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Virtual reality experience in haemato-oncology patients—technical evaluation (ViREB-TE)

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Abstract

Purpose Virtual reality (VR) is increasingly being used in health care. However, its use as part of therapy during prolonged inpatient treatments is less well established. This study assessed the experience of hemato-oncology inpatients, their caregivers or relatives and staff of a 20-min VR expedition to assess acceptability, safety, and opportunities to improve inpatient experience.

Methods Through several familiarisation days, participants took part in a supervised 20-min trial of a 3-dimensional (3-D) VR escape using Google Wander™ delivered via an Oculus Quest 2 VR Headset™. Participants completed a validated survey of their VR experiences.

Results Thirty-one patients, 10 staff members and 9 relatives or patient friends visited 55 unique countries, with 19 participants (38%) wishing to visit home, family, or friends. All participants enjoyed the experience, felt energised or had a sense of well-being following the immersion. One participant felt fatigued by the experience. No one found the experience disagreeable nor had difficulty in navigating within the device. No participant complained of nausea, with two patients experiencing dizziness and one developing a headache. Nine participants (18%) complained of eyestrain, while 12 participants (24%) complained of a sense of "head fullness". None of the symptoms were perceived to need to shorten the immersion experience nor lasted beyond the immersion.

Conclusion 3D-VR "holiday from hospital" can be used safely in acute inpatients with little supervised training. The broad acceptance of the technology, potentially providing a distraction from clinical care routines.

Keywords Virtual reality, Safety, Patient experience

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Introduction

Inpatient hospitalisation for complex treatments is often emotionally or physically traumatic [1]. Haemato-oncology patients often require intensive therapy consisting of high-dose chemotherapy/radiotherapy and may require additional therapy with haematopoietic stem cell transplantation (HSCT). Such patients often require hospitalisation in a single room for 4–5 weeks, during which they experience fatigue, alopecia, mucositis, nausea, infection, and organ dysfunction, with an approximate 5% risk of death. Consequently, most patients experience feelings of isolation, which in turn is linked to prolonged immobility, sedation, disrupted sleep and significant periods of pain [1–3]. Following discharge, many patients exhibit cognitive dysfunction, physical weakness, and symptoms of posttraumatic disorder. Additional stressors relate to patient finances, independence, and daily life [1–3].

Recovery is influenced by the environment of care. Modifiable aspects of clinical care may improve the recovery experience. There is increasing emphasis on early regular exercise, consistent orientation, pain, light and noise management, and routines to promote consolidated sleep [4, 5]. In the early period of a prolonged patient journey, many potential strategies for maximizing emotional recovery are constrained by factors beyond patient control. These include the requirement for regular medical assessment, immune-suppressing drugs whose side effects negatively impact sleep and appetite, and the biological time required to physically heal from conditioning side effects.

A potential strategy allowing an "escape" from the clinical routine is computer simulation or virtual reality (VR). VR immerses a person within a seemingly real interaction, using a computer-generated simulation of a three-dimensional (3-D) image or environment [6]. VR generally uses a head-mounted display to deliver immersive video and audio that enables interaction through tracking head, hand, and body movements [7]. Environmental immersion is created by high-fidelity images that fill the entire field of vision with directive sounds that respond to patient movement, touchscreen or joystick manipulation. Interaction with environmental objects is possible, such as picking up an object or pushing a button. Comfort assured through the use of appropriate depth of field, individual focusing, appropriate visual range, constant speed of object movement and a high frame rate of images to avoid side effects such as motion sickness [6]. Although video games are a well-known example of VR applications, a wide usage has been found to teach skills, provide an experience such as an excursion, social applications beyond simply the sharing of pictures or videos and three-dimensional (3-D) design.

VR simulations have been used in patient care to mitigate the limitations of many therapeutic and environmental approaches [8]. VR has the potential to improve patient experience and quality of life (QoL) during the acute phase of recovery following prolonged inpatient care. To assess this, we designed an observational study examining the feasibility and tolerability of VR as an adjunct QoL supportive care tool for adult haemato-oncology inpatients as well as the experience of staff and supporters.

Materials and methods

Study design

This prospective observational study of VR simulation was a survey evaluation of adults receiving treatment for haematologic malignancy, their carers and treating clinicians. The study aimed to assess patient experience and tolerance with VR simulation, in addition to patient supporter and clinician attitudes toward VR.

Study population

Adult haemato-oncology inpatients, including allogeneic HSCT recipients (Group 1, $n=30$), patients' caregivers (Group 2, $n=10$) and treating clinical staff (Group 3, $n=10$) were offered an opportunity to take part in a VR expedition.

Inclusion criteria were age 18 years or above, undertaking treatment for haematologic malignancy and freely able to give consent. Key exclusion criteria were neurological conditions at risk of exacerbation by VR stimulation (such as active vertigo, labyrinthitis or epilepsy), physical impairment preventing use of VR or inability to complete the survey questionnaire. Patients with hearing or visual impairments were not specifically excluded from the experience day assessment, but clearly their experience may be different. No patients were identified as having these impairments.

Patient recruitment

Patient recruitment was performed following internal advertisement of VR experience days within the Haematology Units of the Royal Brisbane and Women's Hospital (RBWH) and the Townsville University Hospital (TUH). Attendees were invited to be participants. A VR hosting advisor, a volunteer from the not-for-profit charity Chimera Legacy Foundation trained in the operation of the VR equipment, explained the study, led participants through a demonstration on how to fit and operate the VR system and obtained written consent from participants. On the nominated study day, the VR hosting advisor also visited the clinical ward to remind the clinical team and patients of the VR immersion day. The

convenience sample was self-selected to take part in the study on the familiarisation day.

Following demonstration, participants viewed sample intervention content in one 20-min period. Participants arrived over the course of the familiarisation day as their care routines allowed. There were no booked appointments for the VR experience. Where there was no requirement for another participant following the 20 min, participants were able to extend their experience. Participants were required to launch the virtual experience from an iPad controller. The hosts made field notes where participants encountered usability issues, required operational assistance, or experienced technical failures.

Immersive VR experiences were delivered using an Oculus Quest 2 VR Headset (Irvine CA, USA). The intervention content involved original 360° video content (i.e., 360° spherical video recordings where the participant could explore any destination in the world available with freely available Google Wander(™). Head movements allow for interaction within a 270° field of view with a corresponding soundscape using selected background music while participants rested in a reclining chair.

The equipment was cleaned as per guidelines developed in consultation with the institution's infection control department using Clinell™ Universal wipes and Urbansun sanitary Oculus Quest disposable face masks™ between participant uses.

Data collection and statistical analysis

Following the VR simulation, participants completed an evaluation survey to assess tolerance and satisfaction with the experience. A validated survey tool [9] was used with some modifications for local applicability by removing the technology adoption questions, questions that did not relate to use of the Google Wander™ application or the current study context. This shortened the survey from 82 to 26 questions, allowing a realistic timeframe to complete the evaluation. The experience survey used a 5-point Likert-type scale covering the domains of presence, engagement, immersion, flow, usability, skill, emotion, experience consequence and judgement. All questions included in the study are outlined in the results tables. The question complexity of the survey was targeted at an age level of a 9 year old. There was no formal assessment of health literacy of the participants. Each participant group experience was described separately.

Subjects manually entered deidentified survey data directly onto password-secure iPads using two-level verification security and Microsoft Forms™ with each individual VR experience denoted by a unique study number, data entry and field completion validation within the survey tool. Data were then downloaded and imported into a secure, deidentified dataset. Analysis using descriptive statistics (medians, interquartile range (IQR), number, percent) for demographics and postintervention quantitative measures was performed using Microsoft Excel and Stata Version 15 (College Station. TX. USA).

Ethical considerations

Although patient risk was considered low, a risk mitigation matrix was created to ensure safety (Supplementary Material Table 1). Potential risks during VR were expected to include transient motion sickness, nausea, or blurred vision. To mitigate this, participants were provided with a guided experience by a researcher, encouraged to have their carer in attendance with the VR experience delivered while the participant was semi-supine. Patients could cease VR simulation at any time.

The study received multisite ethics approval from our institutions' human research ethics committees (HREC/2021/QRBW/79781) for all participant groups. The Chimera Legacy Foundation (CLF) is a not-for-profit charity with a volunteer team aiming to combine the lived patient experience and clinical expertise with a smart technology platform to enable access to personalized and patient-controlled resources and support. For the current study, the CLF provided the VR equipment "in-kind" as part of their vision with no obligations or contractual arrangements. The clinician researchers ensured equipment was operational and adhered to appropriate infection control requirements. The clinical researchers and protocol were independent of the CLF, and all research data analysis and dissemination of study findings were determined by the clinical investigator team. Data and material will be available on request from the corresponding author.

Results

The study enrolled 50 participants, 31 patients (62%), 9 relatives or supporters (18%) and 10 clinical staff (20%) from 22 familiarisation days: 10 at RBWH and 12 at TUH between 2022 and 2023. The median age was 30.5 years (IQR 25.5–43), with 27 (54.0%) being female. The patient age group varied from 19 – 68 years. Of the patient cohort, 12 (38.7%) were allogeneic HSCT recipients. The use of the VR equipment was generally 20 min, with 55 unique places visited using Google Wander™. Patients were informed of dates and times to participate in the VR program in the week prior to hosting VR program. The majority of patients presented with the opportunity to participate in the VR program willingly accepted with 6 patients being too sick to participate on the set day and time in hosting the VR experiences. The study demographics are outlined in Table 1.

Participant experiences of the VR immersion are outlined in Table 2. In general, there was a uniformly

Table 1 Participant demographics

Participant demographics	*N* = 50 (%) Median (IQR) [Range]	P
Patient		
All	31 (62.0)	
Bone Marrow Transplant	12 (38.7)	
Other Haematology	17 (54.8)	
Other illness	2 (6.5)	
Staff	10 (20.0)	
Carer/Relative/Friend	9 (18.0)	
Patient Primary Diagnoses		
Leukaemia	15 (48.4)	
Lymphoma	10 (32.3)	
Myeloma	3 (9.7)	
Other Haematology	1 (3.2)	
Other Cancer	1 (3.2)	
Not recorded	1 (3.2)	
Age (years)		0.32
All	30.5 (25.5–43) [19–68]	
Patient	28 (24–39) [19–68]	
Relative/Friend	29 (26–42) [20–44]	
Staff	39.5 (31–48) [26–53]	
Gender		0.29
Female	27 (54.0)	
Male	22 (44.0)	
Rather not Say	1 (2.0)	
Use of Equipment (minutes)		0.02
All	20 (15–20) [10–60]	
Patient	25 (20–35) [10–60]	
Relative/Friend	20 (15–20) [10–25]	
Staff	15 (15–25) [10–30]	
VR locations visited		
Unique Places	55	
Australia	13 (23.6)	
North America	10 (18.2)	
Europe	9 (16.4)	
Asia	8 (14.5)	
United Kingdom	5 (9.0)	
Other	10 (18.1)	

positive experience across all participant groups. All participants reported a sense of well-being, immersion in the environment that was perceived as natural ($N=48$, 86%), being able to survey the scene ($N=50$, 100%) and perceive a sense of movement ($N=50$, 100%). There was also a loss of sense of the outside world in 48 participants (96%) with a general feeling of well-being ($N=42$, 84%) within the VR environment. Most participants felt in control of their actions ($N=33$, 66%), with time perceived to pass differently for 48 participants (96%). There were two participants who felt that they were not in control of the environment, with two also finding learning the navigation difficult. Once trained, no participant found navigating the virtual environment a problem.

Participant experiences are noted in Table 3. All participants enjoyed being immersed within the virtual environment, with only one finding the equipment cumbersome. There were no feelings of tension or nervousness while within the virtual environment, with most feeling confident in their navigation of their selected destination ($N=30$, 60%). The immersion resulted in most patients feeling their mind wandering away from their real environment ($N=35$, 70%), with no participants finding the virtual environment disagreeable. One patient experienced fatigue during immersion. No participant complained of nausea, with two patients experiencing dizziness and one developing a headache. Nine participants (18%) complained of eyestrain, but this did not seem related to VR usage time ($P=0.92$), age ($P=0.59$) or gender ($P=0.65$). However, most participants used VR for 20 min. Twelve participants (24%) complained of a sense of "head fullness" as described in the survey tool as a feeling distinct from headache or nausea, which was only related to increasing age ($P=0.006$). None of the symptoms shortened the immersion experience nor lasted beyond the immersion.

Participant requests for improvement included a desire for live interactions to home, family, friends ($N=19$, 38%), additional places in the world to visit ($N=11$, 22%), educational material to preview their expected clinical journey ($N=9$, 18%) or thought there was utility to guided mediation ($N=6$, 12%) (Table 4). The principal criticisms of the experience were related to internet connectivity ($N=3$, 6%), consideration for the needs of elderly patients ($N=1$, 2%) and requests for additional content ($N=5$, 10%).

Discussion

Virtual reality therapy uses a computer-generated environment to simulate realistic situations. Sensations are stimulated within a safe and controlled environment. The VR experience aims to provide cognitive, emotional, and behavioural experiences. As part of an investigation into the feasibility of a complementary inpatient patient-controlled VR aiming to promote wellbeing during complex care, this study demonstrated the safety, acceptance, and potential utility of readily available VR technology for patients, their supporters, and staff. We included staff, patient relatives and friends in the study as they are the principal support persons for the patients. As such, with a direct understanding of the experience and active participation, we were hopeful that in a translation to a

Table 2 Participant experience of VR

	Patient *N* = 31	Relative/ Supporter *N* = 9	Staff *N* = 10	Total *N* = 50	P
1. My interactions with the virtual environment seemed natural					0.59
Strongly Agree	3 (9.7)	0 (0.0)	1 (10.0)	4 (8.0)	
Agree	25 (80.7)	7 (77.8)	9 (90.0)	41 (82.0)	
Neither Agree nor Disagree	3 (9.7)	2 (22.2)	0 (0.0)	5 (10.0)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
2. The visual aspects of the virtual environment involved me					0.28
Strongly Agree	4 (12.9)	3 (33.3)	3 (30.0)	10 (20.0)	
Agree	27 (87.1)	6 (66.7)	7 (70.0)	40 (80.0)	
Neither Agree nor Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
3. I was able to actively survey the virtual environment using vision					0.11
Strongly Agree	2 (6.5)	0 (0.0)	3 (30.0)	5 (10.0)	
Agree	29 (92.6)	9 (100)	7 (70.0)	45 (90.0)	
Neither Agree nor Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
4. The sense of moving around inside the virtual environment was compelling					0.15
Strongly Agree	17 (54.8)	5 (55.6)	2 (20.0)	24 (48.0)	
Agree	14 (45.2)	4 (44.4)	8 (80.0)	26 (52.0)	
Neither Agree nor Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
5. I was involved in the virtual environment experience					0.28
Strongly Agree	4 (12.9)	3 (33.3)	3 (30.0)	10 (20.0)	
Agree	27 (87.1)	6 (66.7)	7 (70.0)	40 (80.0)	
Neither Agree nor Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
6. I become so involved in the virtual environment that I was not aware of things happening around me					0.12
Strongly Agree	1 (3.2)	3 (33.3)	2 (20.0)	6 (12.0)	
Agree	28 (90.3)	6 (66.7)	8 (80.0)	42 (84.0)	
Neither Agree nor Disagree	1 (3.2)	0 (0.0)	0 (0.0)	1 (2.0)	
Disagree	1 (3.2)	0 (0.0)	0 (0.0)	1 (2.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
7. I felt physically fit in the virtual environment. (*N* = 49)					0.67
Strongly Agree	2 (6.7)	1 (11.1)	2 (20.0)	5 (10.2)	
Agree	24 (80.0)	7 (77.8)	6 (60.0)	37 (75.5)	
Neither Agree nor Disagree	4 (13.3)	1 (11.1)	2 (20.0)	7 (14.3)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	

real-world routine care setting, carers and supporters would be useful advocates in promoting VR to improve patient care and compliance.

Our findings in haemato-oncology patients are supported in other patient groups [10], but experience in prolonged inpatient complex care is limited [11]. Virtual

Table 3 Participant constitutional symptoms during VR experience

	Patient *N* = 30	Relative Supporter *N* = 9	Staff *N*-10	Total *N* = 50	P
1. I found the interaction devices (Oculus headset, gamepad and/or keyboard) very cumbersome to use					0.61
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	1 (3.2)	0 (0.0)	0 (0.0)	1 (2.0)	
Neither Agree nor Disagree	6 (19.4)	2 (22.2)	0 (0.0)	8 (16.0)	
Disagree	24 (77.4)	7 (77.8)	10 (100.0)	41 (82.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
2. I enjoyed being in this virtual environment					1.00
Strongly Agree	8 (25.8)	2 (22.2)	3 (30.0)	13 (26.0)	
Agree	23 (74.2)	7 (77.8)	7 (70.0)	37 (74.0)	
Neither Agree nor Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
3. I got tense in the virtual environment					0.40
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Neither Agree nor Disagree	4 (12.9)	1 (1.11)	1 (10.0)	6 (12.0)	
Disagree	26 (83.9)	8 (88.9)	7 (70.0)	41 (82.0)	
Strongly Disagree	1 (3.2)	0 (0.0)	2 (20.0)	3 (6.0)	
4. I enjoyed the experience so much that I feel energised					0.61
Strongly Agree	5 (16.1)	2 (22.2)	3 (30.0)	10 (20.0)	
Agree	26 (83.9)	7 (77.8)	7 (70.0)	40 (80.0)	
Neither Agree nor Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
5. I felt nervous in the virtual environment					0.43
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Neither Agree nor Disagree	4 (12.9)	1 (11.1)	2 (20.0)	7 (14.0)	
Disagree	27 (87.1)	8 (88.9)	7 (70.0)	42 (84.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	1 (10.0)	1 (2.0)	
6. I found my mind wandering while I was in the virtual environment					0.46
Strongly Agree	2 (6.5)	0 (0.0)	0 (0.0)	2 (4.0)	
Agree	18 (58.1)	8 (88.9)	7 (70.0)	33 (66.0)	
Neither Agree nor Disagree	9 (29.0)	1 (11.1)	1 (10.0)	11 (22.0)	
Disagree	2 (6.5)	0 (0.0)	1 (10.0)	3 (6.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	1 (10.0)	1 (2.0)	
7. I found that this virtual environment is disagreeable					0.11
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Neither Agree nor Disagree	3 (9.7)	0 (0.0)	0 (0.0)	3 (6.0)	
Disagree	27 (87.1)	9 (100.0)	7 (70.0)	43 (86.0)	
Strongly Disagree	1 (3.2)	0 (0.0)	3 (30.0)	4 (8.0)	

Table 3 (continued)

	Patient *N* = 30	Relative Supporter *N* = 9	Staff *N*-10	Total *N* = 50	P
8. I suffered from fatigue during my interaction with the virtual environment					0.66
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	1 (3.2)	0 (0.0)	0 (0.0)	1 (2.0)	
Neither Agree nor Disagree	4 (12.9)	0 (0.0)	0 (0.0)	4 (8.0)	
Disagree	25 (80.7)	9 (100.0)	9 (90.0)	43 (86.0)	
Strongly Disagree	1 (3.2)	0 (0.0)	1 (10.0)	2 (4.0)	
9. I suffered from headache during my interaction with the virtual environment					0.57
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	1 (3.2)	0 (0.0)	0 (0.0)	1 (2.0)	
Neither Agree nor Disagree	4 (12.9)	0 (0.0)	1 (10.0)	5 (10.0)	
Disagree	26 (83.9)	9 (100.0)	8 (80.0)	43 (86.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	1 (10.0)	1 (2.0)	
10. I suffered from eyestrain during my interaction with the virtual environment					0.05
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	7 (22.6)	1 (11.1)	1 (10.0)	9 (18.0)	
Neither Agree nor Disagree	9 (29.0)	0 (0.0)	9 (90.0)	9 (18.0)	
Disagree	15 (48.4)	8 (88.9)	0 (0.0)	32 (64.0)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
11. I suffered from nausea during my interaction with the virtual environment					0.75
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Neither Agree nor Disagree	3 (9.7)	0 (0.0)	0 (0.0)	3 (6.0)	
Disagree	27 (87.1)	9 (100.0)	9 (90.0)	45 (90.0)	
Strongly Disagree	1 (3.2)	0 (0.0)	1 (10.0)	2 (4.0)	
12. I suffered from "fullness of the head" during my interaction with the virtual environment					0.38
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	9 (30.0)	2 (22.2)	1 (11.1)	12 (25.0)	
Neither Agree nor Disagree	6 (20.0)	0 (0.0)	3 (33.3)	9 (18.8)	
Disagree	15 (50.0)	7 (77.8)	5 (55.6)	27 (56.3)	
Strongly Disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
13. I suffered from dizziness during my interaction with the virtual environment					0.39
Strongly Agree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Agree	2 (6.5)	0 (0.0)	0 (0.0)	2 (4.0)	
Neither Agree nor Disagree	5 (16.1)	0 (0.0)	1 (10.0)	6 (12.0)	
Disagree	23 (74.2)	9 (100.0)	7 (70.0)	39 (78.0)	
Strongly Disagree	1 (3.2)	0 (0.0)	2 (20.0)	3 (6.0)	

reality has been applied in the management of mental health conditions, coaching, rehabilitation, pain management, health education, procedure and process familiarization with promising results [12]. Where VR has been evaluated with mixed findings, there were wide disparities in populations being assessed, acute versus chronic care settings, and the outcome measures used for assessment [13–15]. Positive effects have been seen for measures such as pain, [7] sleep [7], and tolerance of clinical procedures [13, 14]. However, the number of scoping reviews significantly outweighs trials and descriptions of clinical integration of VR. The use of VR for preoperative relaxation has been shown to reduce anxiety [16, 17]. The use of VR relaxation prior to burn debridement reduces the perception of pain [18]. Pre-emptive VR education of the expected patient journey has been associated with reductions in fear and anxiety [19]. With VR being an illusion, users are drawn into an alternate world,

Table 4 Participant suggestions for improvements to the VR system

Where Would you Like to Go?	N (%)	P 0.40 (FET) between person groups
Video trips to home, family, friends	19 (38)	
Trips to places around the world	11 (22)	
Education to preview the likely clinical journey	9 (18)	
Guided meditation	6 (12)	
Video music streaming	3 (6)	
Education to learn a new skill	2 (4)	
Suggestions For Improvement (*N* = 9)		
Internet connectivity Improvement	3	
Additional Content	5	
Improve Equipment	2 (mainly lightness)	
Consider Elderly	1	
More training	2	

distracting attention and resulting in a reduced ability to process feelings of pain, fear and anxious anticipation [6]. A clear methodology and documentation of the patient experience [20, 21] in trials utilising VR in terms of equipment and access to applications is very important, particularly as such a novel technology is rapidly evolving. To ensure a carefully planned and successful introduction into the clinical environment, the initial focus of any VR research should be to encourage familiarisation of patients and staff [22–24].

In using readily available VR systems, minimising the risks of injury and discomfort is paramount. VR systems appear safe, [7, 25, 26] however, each patient group and context of use may be associated with different safety profiles [27]. Patients' perception of safety, control and comfort is augmented by prior familiarisation [28]. Our study found few side effects in using the VR system with no reports of nausea. However, the potential for eyestrain needs to be appreciated, especially in older patients, perhaps by limiting the time of usage to under 20 min. Our study did not record the participant use of glasses. The use of VR systems has been reported to increase near point accommodation and convergence in the short term [29], with patients with pre-existing eye problems more likely to experience eye-related symptoms with the use of VR [30]. The perception of head "fullness" is intriguing and a separate experience from headache and dizziness, perhaps related to the richness of the sensory experience and the possibility of sensory overload in unwell patients. Motion sickness is generally prevented when the VR environment matches user movements [31]. Infection control concerns related to repeated clinical use of equipment seem to be readily dealt with by a cross infection hygiene program [32].

Implementation need to consider the cost, which may be a barrier in low-income countries or poorly resourced health systems [33]. A tangible patent centred benefit with limited patient adverse effects with applications tailored to the specific patient care context, including cost effectiveness analysis is required. Group accessibility and the use of publicly available applications, such as those used in this study, may reduce costs. In the current study, the partnership with a not-for-profit charity gave a focus and a mission to the program with practical resources available for implementation. The application of VR therapies needs to accommodate patients with disabilities and those from diverse cultural and age backgrounds [33]. This may require adaption of headsets, captions for hearing impairment in addition to a range of culturally and age-appropriate languages and content. Virtual reality experiences are not just the realm of the young. Increasingly, VR has been used in the management of health conditions of the elderly, especially those in institutional care [34]. Such approaches have been used for both entertainment and therapy in our senior citizens. Such specific applications have included stroke rehabilitation [35], cognitive impairment [36], balance training [37], mobility [38], fall reduction [39], and the management of mood, anxiety and dementia [40–43], generally with good acceptance of the technology [44]. Thus, VR should be applicable to a wide range of patient ages and applications. In designing VR therapies, meeting the needs of the patient is paramount [45]. Technical problems are potentially common, principally network

connection speeds [46]. Uniform technical standards for the provision of VR therapies remain to be developed.

The purpose of VR in therapy must be clear with content that is engaging, interactive and entertaining. Attention maintenance is important to provide distraction from the real-world environment. Where VR use is part of a distraction program, patient preferences and interests are important. Our study found that patients visited a wide range of places available within the application; however, they were particularly keen to visit home, family, and friends. The patient experience in VR is crucial to usability and effectiveness [47]. Current consumer expectations are for VR systems to be comfortable, encourage initiative, and easy to use. High-quality graphics and audio in addition to providing a sense of presence are vital to achieve a realistic distraction from clinical therapy.

Our study using readily available applications and hardware demonstrated that such therapy programs could be readily implemented with minimal expertise and cost, but explicit instruction remains important. We noted that by the end of a training session, most participants were comfortable using the technology with the expectation that ongoing experience with VR will improve participant navigation.

This study is limited by use of a convenience sample of patients who were able to attend a familiarisation day. The emphasis of the study was to demonstrate safety and potential utility. A program implementation would familarise patients as part of their admission orientation. The long-term effects of such therapies are not known, but acutely, they are positively received. Ethical issues of addiction, desensitisation and therapist disengagement directly due to the VR experience also need to be considered in programme development [48]. Context-specific programs are defined for pain management, rehabilitation, clinical orientation and education [8]. From this feasibility study, VR was an acceptable and safe tool. Further development of patient context programs to improve well-being is worth exploring for use in prolonged inpatient care.

Conclusions

This study assessed patient, carer and clinician experience and tolerance with VR simulation. Readily available VR appears safe, accessible and acceptable to patients and their supporters. in a haematology-oncology environment. This provides a basis for an informed, documented and evaluated introduction of a range of VR approaches in an integrated manner to improve the patient experience of complex care. There is a potential to reduce the risks of longer-term emotional trauma and stress by using a focused familiarisation day to inform future evaluation of the type, timing, and applications of VR to minimise the negative patient experience of complex therapies such as HSCT.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s44247-023-00060-x.

Additional file 1: Supplementary Material 1. Risk Register. The purpose of this risk register is to identify, assess and controls risks which could impact users whilst using VR-AID Headset. All fields are required, and an explanation of impacts be seen in the 'Ratings' tab.

Authors' contributions

RB, CC, AS, NG, EM, CF, MJ, SC, DT, NW, JV, SA contributed to the study conception and design. Material preparation, data collection was performed by Carley Foster, Matthew Jackson, Sally Collet, Damien Thompson, and Nadine Wardell and analysis was performed by Rob Boots, Damien Thompson, James Vedelago and Stephen Adam. The first draft of the manuscript was written by Rob Boots and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Data and material will be available on request from the corresponding author.

Declarations

Ethics approval and consent to participate

This study was conducted in in accordance with the Declaration of Helsinki. Written informed consent was obtained from each participant. The study received Queensland Health multisite ethics approval through the Royal Brisbane and Women's Hospital human research ethics committee (HREC/2021/QRBW/79781).

Consent for publication

Not applicable.

Competing interests

Damien Thompson is the Founding CEO of the Chimera Legacy Foundation. Nadine Wardell is the Patient Day Coordinator of the Chimera Legacy Foundation. James Vedelago is the Chairman of the Chimera Legacy Foundation. Stephen Adam is the Strategy and Funding Manager of the Chimera Legacy Foundation. Rob Boots is the Medical Advisor to the Chimera Legacy Foundation. None of these are paid positions. The Chimera Legacy Foundation is a volunteer not-for profit charity with a mission to empower patients facing lifesaving treatment on their healthcare journey recognising the importance for patients to be in control with programs designed to reduce the stress and anxiety at each stage of the patient journey.
The Chimera Legacy Foundation is a volunteer not-for profit charity with a mission to empower patients facing lifesaving treatment on their healthcare journey, recognising the importance for patients to be in control with programmes designed to reduce the stress and anxiety at each stage of the patient journey. The Chimera Legacy Foundation provided the virtual reality equipment and organized the familiarization days for the study.
The rest of all the authors declare that they have no conflict of interest.

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