


'Godrevy Project': virtual reality for symptom control and well-being in oncology and palliative care – a non-randomised pre-post interventional trial

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ABSTRACT

Objective The 'Godrevy Project' is an interventional trial designed to determine the effectiveness of immersive virtual reality (VR) on the holistic symptom control and well-being in oncology and palliative care patients. The primary objective of this study was to determine whether VR changed the revised Edmonton Symptom and Assessment System (ESAS-r) score representing an effective improvement in symptom control and well-being.

Methods and analysis This study reports on 60 participants recruited from hospital inpatient oncology and palliative care lists, to participate in an unblinded, VR intervention. Participants were included aged >18 years with a diagnosis of cancer, receiving inpatient treatment of systemic anticancer therapy. Impact evaluation on symptoms was measured using the ESAS-r pre-VR and post-VR intervention. For ethical reasons, participants were not randomised.

Results From the 60 inpatients recruited, 58 participants were included for analysis. Participants recruited were aged 19–84 years with female (58%) and male (42%) participation. The primary outcome of the study demonstrated significant improvement in ESAS-r scores for symptoms and well-being. Total ESAS-r scores showed an improvement of 42% compared with baseline, with well-being ESAS-r scores improving 51%. The most common side effect was drowsiness. There were no adverse events related to study participation.

Conclusion The 'Godrevy Project' successfully demonstrates the feasible, effective use of VR on symptom control and well-being in oncology and palliative care patients. This study demonstrates VR as an effective, patient controlled, non-pharmacological intervention without significant side effects. This interventional trial is well placed to support future research and improve clinical practice.

Trial registration number NCT04821466.

INTRODUCTION

Virtual reality (VR) is a simulated experience to give participants an immersive feel of a virtual world. VR concepts can be traced back to 1838 with Charles Wheatstone's research into stereoscopic processing of two-dimensional images.¹ The 1930s saw the

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Current literature on symptom control and well-being within oncology and palliative care is dominated by pharmacological interventions. While non-pharmacological interventions are being investigated with increasing frequency, further well-powered research is required. Currently, there is little research within the UK, or internationally, regarding the use of virtual reality (VR) as a therapy within oncology or palliative care. Small, current studies in this area are demonstrating initial positive results but have struggled with recruitment numbers and exploration of symptom variety.

WHAT THIS STUDY ADDS

⇒ This study demonstrates a well-recruited and well-powered study to show the beneficial effect of VR on symptom control and well-being in oncology and palliative care. This study demonstrates that VR is an acceptable and accessible intervention for both these complex populations with positive outcomes on a variety of symptoms with limited side effects.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ It is hoped this study will lead to further randomised controlled trials and broaden work in this important area.

creation of the first 'Link Trainer' flight simulator. In the same decade science fiction writer Stanley Weinbaum described 'Pygmalion's Spectacles' where a pair of goggles allowed a person to experience a fictional world through holographic and haptic stimulation.

Modern day VR systems have come a long way from these initial works but are remarkably like the spectacles Weinbaum described. Advances in technology have meant many rapid transitions and the first head-mounted virtual display was developed in 1960.

Symptom control and patient well-being are of paramount importance in both palliative



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care and oncology. The COVID-19 pandemic had a significant negative effect on both oncology and palliative care patients.² These patients became not only increasingly isolated from their support networks, but also suffered delays in diagnosis, treatment and management of their diseases.³ VR has previously been used in multiple palliative care and oncology settings, specifically for pain, anxiety and distraction therapy.⁴⁻⁶ The use of VR as a non-pharmacological, patient-controlled intervention is beneficial to both clinicians and patients. Unfortunately, there are currently very few UK-based PubMed articles on VR use in either oncology or palliative care.

Symptom control within oncology and palliative care is a broad and diverse field. Despite significant advances, the main therapeutic options remain focused on pharmacological therapies, in a patient group which already has a significant pill burden. Polypharmacy is associated with notable negative effects on quality of life and symptom burden. After adjusting for symptom burden, Schenker *et al* found that polypharmacy itself was associated with reduction in quality of life.⁷ Non-pharmacological methods for symptom control have been well described in both oncology and palliative care and include music therapy,⁸ massage therapy,⁹ aromatherapy¹⁰ and hypnotherapy but more research is needed in these fields. VR represents a novel, non-pharmacological system for both symptom control and well-being within oncology, palliative care and wider healthcare generally.^{11 12}

With the increased mobility and availability of VR systems, their uses have significantly diversified into the fields of healthcare, engineering, product design and architecture. In 1991, *The Lancet* published an editorial regarding the ethics of VR.¹³ Most early uses within medicine were in the field of medical education.¹⁴ Rothbaum *et al* described using VR for exposure therapy for the treatment of acrophobia with positive results.¹⁵

Subsequent interventional uses have been described for pain, anxiety, paediatrics, burns, psychiatry, palliative care and oncology. VR within oncology and palliative care has been described but often in a limited capacity. A 2022 systematic review for the use of VR in palliative care only included 8 studies and 138 patients.¹⁶ Johnson *et al* conducted a pilot study in an American hospice including 12 patients with life-limiting illness. Overall, VR was a well-tolerated and positive experience for participants.⁴

Within oncology, VR is less well described. A systematic review of VR as chemotherapy support for anxiety and fatigue only included three studies.¹⁷ Chirico *et al* conducted an intervention study looking at VR, musical therapy and standard of care in Italian breast cancer patients. They found that VR and musical therapy were effective for anxiety relief and improving mood in breast cancer patients receiving chemotherapy.⁸ Menekli *et al* investigated the effect of VR on pain, anxiety and physiological parameters during oncology port catheter implantation. They included 140 patients and found these parameters all improved in the VR group.¹⁸ Schrempf *et al* conducted a randomised pilot study in oncology patients

undergoing curative surgery to investigate the effect of VR and musical therapy on quality of life, well-being and mood. Their results showed that VR was feasible and improved mood but not quality of life in their cohort.¹⁹

A 2022 systematic review by Mo *et al* identified eight studies investigating VR within palliative care.²⁰ The largest of these, by Groninger *et al* investigated VR for pain in heart failure.²¹ This study did not use a validated score but did show VR to be accessible and improved pain in a palliative population.

This study was named the ‘Godrevy Project’ in reference to a well-known Cornish lighthouse. This title was chosen as it reflected the aspiration of the project to create personalised VR experiences for patients and to offer moments of hope in difficult times.

This study aimed to understand the effectiveness of using VR with oncology and palliative care patients. The research questioned whether VR can improve the symptom control and well-being of oncology and palliative care patients as measured by revised Edmonton Symptom and Assessment System (ESAS-r) scores. Patients undertook a VR intervention with assessment of baseline and postintervention symptoms and well-being.

METHODS

Design

This paper describes a prospective, non-randomised, pre-post interventional cohort study. This paper is reported following Consolidated Standards of Reporting Trials (CONSORT) 2010 statement study guidelines for non-randomised pre-post trials.²² The study’s primary aim was to understand whether a VR intervention improved palliative and cancer patient’s symptom control and well-being scores using ESAS-r. One secondary aim of the study was to understand whether the impact of this VR intervention varied by demographic group or time in the intervention. The final secondary aim of this study was to identify and describe any negative experiences patients had from using the VR intervention.

Patient and public involvement

Beyond the scope of participation, patients and public were not directly involved in the study design, conduct or reporting of this research. The authors were inspired by clinical cases and patient experience of oncology care during the COVID-19 pandemic; these experiences influenced study design and methodology.

Participants and recruitment

Sixty adult patients with cancer were recruited who were known to the oncology or palliative care teams who were receiving systemic anticancer therapies (SACT) or were inpatients on the oncology wards. Patients were recruited between 18 February 2022 and 20 September 2022 following identification by clinical nurse specialists or study investigators.



Figure 1 Example 360° video.

Inclusion and exclusion criteria

Inclusion criteria were all patients over the age of eighteen who were known to the oncology or palliative care teams. Participants were excluded if they had known epilepsy, seizure activity or a predisposition to seizures (eg, brain metastasis).

Intervention

Patients were sized into a PICO Neo 3 Pro 5.7K VR headset, in addition to Sennheiser over-ear headphones purchased from 'motus VR' (formerly 'ROVR Systems') who also provided technical support for the project. The headset was controlled using a Galaxy tablet by the research clinician. Patients were then allowed to self-select from 18 VR video experiences using a tablet-controlled VR system, example video shown in figure 1. VR videos were filmed in various locations around Cornwall, The Isles of Scilly and Europe using an Insta360 OneR 360° 5.7K portable camera setup with tripod. Filming and video editing was undertaken by the first author. Video editing was completed using 'Adobe Premier Pro'. The full choice of VR experiences included: four boat trips, an island tour, kayaking, island sunset, The Eden Project, Venice, Tignes, Godrevy Beach, a waterfall, a seafront, an aquarium, a wildlife pond and YouTube VR.

Measures

Demographics

Information was collected from all patients regarding age, gender, cancer type, treatment, treatment intent and line of treatment.

Revised Edmonton Symptom and Assessment System

ESAS-r is a validated Quality of Life scoring system. ESAS-r is well validated in advanced cancer but has also been used for curative treatments.^{23 24} ESAS-r administration manual suggests a change of 1 point for minimal clinically

important difference (MCID) in non-pain-related modalities and a change of 2 points or 30% for pain.²⁵

Non-validated questionnaires

Quantitative clinician and patient questionnaires (score 0–10) plus qualitative negative affects questionnaire.

Study setting

The study was conducted in 2022 in a large district general hospital. Patients were on inpatient wards or the chemotherapy unit.

Procedure

Once recruited, patients completed the baseline ESAS-r questionnaire and demographic information was collected.

There was no time limit for the participants for their VR experience. Once the patient had completed their experience a repeat ESAS-r questionnaire was completed, in addition to a non-validated questionnaire on any negative effects and overall patient experience. The clinician also completed a non-validated questionnaire regarding patient overall experience. Patients were free to interact with the clinician as they needed and had the opportunity to use the VR system again during their treatment if they wished. Following the completion of the postintervention questionnaire, there was no further trial follow-up for the participants. Study protocol, patient information sheet and all data collection materials can be found in online supplemental materials.

The study was designed with input from clinical nurse specialists and physicians from both oncology and palliative care backgrounds. The study was preregistered with the NCT database and designed to assess VR intervention as broadly as possible within the oncology and palliative care population. Final patient demographics are reported below (table 1) and include both curative

Table 1 Demographic information

Demographic	Total participant sample (n=58)	
	M	SD
Age (years)	54.64	15.60
	N	%
Gender male	24	41.4
Gender female	34	58.4
Cancer type breast	17	29.3
Cancer type colorectal	10	17.2
Cancer type lung	5	8.6
Cancer type ovarian	5	8.6
Cancer type other*	21	36.3
Treatment type palliative	24	41.4
Treatment type curative	30	51.7
Treatment type unknown	4	6.9

*Other includes—Gynae (4), Haem (4), Renal (3), Prostate (2), Sarcoma (2), Skin (2), Head & Neck (1), Penile (1), Testicular (1), Upper Gastrointestinal (1).

and palliative oncological patients who were inpatients or receiving SACT. There was no preselection of patients based on symptom burden, age or cancer subtype. Given the patient population and diagnoses, it was felt that using a non-intervention control group was contraindicated and instead the study was internally controlled with the baseline ESAS-r scores.

Analyses

An a priori power calculation using G*Power²⁶ for paired t-tests, determined 60 participants would be sufficient for detecting medium size effects at 80% power (alpha 0.05, beta 0.2, medium effect 0.5, SD 2.7). From the 60 participants, 58 sets of pre–post measures were analysed; one participant withdrew due to intervention equipment side effects and the other had a non-trial related withdrawal.

In this study, descriptive statistics were used to summarise patients' scores on the ESAS-r questionnaire at baseline and after completing one session of the VR intervention. Where assumptions were met, parametric models were used for primary and secondary analyses of data. The primary inferential analyses were repeated-measures t-tests conducted to establish whether statistically significant differences were present between before and after ESAS scores. Cohen's d was used as a measure of effect size where small, medium and large effects are represented are indicated by scores of 0.2, 0.5 and 0.8, respectively.²⁷

Secondary correlational analyses using Pearson's r were used to determine whether change on total ESAS scores were related to covariates such as patient age or time spent using the intervention. In addition, independent-samples t-tests were used to determine whether there was a significant difference between the total change scores

by gender or whether patients were receiving palliative or curative care. Only patients who did not know their treatment type were excluded from this final analysis. The study design did not allow causal investigations into links between demographic factors and treatment effects. However, these secondary analyses allowed a preliminary exploration of whether a dose effect might be present, or whether different groups may experience different impacts of the intervention.

Finally, to answer our final research question, patient's comments regarding negative experiences were reviewed and grouped under themes before being presented in summary table 3.

RESULTS

Patient VR usage

Average time spent using the VR Headset was 26.40 min (SD 12.08); average number of experiences was 2 (range 1–5). The most common experiences were the Lands' End Scillonian (47 uses), Isles of Scilly Tour,¹⁸ Isles of Scilly Kayak,¹² aquarium¹² and Eden Project.¹¹ Thirteen of the 18 experiences were used by one or more participants.

Impact of VR on ESAS-R Scores

A total of 58 participants completed the ESAS questionnaire before and after completing one session of the VR intervention (table 1). Mean participant scores on the subscales of the ESAS and total scores on the ESAS before and after completing the VR intervention are presented in table 2 and figure 2. These mean scores indicated a change in the desired direction on the total ESAS scores, in addition to the pain, tiredness, drowsiness, nausea, lack of appetite, shortness of breath, depression, anxiety and well-being subscales. Repeated measures t-tests indicated that these desirable changes were statistically significant for the total, pain, tiredness, lack of appetite, shortness of breath, depression, anxiety and well-being. As presented in table 2, effect sizes calculated as Cohen's d, were in the moderate-large range for changes for tiredness, well-being and total symptoms, and in the small-moderate range for the pain, lack of appetite, shortness of breath, depression and anxiety subscales. ESAS-r scores for well-being, pain, tiredness and anxiety all reach the threshold for MCID as per the user manual.²⁵

Secondary analyses

Exploratory correlations revealed that there was no significant association between time spent using the intervention and change in total score on the ESAS. However, there was a small but statistically significant positive correlation between participant age and change on total score ($r(58) = 0.39, p=0.003$). There was no significant difference in change on total ESAS score between male ($M=-4.67, SD=5.53$) and female ($M=-7.06, SD=8.87$) participants. However, there was a statistically significantly higher positive change in total ESAS score for patients receiving curative ($M=-6.93, SD=10.01$) rather

Table 2 Repeat measures t-test—mean ESAS sub-scale scores from before and after VR intervention

	Before intervention (n=58)		After intervention (n=58)		Difference scores (n=58)		Repeated-measures t-tests (n=58)			
	M	SD	M	SD	M	SD	t	df	P value	d
ESAS										
Pain	1.07	1.92	0.62	1.60	0.45	1.16	2.95	57	0.005	0.39
Tiredness	3.17	2.62	2.16	2.46	1.02	1.42	5.46	57	<0.001	0.72
Drowsiness	1.84	2.29	1.57	2.27	0.28	1.67	1.26	57	0.214	0.17
Nausea	0.69	1.85	0.52	1.27	0.17	1.43	0.92	57	0.362	0.12
Lack of appetite	1.19	2.17	0.67	1.72	0.52	1.30	3.03	57	0.004	0.40
Shortness of breath	1.05	1.86	0.57	1.26	0.48	1.20	3.06	57	0.003	0.40
Depression	1.29	2.08	0.55	1.16	0.74	1.65	3.42	57	0.001	0.45
Anxiety	1.64	2.38	0.52	1.03	1.12	1.95	4.38	57	<0.001	0.58
Well-being	2.55	2.60	1.26	1.81	1.30	1.81	5.45	57	<0.001	0.72
Total score	14.50	12.78	8.43	9.15	6.07	7.70	6.00	57	<0.001	0.79

ESAS, Edmonton Symptom and Assessment System; VR, virtual reality.

than palliative (M=-5.00, SD=4.24) treatment with a small effect size ($t(52) = 0.88$, $p=0.010$, $d=0.24$).

Negative effects and acceptability

Non-validated scores showed an average participant satisfaction score of 8.36/10 (SD 1.75) and clinical score of 8.34/10 (SD 1.33). The range for both these scores was between 5 and 10, 15 of 58 participants who completed the VR experience (25.8%) reported negative effects. Only one participant who consented had to terminate the VR experience due to the negative effect (1.7%). This participant stopped due to the smell of the headset plastic. All negative effects are summarised in table 3. Feelings

of nausea were most common, but frequently only associated with one particular VR scenario (mobile kayak). Other reported negative effects were feeling hot, visual strain and experiencing the headset as heavy or awkward. No long-standing negative effects or safety concerns were reported by clinicians or patients.

DISCUSSION

The 'Godrevy Project' is a novel research study designed to determine the effectiveness of VR on symptom control and well-being in palliative care and oncology patients.

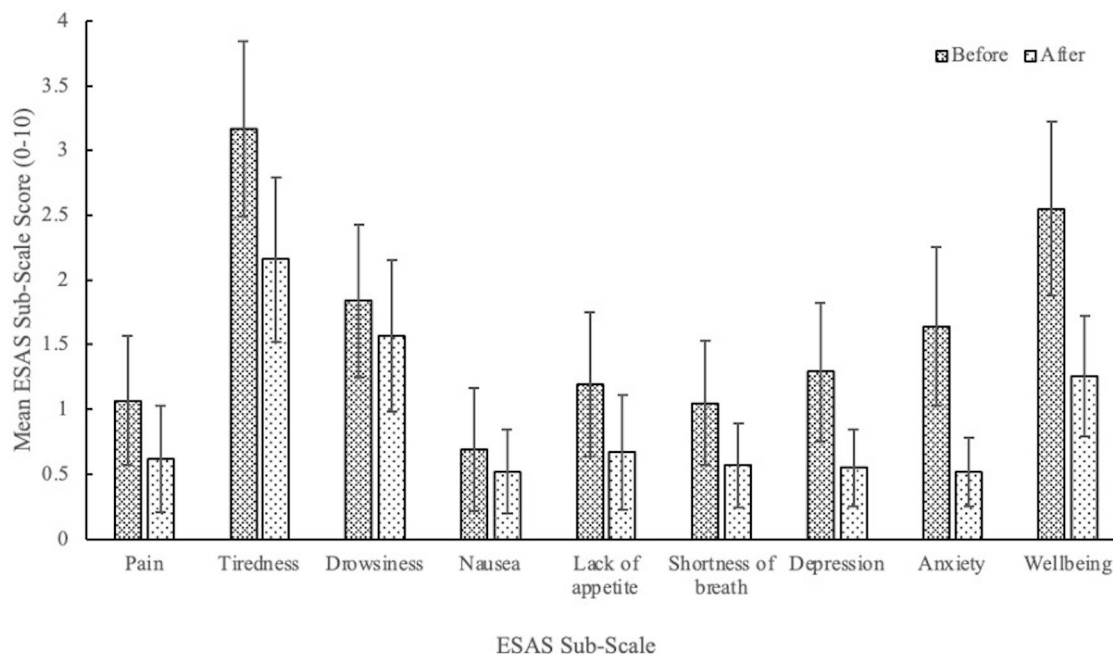


Figure 2 Repeated measures t-test. Scores from before and after VR intervention and repeated-measures t-tests. ESAS, Edmonton Symptom and Assessment System; VR, virtual reality.

Table 3 Negative effects

Type	No of patients	Comments
Nausea	6	For 5 patients this was associated with one specific scenario (mobile kayak)
Visual strain	4	n/a
Heavy or awkward headset	4	n/a
Feeling hot	4	Often reported when patients spent long time in headset
Vertigo/dizziness	2	Associated with particular scenario (mobile kayak)
Mixed emotions	1	The headset brought up mixed emotional feelings for one patient
Summary of categories of negative effects based on patient responses. n/a, not available.		

This study has found that VR provides a statistically significant improvement for patients with the symptoms of pain, tiredness, anorexia, shortness of breath, anxiety and depression. These results were both statistically and clinically significant for pain, anxiety and tiredness. There was also an improvement in overall well-being which again was both statistically and clinically significant.

This study was designed as a proof of concept for the use of VR in a heterogeneous group of oncology and palliative care patients. Patients included were intended to represent oncology and palliative care populations with a wide range of diagnoses, ages and symptom severity. It was felt VR would provide a safe, patient controlled, non-pharmacological intervention for well-being and symptom control.

The ESAS-r was used as a standardised tool which is widely established to provide comparable data effectively enabling baseline and postintervention comparison of nine variables; by comparing nine variables enabled a wide variety of symptoms to be analysed. The standardised tool enables an accurate reproducible structure for future studies.^{28–31} ESAS-r scoring have previously been used to assess VR interventions as exhibited by Johnson *et al.*⁴

The VR experiences varied in location, movement and landscape which enabled the participants to choose an experience which they felt would most suit them. Experiences of stillness which reflected a greater tendency to meditation, for example a waterfall, were preferred by some, whereas others preferred more stimulating experiences for example moving on a kayak or a boat. Giving the participant a choice of experiences ensured they felt in control and self-directed the experience. It was documented by some participants that the movement of the kayak experience contributed to greater incidence of nausea due to motion sickness; other participants,

however, enjoyed the experience with nil nausea effects. This could be remedied with a cautionary disclosure of those susceptible to motion sickness to avoid these experiences prior to initiation.

The time spent wearing the VR headset varied from 10 to 70 min and this was led by participant choice. There was no fixed time determined for each participant to wear the headset. Some participants wore the VR for longer as they enjoyed the experiences, while others were limited by either the interruptions of treatment in the hospital or because they felt they had benefitted from the full experience in a shorter time. It was decided not to control the time on the headset to support whatever time the patient felt necessary to benefit from the equipment.

In comparing this VR study to other interventions, other non-pharmacological therapies are available for this cohort of patients. TENS,³² acupuncture,³³ cognitive-behavioural therapy³⁴ and mindfulness³⁵ are some therapies which have been shown to have some effectiveness in managing symptoms commonly experienced, particularly in palliative care. It was noted however that many of these interventions focus on the benefit of one or two symptoms and do not encompass the breadth of symptoms that has been shown to be of benefit with the VR study here.

Strengths and weaknesses

It has been suggested with this study that VR is a safe, cost-effective intervention for many common symptoms for oncology patients while in hospital. Total equipment costs were less than £4000. All VR content was self-made and edited without any prior experience by the first author. Both patients and clinicians reacted positively to the VR system with overall satisfactions score for both patient and clinician averaging 8.3/10 and 8.4/10, respectively. These were non-validated scores but confirm that both patients and clinicians found the experience beneficial. From the cohort, 15/58 participants experienced some negative effects but only 1 participant stopped the trial due to this effect. Specifically, this was due to the smell of the VR headset.

One headset could be used by many patients per day and is easily portable around the clinical environment. The headset and tablet are easy to clean in line with infection control protocols and the operating systems are intuitive and easy to operate. The device has a reasonable battery life and can easily be charged for recurrent use. The headset is easily applied, adjusted to suit any head shape and can be removed, if necessary, within seconds. It is also suitable for people wearing glasses or contact lenses and compatible with patients wearing a cold cap for chemotherapy. It is an intervention with scope to be patient led with minimal clinical intervention; this is appealing in times of a busy healthcare service and stretched demand on resources. There were no serious side effects from the study and from what was observed, it would be safe to operate independently if able. A history of seizures or metastatic brain pathology was an exclusion criterion for this study; therefore we cannot comment on the safety of

this intervention within these cohorts. This was identified as a theoretical risk prior to the trial commencing and these patients may be included in future work.

The future of VR as a proven and established intervention, will involve the expansion of patient groups with randomised controls. This was a well-powered interventional study, designed to determine the proof of the effectiveness of VR in symptom control in oncology and palliative care patients. Given the trial population, and in consideration with patient groups, it was decided not to undertake a randomised control trial. The design of this trial utilised an internal control group through baseline ESAS-r questionnaires. The lack of a formal control group was one significant limitation to this study. It was felt during study design that by focusing on oncology and palliative care patients, a randomised control group would provide an ethical dilemma. If patients were randomised to standard care this could potentially deprive them of a beneficial treatment opportunity in the precious moments at the end of life; it was felt this was particularly poignant during the COVID-19 pandemic when this study was designed. Further work in this area would be beneficial using a control group randomised to standard of care for the setting being investigated or alternative multimedia intervention as a comparator to VR.

The trial was not designed to compare the time spent wearing the headset, nor to determine the effectiveness of different video environments on improving symptoms; this trial provides a platform for this in future trials. In a similar vein, the trial was not designed for different cancer types or age groups, although these data were collected. One study weakness is the absence of the participant's concurrent medication data, which could potentially confound results; further work could investigate hypothetical relationships between types and use of medication and benefits from VR. This trial encompassed participants who were known to oncology or palliative care teams; it is believed by the trial team this has significant potential to be established in home, district hospital and hospice environments alike. There is certainly scope for further research to determine the benefit and efficacy of VR in different care environments. Further improvements to the study could also involve the comparison of length of time wearing the headset with symptom improvement. It would be interesting also to determine the long-term time of benefit; the postintervention questionnaire was answered within minutes of completing the experience. It would be a reasonable study to determine the long-term benefit, or long-term side effects, on the use of VR beyond the minutes following the intervention. Recurrent use of the headset could be established and investigated as most patients included within this study only used the VR system once with data only being collected at time of use not after a follow-up period. Investigating both recurrent use and long-term effects could also reduce the risk our trial results are simply the effect of a novel intervention.

Comparing the ESAS-r scores for the primary outcomes demonstrates overall improvement in the symptoms of

pain, tiredness, nausea, appetite, shortness of breath, anxiety, depression and well-being. Initial trial results suggest nausea is a symptom of certain experiences and drowsiness can be a general effect of intervention. Patients who felt drowsier frequently documented that this was a positive symptom more suggestive of being relaxed than uncomfortable lethargy. Drowsiness is a reported side effect in using a VR headset, even in a well population, and although it was discussed with patients in the preintervention information, it is noted that this can be a negative side effect for some people. It is felt with appropriate prior information of potential side effects, this remains an otherwise safe and effective intervention for many. The headset, however, remains a generally well tolerated intervention.

Future direction

We propose that VR is a safe, effective non-pharmacological intervention on the symptom control and well-being in oncology and palliative care patients. This study has suggested there are significant improvements to many symptoms, in particular depression, anxiety and well-being with the use of a VR headset. We suggest future research looks further into honing VR as an individualised intervention to provide holistic, effective relief from common symptoms for patients by observing long-term benefit and experience-dependent benefit. There clearly needs consolidated larger, randomised trials to support our results, however, we see this as an important stepping-stone to a significant improvement in symptoms for these patients.

CONCLUSION

We conclude that VR is a safe and effective intervention for improving both symptom control and well-being within oncology and palliative care patients. Clinical and statistically significant improvements were observed for pain, tiredness, lack of appetite, shortness of breath, depression, anxiety and overall well-being. We demonstrated VR as an accessible, patient-controlled intervention that is applicable within oncology and palliative care. Future research should focus on the effect of specific VR experiences as well as controlled research within groups where this is more appropriate.

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Contributors The authors confirm contribution to the paper as follows: study conception and design: NOM, ET and JM; patient recruitment and data collection: NOM, AB and JRH-B; statistical analysis and interpretation of results: EAS, NOM, JRH-B and JM; draft manuscript and critical revisions: NOM; JRH-B, JM and EAS. NOM and JM accept responsibility as guarantor. All authors reviewed the results and approved the final version of the manuscript.

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