Feasibility and preliminary effectiveness of virtual reality as a patient education tool for people with cancer undergoing immunotherapy: a protocol for a randomised controlled pilot study in a regional setting

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ABSTRACT

Introduction Patient education is a critical component of healthcare delivery. However, medical information and knowledge are complex and can be difficult for patients and families to comprehend when delivered verbally. The use of virtual reality (VR) to convey medical information to patients may bridge this communication gap and lead to more effective patient education. It may be of increased value to those with low health literacy and levels of patient activation, in rural and regional settings. The objective of this randomised, single-centre pilot study is to examine the feasibility and preliminary effectiveness of VR as an education tool for people with cancer. The results will provide data to inform the feasibility of a future randomised controlled trial, including sample size calculations.

Methods and analysis Patients with cancer undergoing immunotherapy will be recruited. A total of 36 patients will be recruited and randomised to one of three trial arms. Participants will be randomised 1:1:1 to receive VR, a two-dimensional video or standard care (ie, verbal communication and information leaflets). Feasibility will be assessed by recruitment rate, practicality, acceptability, usability and related adverse events. The potential impact of VR on patient-reported outcomes (ie, perceived information provision quality, knowledge about immunotherapy and patient activation) will be assessed and stratified by information coping style (ie, monitors vs blunters) whenever statistical analyses are significant. The patient-reported outcomes will be measured at baseline, post-intervention and 2 weeks post-intervention. In addition, semistructured interviews will be conducted with health professionals and participants randomised to the VR trial arm, to further explore acceptability and feasibility.

Ethics and dissemination Ethics approval was obtained from the Greater Western Human Research Ethics Committee, New South Wales Local Health District (2022/ETH01760). Informed consent will be obtained from all participants. Findings will be disseminated via relevant conference presentations and publications in peer-reviewed journals.

Trial registration number ACTRN12622001473752.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This pilot study will provide novel data regarding the feasibility and preliminary effectiveness of virtual reality as a patient educational tool for patients with cancer undergoing immunotherapy.
⇒ A novel immunotherapy knowledge quiz was created to assess patients’ understanding of immunotherapy.
⇒ Using a randomised, three-arm study design will reduce potential bias.
⇒ Due to the type of intervention, blinding of study participants and researchers delivering the intervention is not possible.
⇒ Results may not be fully generalisable to all rural patients and settings as this is a single-site study.

INTRODUCTION

People who are diagnosed with cancer are required to process and understand large volumes of information about their diagnosis, upcoming procedures, therapies and associated risks, to enable them to make informed decisions about their care.1 With the increasing emphasis on both patient-centred care (ie, ‘care that is respectful of and responsive to individual patient preferences, needs and values, and ensuring that patient values guide all clinical decisions’)2 and shared decision-making, ensuring that this information is adequately comprehended is increasingly important.3 4 Currently, patient education relies heavily on the verbal communication between the patient and healthcare provider, and additional materials that are handed out, such as pamphlets or booklets. However, studies report that between 40% and 60% of patients cannot correctly report
the information provided by their healthcare provider 10–80 min after their consultation. Similar results are found among patients with cancer where they, on average, only recalled 60% of the information provided during the diagnostic and treatment planning phase. With the increased use of novel therapies, such as immunotherapy, and the introduction of a unique set of autoimmune adverse events (irAEs), new challenges have emerged for oncology nurses and oncologists in delivering patient education and managing irAEs. Immunotherapy side effects can be difficult to detect by patients and challenging to diagnose by primary care or emergency physicians. Not surprisingly, studies on immunotherapy found that patients with cancer had substantial knowledge deficits about immunotherapy, suggesting patients with cancer struggle to recall information provided by their oncologist. Thus, it is even more critical to bridge the diagnostic and treatment planning phase. With the increased use of novel therapies, such as immunotherapy, new challenges have emerged for oncology nurses and oncologists in delivering patient education and managing irAEs. Immunotherapy side effects can be difficult to detect by patients and challenging to diagnose by primary care or emergency physicians. Not surprisingly, studies on immunotherapy found that patients with cancer had substantial knowledge deficits about immunotherapy, suggesting patients with cancer struggle to recall information provided by their oncologist. Thus, it is even more critical to bridge the communication gap when delivering immunotherapy to patients with cancer.

Virtual reality (VR) is an innovative and immersive technology that has the potential to improve the educational experience for patients with cancer receiving immunotherapy treatment. VR is a software/hardware application that allows users to be completely immersed into a virtual environment, or three-dimensional (3D) world, in very near real time, by using an interactive device and a head-mounted display. Compared with conventional text reading, VR has been shown to be associated with increased information retention and recall in memory, due to the user’s involvement and personal relevance. VR is increasingly being used as an education tool in the field of medicine, including the education of medical students and in surgical training. However, the use of VR as a patient education tool is much less well understood. A recent scoping review on the use of VR as a patient education tool highlights that VR has the potential to improve patient education and satisfaction, and reduce anxiety, but more research is required, particularly to investigate for whom education via VR might be most beneficial or potentially harmful. For example, evidence suggests that patients respond differently to medical information. Some patients may seek medical information related to their health (ie, monitors), whereas others deliberately avoid this information (ie, blunters). When given excessive information, patients who identify as blunters will experience more tension, which can result in depression and physical discomfort. On the other hand, those who have a monitoring coping style desire more detailed information. Trialling these new approaches and bridging associated knowledge gaps are likely to be particularly beneficial for patients with cancer undergoing complex new treatments such as immunotherapy.

People affected by cancer who live outside of large metropolitan centres in Australia (ie, a setting described as regional or rural according to the Accessibility/Remoteness Index of Australia (ARIA) as defined by the Australian Bureau of Statistics), on average, experience worse cancer outcomes than their urban counterparts. While the reasons for this are complex, and not fully understood, contributing factors could be the lower levels of health literacy and patient activation (ie, a concept used to describe a patient’s knowledge, skills and confidence in managing their health conditions) in rural areas. Thus, finding new ways to improve patient education in these rural and regional settings may have particular value and positive implications for treatment initiation, adherence, continuation and survival, in rural and regional settings.

**Objectives**

The aims of this pilot study are to assess the: (1) feasibility of VR as an adjunctive patient educational tool for adult patients with cancer undergoing immunotherapy in a regional cancer centre, and (2) preliminary effectiveness of VR on perceived information provision, knowledge about immunotherapy and patient activation. The specific objectives, including hypotheses, of this pilot study are described in [Table 1](#).

**METHODS AND ANALYSIS**

The development of this protocol was guided by the Standard Protocol Items: Recommendations for Interventional Trials 2013 checklist and procedures.

**Trial design**

This multi-arm, randomised pilot study features a single-centre, three-arm design with a 1:1:1 allocation (figure 1). Patients undergoing immunotherapy will be recruited and randomised to one of two education intervention groups, or a control group that receives standard immunotherapy education. Those randomised to one of the intervention groups will either receive a VR-based or two-dimensional (2D)-based immunotherapy educational video intervention, in addition to standard care.

**Study setting**

The pilot study will be conducted at the Central West Cancer Care Centre (CWCCC), Orange Hospital, New South Wales (NSW), Australia. The interventions will be delivered by a credentialed clinical trial coordinator and overseen by the lead researcher (RZ), who is a senior oncologist and director of Clinical Trials Unit at Orange Hospital. The patients randomised to receive the VR experience will undergo the intervention within the CWCCC under supervision by the trial coordinator. They will be appropriately monitored post-intervention for any adverse events. Online supplemental file 1 outlines the standard of care with the intervention timeline for immunotherapy education at this cancer centre.

**Immunotherapy definition**

In this study, immunotherapy refers to all cancer therapies that are based on specific immune checkpoint inhibitors (ICIs), including programmed cell death protein 1 and programmed death-ligand 1, and cytotoxic T
Eligibility criteria

Inclusion criteria

Patients will be eligible to participate if they meet the following criteria: (a) are 18 years and over, (b) are diagnosed with a reportable cancer of any stage (eg, melanoma, kidney cancer, mesothelioma, lung cancer) that will be treated with ICIs, (c) are due to start only immunotherapy agents (ie, patients may not receive any other combined treatment, such as chemotherapy), (d) are able to understand English and (e) are able to give their own consent. All patients included in this pilot study will be receiving immunotherapy as standard treatment, and not as part of a clinical trial.

Exclusion criteria

Patients will be excluded if they: (a) have a condition that interferes with VR usage, including but not limited to seizures, facial injury precluding safe placement of headset and visual impairments, (b) have a prognosis of <3 months from the time of enrolment per treating oncologist, (c) receive other systemic cancer therapies in combination with immunotherapy, or (d) have a pre-existing severe mental health diagnosis or significant cognitive impairment, such as severe dementia that would impair their comprehension and/or ability to provide informed consent.

Exclusion in case of adverse events

The VR intervention will be performed under direct supervision by a trial coordinator with participants sitting on a chair or bed to ensure safety for trial participants. In the event participants experience unexpected symptoms that could be related to the VR, such as blurred vision, dizziness, light-headedness or nausea, the session will be stopped immediately. Any adverse events or unintended consequences will be managed and documented.
Recruitment and withdrawal
All patients, who are advised to undergo immunotherapy treatment during the recruitment period and who meet all eligibility criteria, will be invited to participate in this study. Verbal consent will be obtained 1–3 days after the consultation. The signed informed consent form will be collected by the oncologist or study coordinator on the day of the first education session (see online supplemental file 2). Patients will be free to withdraw from the study at any time point, without consequence.

Sample size
A rule of thumb for pilot studies is to include a minimum of 12 patients per trial arm, so this pilot study will aim to recruit a total of 36 patients with cancer. The results of this pilot study will then inform a power analysis for a future randomised controlled trial (RCT) study, if appropriate.

Randomisation
To ensure participants have an equal and independent chance of being selected in one of three trial arms, a research support unit will produce a computer-generated set of random allocations before the start of the study. The random set of allocations will be sealed in consecutively numbered opaque envelopes and given to participants by the oncologist, who will be concealed to group allocation. Randomisation will happen once the patient has returned a signed copy of the informed consent form.

Blinding
Due to the nature of the intervention, it is impossible to achieve blinding for the participants, those delivering the intervention and the outcome assessors. However, the statistician or researcher who will conduct the analyses will be blinded to treatment allocation.
Interventions

VR group (arm A)
Participants in the VR intervention group will receive immunotherapy education “as usual” plus an immersive, 3D 360° VR experience during or prior to commencing their first immunotherapy treatment. The VR intervention will be delivered by an experienced trial coordinator with the use of a gaming laptop (ie, Gigabyte AORUS 17G XC 17.3-inch Core i7 RTX 3070) and Oculus Quest 2 headset. The VR world shows patients how their immune system reacts to the immunotherapy treatment, what side effects may develop and what patients should do in case they experience any of these side effects (see online supplemental file 3). Participants will be seated throughout the session and will be able to interact within three ways: (1) they will be able to hold a white blood cell (T cell) and move it in space; (2) they will be able to ‘eye witness’ the process of being a foreign cell which is detected and destroyed by CD8 T Cells and (3) they will be able to ‘turn off’ the immune overstimulation by introducing steroid therapy into the scene. The VR experience lasts approximately 5–6 min.

2D video group (arm B)
Participants randomised to this group will receive education as usual and will be shown a 2D video on immunotherapy. The video will be a 2D replica of the immersive, 3D 360° VR experience patients receive when randomised to the VR group (arm A). Patients will watch the video (approximately 5–6 min in duration) on a laptop during or prior to commencing their first immunotherapy treatment.

Control group (arm C)
Participants allocated to the control group will receive education as per usual standard of care, which includes nurse-led verbal education on immunotherapy and provision of printed educational materials (eg, eviQ handouts).

All study groups
Regardless of group allocation, participants will all continue to receive standard medical care from their treating oncologist according to Australian oncology guidelines.

Outcome measures
Study outcomes were designed to determine the feasibility and preliminary effectiveness of VR as a patient education tool, which will determine whether a future RCT is feasible (table 2). Online supplemental file 4 demonstrates the baseline questionnaire for this pilot study.

Feasibility outcomes
The feasibility of VR as a patient education tool will be assessed by looking at the following:

1. Recruitment rate (ie, the number of patients approached, number consenting to participate and those eligible to be randomised).
2. Practicality of the intervention (ie, the degree to which it is possible to deliver the intervention in the event of limited resources, time or commitment).
3. Acceptability of the intervention by health professionals and patients with cancer, including satisfaction, via qualitative interviews.
4. Usability of VR as a patient education tool in the healthcare setting (eg, barriers and facilitators to VR use), via qualitative interviews.
5. Safety of the intervention (ie, VR-related adverse events).

Patient-reported outcomes

Patient information coping styles

Evidence suggests that patients respond differently to medical information.25 26 Some patients may seek medical information related to their health (ie, monitors), whereas others deliberately avoid this information (ie, blunners).27 This may affect how participants respond to the VR intervention; hence, monitoring and blunting coping styles will be assessed with the shortened version of the Threatening Medical Situations Inventory (TMSI). The shortened TMSI consists of two hypothetical situations, including experiencing headaches and dizziness, and considering heart surgery.44 Each description is followed by six items, three monitoring and three blunting coping styles (at random), for which participants are asked to score the items on a 5-point Likert scale (response options range from 1=‘not at all applicable to me’ to 5=‘strongly applicable to me’). Blunting subscale scores will be subtracted from the monitoring subscale scores to calculate a sum score.27 Patients who have a sum score equal or below the median will be categorised as monitors. Subsequently, patients reporting a subscore above the median will be categorised as blunners. The internal consistency has shown to be good for both the monitor and blunting subscale (Cronbach’s α >0.70), and test–retest reliability has been established as sufficient (Pearson correlation, 0.64–0.83).44

Perceived information provision

The 25-item European Organization for Research and Treatment Quality-of-Life Group Information Questionnaire (EORTC QLQ-INFO25) will be used to evaluate the information received by patients with cancer about aspects of their disease and treatment.45 The EORTC QLQ-INFO25 questionnaire is composed of four multi-item subscales (ie, information about the disease, medical tests, treatment and other care services) and eight single-item scales. Patients rate the items on a 4-point Likert scale (ranging from 1=‘not at all’ to 4=‘very much’), except for four items, which have a dichotomous (yes/no) response. Following the EORTC scoring manual, scores are transformed to a linear scale from 0 to 100, for which a higher score is seen as better-perceived information.46 The test–retest reliability has been established as good (intraclass correlation, 0.71–0.91).45
Knowledge about immunotherapy

No standard method for the assessment of knowledge of immunotherapy of patients with cancer was identified in the literature. Therefore, a new immunotherapy study-specific, true/false questionnaire was drafted by a psychoncology researcher, with experience working as a clinical psychologist in a tertiary cancer centre (KMG), based on the true/false questionnaire format employed in a previously published study on the knowledge of patients with cancer47 and a list of key pieces of knowledge that need to be conveyed to immunotherapy patients (eg, eviQ). It was then reviewed and revised in an iterative process by an experienced oncologist (RZ) and clinical nurse researcher (DM). Twenty items were deemed adequate for assessing patient’s knowledge as a review showed that the majority of studies measuring patient’s knowledge in patient education use 20 items.48 The questionnaire broadly asks questions in the following categories: (a) the basic mechanism behind checkpoint immunotherapy, (b) mechanistic differences between chemotherapy and immunotherapy, (c) identification of likely and unlikely side effects attributable to immunotherapy, and (d) when to report problems to the cancer care team. The face validity of the questionnaire was tested by a group of experts and patients, then field tested with patients who were currently undergoing or had been treated with immunotherapy in the past. Comments and queries were collated, and the questionnaire was refined until a consensus was reached by DM and RZ.

Patient activation

The 13-item version of the Patient Activation Measure (PAM-13) will be used to measure patient activation.49 A critical component of immunotherapy education is to improve a patient’s ability to self-report side effects as early as possible in order to prevent or minimise the

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<td>Estimate the recruitment rate and appraise reasons for ineligibility</td>
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<td><strong>Acceptability</strong></td>
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<td>Investigate the potential effectiveness of VR as a patient education tool on patient-reported outcomes</td>
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<td>Assess effectiveness of VR by patient information coping styles</td>
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N/A, not applicable; VR, virtual reality.
development of grade 3 or 4 toxicities, by implementing countermeasures such as steroids to limit the severity of the event. The PAM-13 is designed to measure the patient’s self-reported knowledge, skill and confidence in managing one’s health or chronic condition. Participants are asked to score the items on a 5-point Likert scale (ranging from 1=‘strongly disagree to 5=‘strongly agree’) including an additional ‘not applicable’ option. A PAM score is calculated by dividing the raw score by the number of answered items (except non-applicable items) and multiplying by 13. The score will then be transformed to a linear interval scale of patient activation scores, ranging from 0 to 100, with higher scores indicating higher patient activation. Within the converted scale, patients will be categorised into one of four patient activation levels using cut-off points: score of ≤47 for level 1 (not having confidence to take an active role in their care); 47.1–55.1 for level 2 (not having knowledge and confidence to take action in self-management); 55.2–67.0 for level 3 (starting to take action but lacking necessary confidence and skills) and ≥67.1 for level 4 (adopting self-management behaviours with possible lack of maintenance of these behaviours).

**Sociodemographic-related and disease-related outcomes**

Demographic characteristics will be obtained through a self-administered questionnaire at baseline, including age, gender, level of education, employment status and marital status. Area-level socioeconomic status will be obtained by postcode and will be derived from the Index of Relative Socioeconomic Disadvantage from the Socio-Economic Indexes for Areas. Remoteness will be classified according to ARIA, and will be categorised into major cities of Australia, inner regional Australia, outer regional Australia, remote Australia and very remote. Use of internet will be obtained by asking ‘How often do you use the internet?’, with answer options categorised into daily, weekly, monthly, never or unknown. Comorbidity will be assessed by presenting a list of comorbidities, for which answers will be categorised into no comorbidities, 1 comorbidity or >1 comorbidity. Type of cancer, stage of cancer and date of diagnosis will be obtained from hospital records with permission. Participants will also be asked whether anyone helps them with making medical decisions, if they have a smartphone and for how many hours (ie, 0–2 hours, 3–4 hours, 4–8 hours or more than 8 hours) they use electronic devices during the day.

**Data collection methods and timeline**

The time points for enrolment, interventions and assessments are summarised in table 3. Please note that days are estimates based on the average time frame of patients with cancer undergoing immunotherapy at the study’s cancer centre, and thus exact days may vary from patient to patient. It is anticipated that the study recruitment will

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<td>Enrolment</td>
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<td>Eligibility screening</td>
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<tr>
<td>Sociodemographic and disease-related outcomes</td>
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<td>Patient information coping styles</td>
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<tr>
<td>Perceived information provision</td>
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<td>Knowledge</td>
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<td>Patient activation</td>
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<td>Qualitative interview</td>
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*Only participants in the VR intervention group will be interviewed.†Qualitative interviews will be held 1–3 days after the patient’s first immunotherapy treatment session.

2D, two-dimensional; VR, virtual reality.
commence in July 2023 and will be completed 12 months later.

**Enrolment (−t1)**
Patients will be referred to the oncologist for their first consultation (day 0). During this consultation, the oncologist will explain to the patient that immunotherapy is indicated for their cancer and will briefly outline the mechanism of action of immunotherapy therapy, which includes verbal information and a printout (eg, NSW Cancer Institute eviQ immunotherapy https://www.eviq.org.au/clinical-resources/side-effect-and-toxicity-management/immunological/1993-management-of-immune-related-adverse-events). If a patient consents to receive immunotherapy, the oncologist will determine whether the patient is eligible to participate in the current study, and if so, explain the study to the patient. Those who are interested in participating will be provided with an envelope containing the participant information and consent form (PICF) and baseline questionnaire. The latter will include questions on the patient’s demographics, information coping style (ie, TMSI), perceived information provision (ie, EORTC QLQ-INFO25), knowledge quiz and activation assessment (ie, PAM-13). Over the next few days (days 1–3), the oncologist or study coordinator will call the patient to answer any questions and then verbally consent them into the study, and if consent is given, they will fill out the baseline questionnaire and bring the completed forms to their standard of care immunotherapy educational session. During the recruitment period, the oncologist will track the number of eligible patients approached and reasons for refusal on a case report form (see online supplemental file 5).

**Randomisation (t0)**
Upon the patient’s arrival to the standard of care education session (days 7–10), the oncologist or study coordinator will ask the patient for the completed forms. The study coordinator will check if the patient has consented to the study, which triggers randomisation to one of the three intervention arms: arm A—standard education+VR experience; arm B—standard education+2D video; arm C—standard education. The oncologist or study coordinator will countersign the PICF.

**Post-randomisation (t1 and t2)**
Following the standard of care education session, during which nurses take patients through the eviQ checklist, patients can start to receive their first immunotherapy treatment. This can occur on the same day of the education session or on a later day, depending on the distance to the treatment centre. While patients are receiving their first treatment, those randomised to the VR intervention group or 2D video group (arm A or arm B, respectively) will be given the additional education session, whereas participants in the control group will continue with standard of care. On the day of the first immunotherapy treatment, all patients will be given the first follow-up questionnaire (t1), which will include questions on the patient’s perceived information provision (ie, EORTC QLQ-INFO25), knowledge quiz and activation assessment (ie, PAM-13). A second follow-up questionnaire (t2), including the same questions, will be given to all patients approximately 2 weeks after their first immunotherapy treatment (day ±24). Patients will have been given a sealed envelope containing the questionnaire after their first treatment session and a trial nurse will phone the patient to complete it on a specific day. In addition, participants randomised to the VR intervention will be briefly interviewed about the feasibility of VR as a patient education tool, similar for health professionals. Interviews will be conducted by a member of the research team in person, over the telephone or via Zoom, depending on the patient’s preference (days 11–13). Box 1 details the topic guide for these interviews, which is based on literature and a methodological framework for the application of VR in healthcare.

**Data management and monitoring**
All patient-related data that are collected and analysed will be de-identified by assigning a randomly generated 4-digit, numerical code on receipt of the written PICF. Patient-reported outcome data will be transferred manually from the questionnaires to an electronic SPSS (version 25) database sheet. All collected data, including qualitative data, will be stored on a protected server of the NSW Health. As per the National Health Medical Research Council guidelines on the retention of clinical trial data, research data will be retained for 15 years following study completion, after which it will be permanently deleted from the server. Paper-based data will be stored in a locked office at the study site and will be destroyed after 15 years, by disposing of it in confidential bins that go to an office shredder.

The lead researcher (RZ) and research team will be responsible for monitoring data safety and integrity. Specific monitoring tasks will include:
- Monitoring patient accrual: data will be collected on the number of patients who are eligible to participate, the number of participants completing informed consent and the number of patients refusing study participation. This will be routinely monitored with periodical reports during the recruitment period (ie, May 2023–May 2024), and reviewed by the lead researcher and project manager.
- Monitoring adverse events: all trial coordinators will be given an information education session on how to use the VR and the possible adverse events that may occur. If an adverse event is determined to be likely due to study participation or the immunotherapy,
Monitoring study progress: patient-related data will be summarised using a rate and feasibility outcomes.

Data analysis plan

Feasibility outcomes

Recruitment data will be summarised using a rate and CI using the Poisson distribution. Acceptability and usability constructs, rather than adding quantitative methods. The interviews will be audio-recorded, transcribed and analysed using thematic framework analysis. Interview data that relate to the research questions will be arranged in an Excel spreadsheet. The researchers will first familiarise themselves with the data by reading and rereading the data and noting initial ideas. Thereafter, data will be coded, and codes will be collated into potential themes. Thematic maps will be constructed and discussed, after which the themes will be defined and presented alongside corresponding data.

Effectiveness outcomes

SPSS (version 25) will be used for descriptive and inferential statistical analysis to explore the feasibility and preliminary effectiveness of the VR on the dependent variables (ie, information provision, knowledge and patient activation). Data will be analysed according to the intention-to-treat analysis method. Linear, multilevel regression analysis, with random intercept on patient level to adjust for intradependency between repeated measures, will be used to assess the impact of VR on patient-reported outcomes (ie, information provision, knowledge and patient activation). An interaction term of information coping style and trial arm (control will be the reference group and will be compared with the intervention groups), with selected covariates (ie, demographic and clinical data obtained), will be added to assess the moderating effect of information coping style on the outcome measures. The analyses will be stratified by information coping style whenever the interaction term of coping style and trial arm is significant. To compensate for the multiple comparisons and control for type I error, Bonferroni will be employed. Statistical significance will be determined as p<0.05 (two tailed) and estimates will be presented with 95% CI.

Qualitative data

The acceptability and usability of the VR intervention will also be explored by using qualitative interviews with health professionals and participants who have experienced the VR intervention. Qualitative methods provide an additional layer of data that can inform intervention development and provide insights for a larger trial, when used concurrently with quantitative methods in a pilot study. For this reason, as well as not to burden patients, qualitative methods will be used to explore the acceptability and usability constructs, rather than adding quantitative methods. The interviews will be audio-recorded, transcribed and analysed using thematic framework analysis. Interview data that relate to the research questions will be arranged in an Excel spreadsheet. The researchers will first familiarise themselves with the data by reading and rereading the data and noting initial ideas. Thereafter, data will be coded, and codes will be collated into potential themes. Thematic maps will be constructed and discussed, after which the themes will be defined and presented alongside corresponding data.

Box 1 Topic guide for semistructured interviews

<table>
<thead>
<tr>
<th>General topics (ie, for both health professionals and participants)</th>
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<tbody>
<tr>
<td>➞ Background information on the interviewee.</td>
</tr>
<tr>
<td>➞ Identify and elicit details on the interviewee’s familiarity, skills and experiences with digital technology at home and in healthcare before the intervention:</td>
</tr>
<tr>
<td>➞ Experience with technology use.</td>
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<tr>
<td>➞ Willingness to use new technologies.</td>
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<tr>
<td>➞ Identify and elicit details on the interviewee’s opinion on the usability of virtual reality (VR):</td>
</tr>
<tr>
<td>➞ Ease of use or complexity (eg, difficulties encountered?).</td>
</tr>
<tr>
<td>➞ Barriers/facilitators to VR use.</td>
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<tr>
<td>➞ Identify and elicit details on the interviewee’s thoughts on the VR content:</td>
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<tr>
<td>➞ Pros and cons of the VR content.</td>
</tr>
<tr>
<td>➞ Anything missing/suggestions for improvement.</td>
</tr>
<tr>
<td>➞ Anything else that the interviewee feels has been missed and anything that they did not get a chance to discuss fully.</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Specific topics for health professionals</th>
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<tbody>
<tr>
<td>➞ Identify and elicit details on health professionals’ opinion and thoughts of VR as a patient education tool:</td>
</tr>
<tr>
<td>➞ Degree to which the VR treatment can be successfully integrated within the flow of standard of care.</td>
</tr>
<tr>
<td>➞ Potential facilitators, barriers and solutions.</td>
</tr>
<tr>
<td>➞ Usefulness for patients.</td>
</tr>
<tr>
<td>➞ Would they recommend implementing the intervention in their setting?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific topic for participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>➞ Identify and elicit details on participants’ opinion and thoughts on VR as a patient education tool:</td>
</tr>
<tr>
<td>➞ Thoughts on usefulness for other patients like them.</td>
</tr>
<tr>
<td>➞ What surprised them about the VR intervention.</td>
</tr>
<tr>
<td>➞ Delivery of education via VR, as opposed to more traditional methods (eg, pamphlet).</td>
</tr>
<tr>
<td>➞ Identify and elicit details of the participants’ experience with side effects related to VR use:</td>
</tr>
<tr>
<td>➞ Physical side effects (eg, vertigo, nausea and ‘cybersickness’).</td>
</tr>
<tr>
<td>➞ Psychological (eg, fear, anxiety).</td>
</tr>
<tr>
<td>➞ General discomfort.</td>
</tr>
</tbody>
</table>

the session will be stopped. All adverse events will be documented.

Monitoring study progress: patient-reported outcome data will be collected by the research team and monitored by the lead researcher and, if necessary, by a biostatistician. The lead researcher and project manager will meet regularly to monitor recruitment and patient safety.

Following publication of all study results, deidentified participant-level data may be made available on reasonable request to the lead researcher.

Data analysis plan

Feasibility outcomes

Recruitment data will be summarised using a rate and 95% CI using the Poisson distribution. Acceptability and appropriateness of study measures will be summarised using a proportion and 95% CI, which will be estimated using the Wilson method. The practicality of VR (ie, time spent by the study coordinator completing intervention-related activity) will be recorded in the study coordinator’s data collection instrument, including total time spent per patient as well as activity-specific time (eg, intervention preparation). Any adverse events related to the use of VR will also be recorded in the study coordinator’s data collection instrument. Means and SDs will be used to summarise time data. The feasibility outcomes will be judged against prespecified criteria, where appropriate (table 2).
Patient and public involvement
The research team tested the VR intervention as well as the knowledge questionnaire for face validity, comprehension and acceptability with patients in an iterative process that involved making revisions and then retesting the content with other consumers. No further patient and public involvement for the pilot study is anticipated.

Ethics and dissemination
This study was approved by the Greater Western Human Research Ethics Committee, NSW Local Health District (ID: 2022/EHTO1760) and registered in the Australian New Zealand Clinical Trials Registry (ID: ACTRN12622001473752). Informed consent will be obtained from all participants; on consent, each participant is assigned a randomly generated study identification code. All identifying information will be removed from the qualitative interview transcripts. The results will provide data to inform the feasibility of a future RCT, including sample size calculations. Findings will be published in peer-reviewed journals, and results will be shared broadly via conference presentations.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

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