly updated, healthcare providers should carefully screen the resources before recommending them for rehabilitation purposes. Avoiding games with violent content or inappropriate guidance is crucial. As the price of commercial VR equipment continues to decrease and the quality of the visuals improves, along with the constant updates to VR games and video resources, the difficulty and cost of developing VR programs or games in-house by healthcare institutions have decreased. This greatly enhances the feasibility of widespread adoption of VR technology in clinical settings.

The current study revealed that patients also experience some negative effects, such as stress and anxiety, when using VR games. Patients may feel stressed and worried about being disliked by medical staff if they struggle to master the VR operation methods taught by the staff or if they learn slowly. Additionally, some participants provided feedback that they found it challenging to become proficient in operating VR games and expressed a desire for more detailed teaching instructions. Previous studies [25,26] have indicated that patients are more likely to master the use of VR games or devices, which differs from the results of this study. This discrepancy may be related to factors such as the participants' ethnic and cultural backgrounds, education levels, and the direct application of commercial VR devices for gaming. Therefore, in future clinical applications, medical staff should provide thorough explanations of VR applications before teaching participants and demonstrate sufficient tolerance and patience during the teaching process to alleviate the pressure and stress experienced by patients when using VR games. Additionally, medical staff can consider recording instructional videos on the use of VR equipment for patients to watch and learn in advance or repeatedly. This approach aims to improve the success rate of VR game applications and enhance patients' confidence and participation.

The vast majority of patients reported that they felt their brain and limbs were exercised simultaneously when using VR games, and that this feeling helped with concentration. They also noted feeling hardly tired while playing, which is consistent with the findings of Stewart et al. [27]. The perceived exertion during a VR game may be lower than the actual exertion, and it may be related to the difficulty setting of the game. However, some patients in this study reported feeling very fatigued after using the VR game. This suggests that healthcare professionals need to appropriately control the usage duration during clinical application, rather than solely relying on patients' personal complaints. To prevent excessive fatigue among postoperative cardiac patients during rehabilitation, medical staff must prioritize patient safety. They should gradually implement exercise and prevent complications associated with excessive physical exertion.

Finally, participants expressed some preferences regarding VR devices and the operating environment when using VR games. They hoped that the headset could be lighter, possibly because they had not fully recovered their physical strength after undergoing major surgery. The current weight of the QUEST2 headset is approximately 500 g, and the weight of the upgraded version QUEST3 has been reduced to 80% of the weight of the original version, with a 40% reduction in volume. Healthcare organizations may consider acquiring lighter VR wearable devices for future clinical applications to better meet patients' needs. Additionally, participants expressed a desire to use the game in a more open space and to have company while using it, which would reduce the likelihood of physical collisions and alleviate concerns about damaging the VR devices. Medical institutions should consider providing patients with suitable spaces for VR applications, ensuring that the patient's operating area is free of obstacles. During renovations, cushioning pads can be installed on the floor or walls to prevent patients from accidentally falling or bumping into objects during operation. Patients must be accompanied by a medical professional throughout the use of VR games, and cardiac monitoring should be implemented for patients when necessary. This ensures the safety of patients during VR gaming and helps alleviate their concerns about their safety during operation.

Limitation

Despite the contributions of this qualitative study, it has some limitations. First, the interviewees were from the same cardiac surgery center, and only one brand of commercially available VR equipment was utilized. Therefore, patients' feedback on deficiencies in the implementation of VR games, particularly regarding hardware facilities, may not be applicable to all healthcare institutions. Second, the researchers were nurses working in this cardiac surgery center. Although patients were informed prior to the interviews that the content would be kept strictly confidential, it cannot be ruled out that some interviewees refrained from expressing more negative feedback owing to their collaborative relationship with the nurses. Finally, this study was conducted in a cardiac surgery center, and although a purposive sampling method was employed, the respondents were all patients who had undergone cardiac surgery. Therefore, further experimental validation is needed to determine whether the findings are applicable to patients undergoing internal-medicine treatments or other surgical procedures.

Conclusion

Postoperative cardiac surgical patients believe that the use of commercially available VR games can facilitate their early postoperative rehabilitation by increasing motivation to participate in exercise, enhancing the quality of exercise, and improving mood. Moreover, lighter VR wearable devices, spacious and safe areas for use, professional staff accompaniment, and comprehensive instructions could enhance patients' experience of the benefits of VR games in their rehabilitation.

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