PEC Innovation 1 (2022) 100015

Contents lists available at ScienceDirect

PEC Innovation

journal homepage: www.elsevier.com/locate/pecinn

Patients' voices in the development of pre-surgical patient education using virtual reality: A qualitative study

Marijke van der Linde-van den Bor [a], Sarah A. Frans-Rensen [a], Fiona Slond [b], Omayra C.D. Liesdek [a], Linda M. de Heer [a], Willem J.L. Suyker [a], Tiny Jaarsma [c,d], Saskia W.M. Weldam [a,*]

[a] Utrecht University Medical Centre, Department of Cardiothoracic Surgery, Utrecht, The Netherlands
[b] Utrecht University Medical Centre, Centre for Education, Department of Technology Enhanced Learning, Utrecht, The Netherlands
[c] Utrecht University Medical Centre, Julius Centre for Health Sciences and Primary Care, Utrecht, The Netherlands
[d] Linkoping University, Department of Health, Medicine and Caring Services, Linkoping, Sweden

ARTICLE INFO

Keywords:
Anxiety
Cardiac surgery
Information needs
Patient education
Qualitative research
Thematic analysis
Virtual reality

ABSTRACT

Objective: To identify the information needs and perceptions of patients regarding the application of virtual reality in pre-surgical patient education.
Methods: A qualitative study was conducted between March and July 2020. The study population consisted of a purposive sample of patients scheduled for cardiac surgery from a single institution. Semi-structured individual interviews (n = 19) were conducted and analysed using thematic analysis.
Results: Patient perceptions regarding virtual reality and information needs related to hospitalisation and surgery could be categorised into three themes: Creating familiarity, contents to explore and challenges and preconditions.
Conclusions: Virtual reality technology is a promising tool that can enhance conventional patient education to improve understanding and to potentially reduce concerns and anxieties. The virtual reality environment creates an opportunity for patients to be in control of the timing, quantity, depth and frequency of patient education. A virtual reality education tool should not be a substitute for personal contact with the physician.
Innovation: Patient information needs were identified profoundly to the further development of a virtual reality intervention. This intervention aims to educate patients prior to elective cardiac surgery.

1. Introduction

Many patients experience cardiac surgery as a life-threatening event that influences physical and emotional well-being with feelings of dependency and anxiety [1]. Patients scheduled for general anaesthesia and major surgery often become anxious and stressed [2,3], especially in more complex or invasive procedures such as cardiac surgery [4]. Anxiety could be triggered by expectations of postoperative pain, separation from family, incapacitation, loss of independence and fear of surgery, complications and death [5,6]. Although anxiety is often considered a normal part of the preoperative encounter, patients have to cope with this situation. When stress exceeds individual patient resources, it may negatively affect recovery from surgery and quality of life [2,3,7-9].

To address preoperative anxiety and stress, preoperative patient education could be helpful in reducing anxiety and stress [10-12]. Preoperative education is defined as helping the patient understand and mentally prepare for the surgical procedure and the recovery process during the postoperative period [10]. Providing information helps patients understand what to expect during their hospital stay and treatment, improves adherence to treatment and could minimize their worries and anxieties [10,13,14]. However, due to the complexity of medical information, patients experience difficulty in understanding and retaining the information given to them, especially when patients have limited literacy [12,15]. Different methods of presenting information can promote understanding and successful retention of the information [12,16]. In this context, applications of state-of-the-art information technology, such as web-based education programs [16,17], serious gaming [18] and apps to promote healthy behaviour [19,20], are being developed and investigated. These interventions are promising, as they appear to be at least as effective as conventional education programmes and, in many studies more effective for improving knowledge, skills, and patient satisfaction. An additional direction of development in information technology for patient education could be the application of virtual reality.

* Corresponding author at: Heart and Lung Department, Utrecht University Medical Centre (UMC Utrecht), Internal PO E03.511, PO Box 85500, 3508 GA Utrecht, The Netherlands.
E-mail addresses: M.vanderlinde@umcutrecht.nl (M. van der Linde-van den Bor), S.A.Frans@umcutrecht.nl (S.A. Frans-Rensen), F.Slond@umcutrecht.nl (F. Slond), O.C.D.Liesdek@umcutrecht.nl (O.C.D. Liesdek), L.M.deHeer-3@umcutrecht.nl (L.M. de Heer), W.J.L.Suyker@umcutrecht.nl (W.J.L. Suyker), Tiny.Jaarsma@liu.se (T. Jaarsma), S.Weldam@umcutrecht.nl (S.W.M. Weldam).

http://dx.doi.org/10.1016/j.pecinn.2021.100015
Received 17 September 2021; Received in revised form 17 December 2021; Accepted 29 December 2021

Virtual reality is a medium composed of interactive computer simulations that sense the participant's position and actions and that provide feedback to one or more senses, giving the feeling of being mentally immersed or present in the simulation [21]. Key concepts in virtual reality are interactivity and integration of senses (visual, haptic, aural and olfactory) [21]. In patient education, virtual reality can be used for the purpose of better preparing the patient by increasing knowledge, improving patient satisfaction and participation and reducing anxiety and distress [23-25].

To address anxiety and to improve understanding, we instituted a virtual environment to prepare patients for elective cardiac surgery. In this 'Virtual Patient Tour', the patient experiences a tour of the hospital admission process. The patient is introduced to the nursing ward, the operating theatre, the intensive care unit and the medium care unit. The 'Virtual Patient Tour' was developed using 360 degree video and filmed from the patient's perspective. A narration track of the script was recorded for overlay. Patients can experience the 'Virtual Patient Tour' by a Head Mounted Display system with hand motion controller).

The methodological framework to guide the design, implementation and evaluation of virtual reality applications in healthcare is used [26]. An important part of this framework is the incorporation of patients' needs because non- adaptation to user feedback can lead to the failure of digital interventions [26]. Therefore, the objective of this study is to identify the information needs and perceptions of patients regarding the application of virtual reality in pre-surgical patient education, in order to adjust the content of the 'Virtual Patient Tour' accordingly.

2. Methods

2.1. Design and context

A qualitative design was used. Two of the authors, a health scientist and a nursing scientist, conducted semi-structured interviews (MLB and SFR). They were not known to the participants of this research prior to undertaking the study.

The study was conducted at the cardiac surgery department of a single institution.

A purposive sampling strategy was used to focus on patients' perceptions and information needs regarding virtual reality in patient education. We strived for a heterogeneous sample with regard to sex, age and familiarity with the concept of virtual reality and aimed to include patients both prior to surgery and after surgery. All patients scheduled for elective cardiac surgery (coronary artery bypass grafting and/or heart valve repair or replacement) and physically and mentally able to participate in an interview were asked to participate in the study. Patients were excluded if they did not speak Dutch. Patient recruitment continued until no new information was added.

2.2. Data collection

In-depth, semi-structured interviews were held with patients individually. Ten interviews were conducted with patients prior to surgery, and nine interviews were conducted with a separate group of patients after surgery. The interviews were held from 2 days to 16 hours prior to surgery for the preoperative participants, and 2 days to 6 weeks after surgery for the postoperative participants. A pre-prepared interview guide was created based on the literature on perceptions and expectations of cardiac surgery patients [1], education and information transfer [27], personality and coping [2], factors influencing health-related behaviour [28] and expert consultation. The interview guide consisted of the following main topics: patient experiences preceding and during hospital stay, pre- and postoperative information needs, degree of anxiety and distress, and opinions on virtual reality related to patient education. Because information needs are linked with coping mechanisms, topics on personality and coping were also added. All interviews were digitally recorded.

To evaluate the patients' perception of virtual reality objectively, the prototype of the Virtual Patient Tour was not presented to the participants. As a consequence, some participants were unable to specify which information would be desirable in a virtual reality environment. If this was the case, the participant reflected on a number of hypothetical possibilities, like an anatomic model or patient story, proposed by the interviewer. Data collection continued until no new information was added. Patient profiles, such as age, sex, diagnosis and treatment, were collected from medical files.

2.3. Data processing and analysis

Thematic analysis was used as a method for identifying, analysing, and reporting patterns within data [29]. Verbal data were anonymised, and participants were given gender-neutral pseudonyms. The verbal data were transcribed verbatim and imported into the software program QRS NVivo Pro version 12 [30]. The researchers familiarised themselves with the data by reading and rereading the data and noting initial ideas. Data were initially coded independently according to a coding outline. All codes were compared and discussed until consensus was reached. Codes were collating into potential themes and patterns and checked for coherence. Thematic maps were constructed and discussed with all authors of this paper in two peer review meetings. After peer reviewing, the themes were defined and the analysis was linked back to the literature and the research questions, and complemented with compelling examples [29]. The analysis was conducted in a non-linear, iterative process of describing, comparing, relating and adjusting [31]. Reporting was in accordance with the Standards for Reporting Qualitative Research, which is accounted in appendix A [32].

2.4. Techniques to enhance trustworthiness

The trustworthiness of qualitative studies can be assessed by their credibility, transferability, conformability and dependability [33]. The first interview (P1) was used to train the researchers and to ensure that the questions were well understood by patients and therefore excluded from the analysis. To enhance credibility and to reduce potential bias, triangulation was applied in various ways. For methodological triangulation, field notes with observations were collected during the interviews, and they were matched with the transcripts. To implement investigator triangulation, the researchers coded separately. All codes were compared and discussed until consensus was reached. For data triangulation, transcripts, codes and themes were iteratively analysed throughout the process. Member checking was done as the researchers regularly summarised the information provided to them, to verify they had a clear understanding. To facilitate transferability, the context, the selection, the clinical profile of the respondents, the data collection and the analysis process were documented carefully. Dependability and confirmability were enhanced by recording major decisions in an audit trail [34] and having the detailed description of the data analysis and structure of the themes verified by three investigators. Three peer debriefing sessions were conducted to evaluate the interview process and to discuss difficulties.

2.5. Ethical issues

The study was conducted in accordance with the Declaration of Helsinki and Dutch regulations. The Medical Research Ethics Committee of the University Medical Centre Utrecht concluded that Medical Research Involving Human Subjects did not apply to the study: therefore no approval was needed. Patients were recruited during outpatient visits. Patients were adequately informed in person about participating in the study. Written informed consent was obtained from all participating patients. Data were only used for research purposes. The interviews were conducted between March 2020 and July 2020.

3. Results

Twenty patients gave their consent. One patient (P4) was excluded due to failure of the audio equipment during the interview. Consequently,

nineteen patients were included in the study. The interviews were conducted in a face-to-face meeting. However, due to the COVID-19 pandemic, five interviews were conducted by video call. The interviews lasted between 16 and 51 minutes. The clinical profile of the participants are presented in Table 1.

The qualitative analysis deduced three themes: creating familiarity, contents to explore using virtual reality and challenges and preconditions in development and implementation. The findings are summarised in Table 2.

3.1. Creating familiarity

The application of virtual reality in patient education in addition to traditional education was considered valuable. By experiencing hospital admission virtually, expectations of what is to come became more realistic. It was reassuring to know what to expect, and it could reduce worries and concerns. This was especially true if the patient had never been admitted to a hospital before (Q1).

The addition of vision next to listening and reading was also mentioned as a benefit of virtual reality. Multimodal information (listening, watching and reading) will provide something appealing to every patient. When provided verbally or in writing, important information tended to be understood only partially and retained only temporarily due to language barriers or by experiencing anxiety and stress. A cultural barrier was also mentioned as a reason for limited understanding of verbal information. In some culture, patients confirm to the physician that they understood the information provided to them out of politeness even when they do not understand it or do so only incompletely. A virtual reality environment could potentially reduce these barriers (Q2).

3.2. Contents to explore

Participants had a very clear opinion about what they would and would not like to experience in a virtual reality environment. However, these needs are heterogeneous and depend on personal preferences and past hospital experiences.

Table 1
Clinical profiles of participants (n = 19).

Participant[$]	Sex	Age (range)	Surgery[#]	Familiar with virtual reality	Timing interview
P2	Female	50-59	MIDCAB	Unknown	Pre-operative
P3	Male	50-59	CABG	Yes	Pre-operative
P5	Male	50-59	MIDCAB	No	Pre-operative
P6	Male	50-59	CABG	Yes	Post-operative
P7	Male	60-69	CABG	Yes	Pre-operative
P8	Male	50-59	CABG	No	Pre-operative
P9	Male	60-69	MIDCAB	Yes	Pre-operative
P10	Male	70-79	CABG	No	Pre-operative
P11	Female	50-59	MIDCAB	Yes	Post-operative
P12	Male	60-69	CABG + MVP	Yes	Pre-operative
P13	Male	50-59	MIDCAB	No	Pre-operative
P14	Female	50-59	CABG	Yes	Pre-operative
P15	Female	50-59	Mini AVR	Unknown	Post-operative
P16	Female	40-49	AVR	Yes	Post-operative
P17	Male	70-79	MIDCAB	Yes	Post-operative
P18	Male	60-69	MVP	Yes	Post-operative
P19	Male	70-79	MVP	Yes	Post-operative
P20	Male	70-79	CABG	Yes	Post-operative
P21	Male	70-79	CABG	Yes	Post-operative

[$] P1 was excluded as the first interview was used to train the researchers and to ensure that the questions were well understood by patients. P4 was excluded due to failure of audio equipment during the interview.

[#] CABG: Coronary Artery Bypass Grafting; AVR: Aortic Valve Replacement; MIDCAB: Minimal Invasive Coronary Artery Bypass; mini-Aortic Valve Replacement; MVP: Mitral Valve Plasty

Table 2
Summary of the findings regarding patient needs and perceptions of virtual reality in patient education.

Themes	Subthemes	Findings
Creating familiarity		• Reassurance by experiencing what is to come • Potentially reduction of worry and concern • Multimodal information provision improves understanding and reduces language and cultural barriers
Contents to explore	Factual knowledge	• Virtual tour of hospital stay • 3D anatomic model • Physical therapy education • Importance of a good health before surgery • Physical labour and pain management
	Emotional support	• Distraction and relaxation • A patient story • Addressing personal concerns
Challenges and preconditions	Development and design	• Identification with virtual patient • Evocation of fear • Personalized information • Avoid being overwhelmed • Facultative information • Interactivity • Pleasant experience for all generations
	Implementation	• Involvement of partner or relative in virtual experience • Frequency and timing at own pace • Complementary to conventional information provision • Voluntary to experience

Each of these themes are described in the following paragraphs and illustrated by quotes of the participants in Table 3 (Q references in the text refer to quotes of specific themes).

3.2.1. Factual knowledge

Participants stressed the importance of a virtual tour encompassing the entire duration of their hospital stay, including information on what they would encounter during their time in the hospital (Q3). Patients indicated that they were interested not only in seeing the different departments they would go through, but also in obtaining an explanation of the necessary medical equipment and the accompanying sounds. Opinions were divided on the experience of the operation itself: from “no need” to “very interested”. No need was indicated because patients do not consciously experience the time in the operating theatre. In addition, there was a certain fear of being confronted with scarifying images. Participants referred to the large number of people who were present in the operating theatre. They wondered what these people were doing, and they were interested in the tasks and responsibilities of these healthcare professionals.

Incorporating a 3D anatomical model in virtual reality in the preoperative education would be valuable as a supportive tool for the explanations of diagnosis and treatment. Patients also indicated the need for personalised information on diagnosis and treatment. An interactive 3D anatomical model in which the patient’s diagnosis, for instance, valve insufficiency, is visualised, could improve understanding (Q4).

On the topic of improving physical condition, participants mentioned this in all phases of the surgical encounter. Prior to surgery, to provide information about the importance of healthy physical condition. Physical recovery is facilitated if the patient is in a good physical condition, and it reduces the risk of postoperative complications. During hospital stay, education on physical therapy is important to encourage exercise to prevent pneumonia and regain mobility. During the recovery period, information is needed on physical exertion and pain management. Patients indicated that they were interested in what to expect during the recovery period (Q5).

3.2.2. Emotional support

Participants indicated that they were interested in contents related to their need to feel informed and understood, and also those that address

Table 3
Illustrative quotes related to the identified themes

(Sub)Themes	Quotes	
Creating familiarity	Q1	P12: "When you are admitted to the hospital, you end up in a completely different environment. If you have already experienced that before, you will be better prepared for what awaits you"
	Q2	P3: "I work in an organisation with many people who are inclined to say yes, to be polite or because the doctor says so"
Content to explore		
- Factual knowledge	Q3	P9: "I think, for those who are open minded, a tour through the different departments can be very informative. I'd like to see that personally"
	Q4	P6: "A 3D model of the heart would be very helpful in the preoperative consult. Questions can not only be answered verbally, but also visually by pointing it out in the model"
	Q5	P7: "I read about the importance *[of regaining mobility]* in the booklet. Show me how to do this, show me what to expect"
		P12. "Especially the part about moving my body during the recovery period ... How do you do that? What do you encounter? That would be helpful in virtual reality"
		P21: "I would like to know which physical exertion is allowed and which is not"
- Emotional support	Q6	P9: "I dread the moment of awakening from the anaesthesia. Suppose I choke, suppose I get something in my lungs and that creates a complication... this is worrisome to me"
		P19: "The wall of my heart has been thinned because of my illness... there is risk of rupture ... I'd rather have surgery done today than tomorrow"
Challenges and preconditions		
- Development and design	Q7	P6: "The power of virtual reality is to be able to identify yourself with the virtual patient. The patient's experience in the virtual reality environment must be as close as possible to the patient's own experiences"
	Q8	P12: "You have to ensure that the message you want to convey remains manageable. You should not want to put in too many peripheral phenomena that distract from the main message"
		P17: "A virtual environment is lifelike. A 2D picture also gives an image, but does not come to you as penetratingly as in virtual reality"
		P21: "Be careful which images you show in a virtual reality environment. It can be too immersive and become frightful. An animation in virtual reality may be sufficient"
	Q9	P18: "I wouldn't be much interested in the virtual reality experience. That's my generation, I did not grow up with digital skills"
- Implementation	Q10	P7: "You want to meet the person who will 'cut your tissue'"

emotional needs. The use of a virtual reality environment as distraction or relaxation prior to surgery to reduce anxiety and stress was also mentioned. Although not all participants felt the need for distraction, they did acknowledge the added value in its availability.

A patient's own story of his or her experiences of hospital stay and surgery was considered a topic for further development. A patient is an expert by experience, and messages from fellow patients could be different from the information provided by healthcare professionals. At the same time, participants indicated that a patient's own story is difficult to be developed for virtual reality because the experience of the virtual patient cannot be a substitute for the personal experience of the affected patient, which is considered a requirement.

In addition to general concerns related to surgery and anaesthetics, physical discomfort, fear of death or complications during surgery, patients expressed personal concerns caused by past experiences with surgery or physical impairments in daily life. Daily confrontation with the consequences of heart disease could lead to uncertainty, worries or anxiety. This was reinforced by a long waiting period before surgery (Q6).

3.3. Challenges and preconditions

3.3.1. Development and design

Patients wanted to feel 'this is about me'. Therefore, the virtual environment should approach reality as closely as possible and all senses should be addressed (Q7).

Personalised information was preferred, especially with regard to diagnosis and treatment. Incorporation of facultative elements was recommended, to be able to choose additional or in-depth information or to be able to make the choice not to see/read/experience this information.

Participants warned that care must be taken so that information would not become overwhelming. Moreover, images in a reality-based environment could evoke or even aggravate feelings of anxiety and stress (Q8).

Interactive features should be implemented to improve engagement. A participant with professional virtual reality experiences stressed that the virtual reality experience should be intuitive and a pleasant experience regardless of generation, although there will always be patients who are not interested in virtual reality technology. A patient who responded that he did not see the added value of virtual reality stated that he did not need to know all the details on hospital stay and surgery. He trusted the skills and experiences of the physicians. An elderly individual indicated that his disinterest in virtual reality was probably due to his age, as he did not grow up with today's digital possibilities (Q9).

3.3.2. Implementation

Involvement of the partner or relatives in the patient education to foster social support and understanding is considered important. Additionally, partners and relatives have their own concerns that need to be addressed. Availability of the virtual reality tool was mentioned. It is desirable to experience the virtual reality environment at their own pace. Information can then be accessed repeatedly if questions remain unanswered or new questions arise.

The virtual reality tool should be available at any time, not just in the preoperative phase, and should not be restricted to the period of hospital stay. Virtual reality content that is irrelevant or less relevant prior to surgery could be interesting or useful in the recovery period. Virtual reality education should be complementary to conventional modes of instruction and cannot replace them completely, because personal contact with the physician is essential (Q10). Moreover, personal connection with the surgeon was found to be important to feel confident about his or her expertise. Finally, a patient should be free to choose whether or not to engage in the virtual reality environment.

4. Discussion and conclusion

4.1. Discussion

This qualitative study was designed to identify the information needs and patients' perceptions regarding the application of virtual reality in pre-surgical patient education so that a virtual reality prototype environment can be adjusted accordingly. With regard to information needs and perceptions, three main themes were identified: Creating familiarity: seeing and experiencing what is to come in advance creates realistic expectations. Moreover, the combination of visual and auditory information potentially improves understanding and reduces worries and concerns. Contents to explore; various applications of virtual reality in pre-surgical patient education were suggested, with a general interest in a virtual tour of the hospital stay. Challenges and preconditions: create a realistic environment wherein identification with the virtual patient is guaranteed and facultative elements are integrated so that the user can make a choice whether to access in-depth information or not. Moreover, involvement of the patient's partner in the virtual reality experience is important in implementing the virtual reality tool in clinical practice.

Although the amount of literature on the application of virtual reality in pre-surgical patient education and patient participation in virtual reality development is limited, some of the findings in the current study are in line with previous studies.

Our finding that the combination of visual and auditory information potentially improves understanding is reflected in a qualitative study on patient education prior to radiation therapy [35]. In this study, a prototype virtual reality intervention was presented to patients, and the patients were asked to give feedback. Consistent with this current study, patients indicated that the virtual reality intervention potentially improved understanding and reduced anxiety. Similarly, they reported that realism, timing and age barriers needed to be taken into account in the further development of virtual reality interventions [35]. On the other hand, in contrast to our findings, accuracy, generalisability and language issues were mentioned. This difference might be due to the fact that, in their study, the patients gave feedbacks on their actual experience of the virtual reality prototype as opposes to our study, where the patients responded to imaginary experiences.

In this current study, patients proposed interesting topics to explore in virtual reality, of which three were investigated in previous research. The first proposed topic is an anatomical 3D model. Various 3D models in virtual reality are used in the education of healthcare professionals. A few of these models are adapted for patient education to facilitate explanation of diagnosis and treatment. Ongoing developments incorporate personalised information in these models based on patient anatomy reconstructed from computer tomography or magnetic resonance imaging. Patients perceived virtual reality to be a useful educational resource [15], which improved understanding and decreased anxiety and distress [36,37]. The second proposed topic is the physical therapy. In the literature, exercises in a virtual reality environment are used to promote functional mobility training to improve balance and reduce the risk of falling. The results are promising, as the rehabilitation after total hip replacement was facilitated [38] and the balance and the gait in patients with Parkinson's disease improved [39]. The third topic is distraction or relaxation. The application of virtual reality to distract in a stressful situation is the subject of research in various areas. To alleviate pain and distress during medical procedures [40], and in the management of psychological stress [41]. Virtual reality as a distraction tool has proven to be effective. The number of hospitals offering virtual reality not only as a therapeutic instrument but also as a tool of distraction, is increasing.

Some limitations of this study need to be considered. First, although we strived for a heterogeneous sample, the sample, regarding to sex and familiarity with the concept of virtual reality, showed limited variation. This is partly due to the study population. Prevalence of cardiovascular disease is lower in women compared to men [42]. Consequently the number of women in the sample is limited. Second, the results of our study are limited to the early phase of the post-operative period. Consequently, we could not identify changes in experiences and information needs over time.

With respect to the limited research available within this topic, it is a strength of this study that the patient's needs in the development of the virtual reality education tool have been identified in a very early stage. Another strength is the credibility of the interpretations. The interviews enabled a deeper understanding of participants' information needs and perceptions regarding the application of virtual reality in patient education. Coding and a profound data analysis were performed in an iterative process.

In the development of a virtual reality education tool, the patients' information needs identified in this study should be addressed. Further development and research should be undertaken by a joint, multidisciplinary team of experts on education, communication, virtual reality technology and healthcare professionals in cardiac surgery. In line with the methodological framework to guide the design [26] and implementation and evaluation of virtual reality applications in healthcare, the next step is to test the virtual reality environment in cardiac surgery patients with a focus on feasibility, acceptability and safety.

Additional research is necessary to determine the effect of patient education using virtual reality technology on clinical outcomes such as anxiety, understanding, patient satisfaction and quality of life.

4.2. Innovation

Although in the development of VR interventions patient opinions were asked (35), this study investigated patient information needs, more profoundly. To the best of our knowledge, this is the first study which identified patient needs regarding a virtual reality intervention, to invest in the further development of the virtual reality intervention.

Participants in this current study provided critical insights to be incorporated in the development and implementation of a virtual environment to prepare patients for elective cardiac surgery. The original justification for developing a virtual reality environment for this patient category was to improve understanding and reduce concerns and anxieties for the surgical encounter. These two goals were also indicated as potential benefits by the study participants, which supports that implementation of virtual reality as an education tool in clinical practice is promising. However, it is important to address and explore the added value of virtual reality over other forms of technological innovations in patient education. Before further development and implementation of a virtual reality environment in patient education, it is important to reflect on both the strengths and weaknesses of virtual reality.

Within this context, several strengths can be considered. Compared to other forms of web-based technology, such as eHealth apps, eLearning programs or serious gaming, virtual reality is immersive. All senses are addressed, which creates a feeling of being present in the situation. In contrast to conventional (written and verbal) patient education method, web-based and virtual reality technologies allow optional and interactive features to be integrated. Technology can address the curiosity-driven interest of patients. Therefore, self-management is facilitated by allowing the patient to choose the topics, quantity and depth of the information to be provided. However, some distinction will have to be made between 'necessary to know' and 'nice to know' information. The availability of web-based and virtual reality technologies during the patient journey is another strength over traditional verbal patient education. The patient determines the moment, quantity and frequency of the virtual reality experience. In regard to out-of-hospital patient education (prior and post admittance) hardware availability, data security, infection prevention and privacy issues must be taken into account.

Although virtual reality is a promising tool and can address many information needs of the patients, weaknesses should also be considered. A virtual reality education tool cannot totally replace the human aspect of traditional patient education. In addition to providing substantive information, the patient also needs emotional reassurance, attention and recognition. Although virtual reality is very realistic and real physicians and nurses can be included as actors in the virtual reality environment, it cannot completely replace the human aspect to address emotional needs. Currently, virtual reality is complementary and improves communication by providing a valuable opportunity for additional dialogue between physicians and patients [37].

4.3. Conclusion

Virtual reality technology is a promising tool that offers opportunities to enhance conventional patient education to improve understanding and to potentially reduce concerns and anxieties. An additional strength of virtual reality is the opportunity for patients to be in control in the timing, quantity and frequency of the virtual reality experience. However, a virtual reality education tool should not be a substitute for personal contact with the physician.

Statement patient identifiers

I confirm all patient/personal identifiers have been removed or disguised so the patient/person(s) described are not identifiable and cannot be identified through the details of the story.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pecinn.2021.100015.

References

[1] Lindsay GM, Smith LN, Hanlon P, Wheatley DJ. Coronary artery disease patients' perception of their health and expectations of benefit following coronary artery bypass grafting. J Adv Nurs. 2000;32:1412–21. https://doi.org/10.1046/j.1365-2648.2000.01621.x.
[2] Aust H, Rüsch D, Schuster M, Sturm T, Brehm F, Nestoriuc Y. Coping strategies in anxious surgical patients. BMC Health Serv Res. 2016;16:250–60. https://doi.org/10.1186/s12913-016-1492-5.
[3] Jarmoszewicz K, Nowicka-Sauer K, Zemła A, Beta S. Factors associated with high preoperative anxiety: results from cluster analysis. World J Surg. 2020;44:2162–9. https://doi.org/10.1007/s00268-020-05453-x.
[4] Burton D, King A, Bartley J, Petrie KJ, Broadbent E. The surgical anxiety questionnaire (SAQ): development and validation. Psychol Health. 2019;34:129–46. https://doi.org/10.1080/08870446.2018.1502770.
[5] Mitchell M. Patient anxiety and modern elective surgery: a literature review. J Clin Nurs. 2003;12:806–15.
[6] Caumo W, Schmidt AP, Schneider CN, Bergmann J, Iwamoto CW, Bandeira D, et al. Risk factors for preoperative anxiety in adults. Acta Anaesthesiol Scand. 2001;45:298–307. https://doi.org/10.1034/j.1399-6576.2001.045003298.x.
[7] Refai M, Andolfi M, Gentili P, Pelusi G, Manzotti F, Sabbatini A. Enhanced recovery after thoracic surgery: patient information and care-plans. J Thorac Dis. 2018;10. https://doi.org/10.21037/jtd.2017.12.87 S512-S6.
[8] Goyal T, Idler E, Krause T, Contrada R. Quality of life following cardiac surgery: impact of the severity and course of depressive symptoms. Psychosom Med. 2005;67:759–65. https://doi.org/10.1097/01.psy.0000174046.40566.80.
[9] Blumenthal JA, Lett HS, Babyak MA, White W, Smith PK, Mark DB, et al. Depression as a risk factor for mortality after coronary artery bypass surgery. Lancet. 2003;362:604–9. https://doi.org/10.1016/s0140-6736(03)14190-6.
[10] Ramesh C, Nayak BS, Pai VB, Patil NT, George A, George LS, et al. Effect of preoperative education on postoperative outcomes among patients undergoing cardiac surgery: a systematic review and meta-analysis. J PeriAnesth Nurs. 2017;32:518–29. https://doi.org/10.1016/j.jopan.2016.11.011.
[11] Koivisto JM, Saarinen I, Kaipia A, Puukka P, Kivinen K, Laine KM, et al. Patient education in relation to informational needs and postoperative complications in surgical patients. Int J Qual Health Care. 2019;32:35–40. https://doi.org/10.1093/intqhc/mzz032.
[12] Hounsome J, Lee A, Greenhalgh J, Lewis SR, Schofield-Robinson OJ, Coldwell CH, et al. A systematic review of information format and timing before scheduled adult surgery for peri-operative anxiety. Anaesth. 2017;72:1265–72. https://doi.org/10.1111/anae.14018.
[13] O'Brien L, McKeough C, Fau - Abbasi R, Abbasi R. Pre-surgery education for elective cardiac surgery patients: a survey from the patient's perspective. Aust Occup Ther. 2013;60:404–9. https://doi.org/10.1111/1440-1630.12068.
[14] McCann M, Stamp N, Ngui A, Litton E. Cardiac prehabilitation. J Cardiothorac Vasc Anesth. 2019;33:2255–65. https://doi.org/10.1053/j.jvca.2019.01.023.
[15] Pandrangi VC, Gaston B, Appelbaum NP, Albuquerque FC, Levy MM, Larson RA. The application of virtual reality in patient education. Ann Vasc Surg. 2019;59:184–9. https://doi.org/10.1016/j.avsg.2019.01.015.
[16] Friedman AJ, Cosby R, Boyko S, Hatton-Bauer J, Turnbull G. Effective teaching strategies and methods of delivery for patient education: a systematic review and practice guideline recommendations. J Cancer Educ. 2011;26:12–21. https://doi.org/10.1007/s13187-010-0183-x.
[17] Fredericks S, Martorella G, Catallo C. A systematic review of web-based educational interventions. Clin Nurs Res. 2015;24:91–113. https://doi.org/10.1177/1054773814522829.
[18] Gentry SV, Gauthier A, L'Estrade Ehrstrom B, Wortley D, Lilienthal A, Tudor Car L, et al. Serious gaming and gamification education in health professions: systematic review. J Med Internet Res. 2019;21. https://doi.org/10.2196/12994 e12994-e.
[19] Yin AL, Hachuel D, Pollak JP, Scherl EJ, Estrin D. Digital health apps in the clinical care of inflammatory bowel disease: scoping review. J Med Internet Res. 2019;21:e14630. https://doi.org/10.2196/14630.
[20] Timmers T, Janssen L, van der Weegen W, Das D, Marijnissen WJ, Hannink G, et al. The effect of an app for day-to-day postoperative care education on patients with total knee replacement: randomized controlled trial. J Med Internet Res Mhealth Uhealth. 2019;7:e15323. https://doi.org/10.2196/15323.
[21] Rubio-Tamayo JL, Gertrudix Barrio M, García García F. Immersive environments and virtual reality: systematic review and advantages in communication. Interaction and Simulation Multimod Technol Interact. 2017;21:1–20. https://doi.org/10.3390/mti1040021.
[23] Marquess M, Johnston SP, Williams NL, Giordano C, Leiby BE, Hurwitz MD, et al. A pilot study to determine if the use of a virtual reality education module reduces anxiety and increases comprehension in patients receiving radiation therapy. J Radiat Oncol. 2017;6:317–22. https://doi.org/10.1007/s13566-017-0298-3.
[24] Bekelis K, Calnan D, Simmons N, MacKenzie TA, Kakoulides G. Effect of an immersive preoperative virtual reality experience on patient reported outcomes: a randomized controlled trial. Ann Surg. 2017;265:1068–73. https://doi.org/10.1097/SLA.0000000000002094.
[25] Han S-H, Park J-W, Choi SI, Kim JY, Lee H, Yoo H-J, et al. Effect of immersive virtual reality education before chest radiography on anxiety and distress among pediatric patients: a randomized clinical trial. J Amer Med Assoc Pediatr. 2019;173:1026–31. https://doi.org/10.1001/jamapediatrics.2019.3000.
[26] Birckhead B, Khalil C, Liu X, Conovitz S, Rizzo A, Danovitch I, et al. Recommendations for methodology of virtual reality clinical trials in health care by an international working group: iterative study. J Med Internet Res Ment Health. 2019;6:e11973. https://doi.org/10.2196/11973.
[27] Mayer R. Thirty years of research on online learning. Appl Cogn Psychol. 2019;33:152–9. https://doi.org/10.1002/acp.3482.
[28] Bellamy R. An introduction to patient education: theory and practice. Med Teacher. 2004;26:359–65. https://doi.org/10.1080/01421590410001679398.
[29] Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3:77–101.
[30] QRS International PL. NVivo. 12 ed2018; 2018.
[31] Bazeley P. Analysing qualitative data: More than 'identifying themes'. Malays J Qual Res. 2009;2:6–22.
[32] O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for reporting qualitative research: a synthesis of recommendations. Acad Med. 2014;89:1245–51. https://doi.org/10.1097/acm.0000000000000388.
[33] Korstjens I, Moser A. Series: practical guidance to qualitative research. Part 4: trustworthiness and publishing. Eur J Gen Pract. 2018;24:120–4. https://doi.org/10.1080/13814788.2017.1375092.
[34] Holloway I, Galvin K. Qualitative research in nursing and healthcare. 4th ed. Wiley-Blackwell; 2016 October 2016. 376 p.
[35] Johnson K, Liszewski B, Dawdy K, Lai Y, McGuffin M. Learning in 360 degrees: a pilot study on the use of virtual reality for radiation therapy patient education. J Med Imaging Radiat Sci. 2020;51:221–6. https://doi.org/10.1016/j.jmir.2019.12.008.
[36] Yang J-H, Ryu JJ, Nam E, Lee H-S, Lee JK. Effects of preoperative virtual reality magnetic resonance imaging on preoperative anxiety in patients undergoing arthroscopic knee surgery: a randomized controlled study. Arthroscopy. 2019;35:2394–9. https://doi.org/10.1016/j.arthro.2019.02.037.
[37] Wang LJ, Casto B, Luh JY, Wang SJ. Virtual reality-based education for patients undergoing radiation therapy. J Cancer Educ. 2020;1-7. https://doi.org/10.1007/s13187-020-01870-7.
[38] Hadamus A, Bialoszewski D, Wydra K, Kowalska AJ, Urbaniak E, Boratyński R, et al. Balance training in virtual reality improves temporal gait parameters in patients after total hip replacement. Gait Posture. 2019;73:99. https://doi.org/10.1016/j.gaitpost.2019.07.052.
[39] Feng H, Li C, Liu J, Wang L, Ma J, Li G, et al. Virtual reality rehabilitation versus conventional physical therapy for improving balance and gait in parkinson's disease patients: a randomized controlled trial. Med Sci Monit. 2019;25:4186–92. https://doi.org/10.12659/msm.916455.
[40] Indovina P, Barone D, Gallo L, Chirico A, De Pietro G, Giordano A. Virtual reality as a distraction intervention to relieve pain and distress during medical procedures: a comprehensive literature review. Clin J Pain. 2018;34:858–77. https://doi.org/10.1097/ajp.0000000000000599.
[41] Gaggioli A, Pallavicini F, Morganti L, Serino S, Scaratti C, Briguglio M, et al. Experiential virtual scenarios with real-time monitoring (interreality) for the management of psychological stress: a block randomized controlled trial. J Med Internet Res. 2014;16:e167. https://doi.org/10.2196/jmir.3235.
[42] Timmis A, Townsend N, Gale C, Grobbee R, Maniadakis N, Flather M, et al. European society of cardiology: cardiovascular disease statistics 2017. Eur Heart J. 2018;39:508–79. https://doi.org/10.1093/eurheartj/ehx628.