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The design and initial service evaluation of a virtual tour of a radiotherapy department to improve patient experience

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Original Article

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Abstract

Introduction: For any patient's cancer journey, effective communication and helpful information are key to staying informed and reducing anxiety; for radiotherapy, ideally before treatment commencement. This paper details the initial design and service evaluation of a virtual tour (VT) aimed at familiarising patients with the department before treatment starts.
Methods: Created by local digital science students, with input from hospital Patient Public Involvement groups, patients were recruited (after their initial planning visit) into non-VT and VT groups; the latter viewing the VT before their first treatment. Both groups completed identical online surveys with Likert-style questions and free-text entry to assess knowledge and understanding.
Results: Twenty-three completed survey responses were received: 9 and 14 from the non-VT and VT groups, respectively.

- 66.7% of the non-VT group felt anxious attending the department for the first time; compared with 28.6% in the VT group. Key comments included 'not now that I've seen the video'
- 92.9% of the VT group understood the queue calling and changing room systems compared with 55.6% in the non-VT group.
- 85.7% of the VT group knew what to expect in the treatment room, compared to 33.3% in the non-VT group. Key comments included 'the video helped'.

Other comments included 'excellent idea' and 'alleviates the concerns about where to go and what to expect ahead of that first visit'.
Conclusion: The implementation of the VT has proved beneficial to patients, providing key information prior to treatment start, alleviating concerns and resulting in improved patient experience without the need for an extra visit.

Introduction

Information and communication are a key component to help patients and families stay informed and relaxed on their cancer journey. Evidence suggests that patients have concerns about the unknown aspects of hospital visits, such as navigating their way around the hospital and what to expect from their radiotherapy (RT) treatment.[1–4] Previous work reveals that the points of a patient's journey where anxiety and distress are most significant include commencing treatment and that different methods including information sessions prior to starting RT can help with reducing these anxious feelings.[5–8] After the initial visit, patients report feeling more relaxed, related to being more familiar with the process, with greater information support.[5,9]

The Transforming Cancer Care Social Value working group was set up to establish a legacy in Liverpool as part of the construction of Clatterbridge Cancer Centre Liverpool (CCCL). One work stream within the group was entitled 'Project Innovation', providing industry work experience for 80 Computer Science Digital (Level 3) students. This paper focuses on that project, aimed to enhance the patient experience and specifically *to develop a digital welcome application* or *virtual open event*. In resource-constrained settings, such as the National Health Service (NHS), collaboration with external organisations is essential to deliver services that exceed standard care and are not routinely funded. The authors believe that providing contextual detail on how this work was resourced offers pragmatic insight that may support the adoption of similar approaches by other NHS Trusts.

Open evenings, information sessions or pre-visits have been shown to be beneficial for patients and their families in terms of meeting their information requirements and reducing anxiety.[5,10]

Attending a physical open evening is not always practical or attractive, especially when people may be travelling a distance to access radiotherapy treatment. A virtual tour of a radiotherapy department may be preferred over in-person visits due to multiple practical and economic considerations. Ongoing workforce challenges in radiotherapy limit staff capacity to support non-clinical activities such as guided tours, while many patients are required to travel long distances for treatment, making attendance at in-person events more time-consuming and expensive. Additionally, open events often require recurrent funding for staffing and logistics, which is increasingly difficult to sustain in the current NHS economic climate. A virtual tour provides a scalable, cost-effective alternative that can improve patient preparedness and reduce anxiety without placing additional strain on limited resources.

Other methods have been employed to help inform and educate patients prior to treatment. These have included the use of printed materials, videos, multimedia presentations, interactive virtual reality (VR) tools and one-to-one discussions[11–16]; all to help reduce anxiety and tension, and bring greater education to the patient on different aspects of their RT pathway. To this end, VR systems have been used increasingly with both adult and paediatric patients, at various points in the pathway before the delivery of the first fraction of treatment; sometimes including anonymised or the patient's own treatment plans[6–8,15,17–21]; sometimes in areas outside RT.[22,23]

More portable digital methods have centred on the use of Apps on smartphones and other wireless devices; an aspect defined as mHealth by the WHO[24] for what might be achieved through mobile technologies. With the increasing use of smartphones and tablets, there is the potential for adoption across the entire cancer care setting[25] at a variety of points in the healthcare process, in an interactive and empowering way for the patient.[26–31]

Our approach here has been to make further use of technological enhancements in a virtual setting, with the following key aims:

- To be proactive in meeting patients' information requirements and resulting in that '*much happier now I know what's going on*' feeling earlier in the patients' journey; by listening directly to patient voices.
- To provide key information using a 'Virtual Tour' (VT), negating the need for an extra hospital visit.
- To engage with patients and colleagues to evaluate the effectiveness of the VT, thus providing evidence for further development.

We report here the design and creation principles, methods of implementation and an initial service evaluation of the VT and its effectiveness with patients at CCCL presented orally elsewhere[32]; the qualitative evaluation with healthcare staff colleagues has been presented elsewhere[33] and will be submitted in a follow-on paper.

Materials and Methods

Ethical considerations

The CCCL Trust Clinical audit sub-committee was approached for approval from the start of this work. They validated and approved the work. All data were completely anonymised and stored on secure Trust servers. Participant information sheets, giving details of the project, were given to all staff and patients taking part; informed consent was given by all participants.

Creation of the virtual tour (VT)

Our methods differed from previous published evidence, in making use of wired and wireless technologies and VR software developments in a novel way. For instance, by including actual Computer Aided Design (CAD) materials from the construction of CCCL, designing an avatar based upon CCCL staff, with an audio script designed by both staff and patient representatives. We have included, below, some technical details to support those seeking to adopt a similar approach.

The virtual representation of the building and its environment was developed in 3D (using Revit software to create a Building Information Model (BIM)), gathering data to assist the different stages of the project, including simulating the virtual construction in a safe environment before building in reality. The BIM models have enabled seamless design coordination, building performance analysis, and facilitating the project estimation, coordination, planning, executing and monitoring, including the production of information to assist operation and maintenance activities. The Social Value Committee, comprising representatives from CCC, PropCare, Laing O'Rourke and patient representatives, developed an outline brief to develop an interactive induction application for users of the building based on the BIM assets.

Patient Public Involvement (PPI) involvement was used in developing and co-producing the brief with patient representatives, colleagues from the City of Liverpool College and CCC colleagues. The brief was tested with patient focus groups led by students from the City of Liverpool College. Clatterbridge's PPI Group ensured it was meeting the brief and addressing patients' requirements.

Laing O'Rourke provided CAD files from the BIM model, which facilitated the creation of the virtual environment. The CAD files were assembled in the game engine (Unreal Engine 4, Epic Games, North Carolina) with some assets requiring additional work to make the assets game-ready in regards to optimisation and graphics, allowing students to begin work on lighting, reflections and general mechanics for the virtual tour.

Photographs were taken once the department was fully furnished to provide the most realistic version of the virtual tour, as can be seen in Figure 1. Additional images are in the Supplementary Materials (S1–S3).

Creation of the avatar

The avatar (Figure 2) was developed using Character Creator 3 software (Version 3, Reallusion, California); the character based on a male Therapeutic Radiographer (TR) from CCC. Photographs were taken in uniform (anterior, posterior and lateral images) to create an avatar with real-world characteristics. Marvellous Designer (CLO Virtual Fashion, version 12, South Korea) was used to create the uniform, replicating the colour and style worn at CCC, so that patients recognise the therapeutic radiographers. Once the avatar was created, it was imported into the game engine and the mechanics were developed, enabling him to walk around the department. This involved the TR attending the City of Liverpool College to utilise the motion capture facilities, this technology is similar to that used in computer games with character motion, such as Fortnite and FIFA.

Creation of the script

The audio script was co-produced by two TRs and four patient representatives from Clatterbridge's PPI group. This involved undertaking a walk-through of the journey a patient would make to

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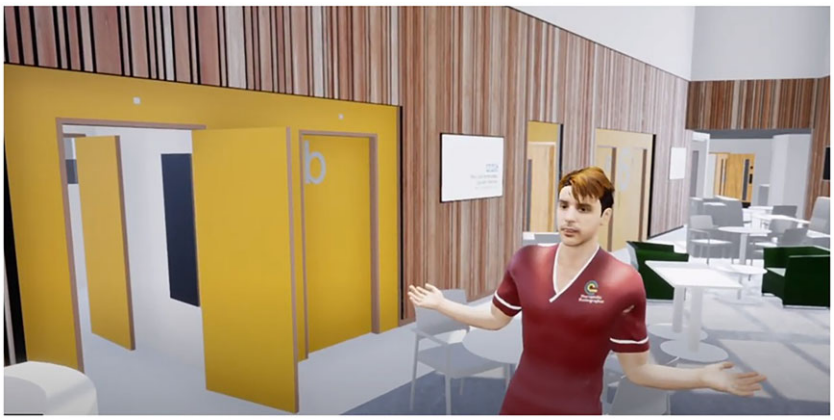

Figure 1. VT radiotherapy waiting area.

Figure 2. TR avatar.

the radiotherapy floor, identifying key touch points including the main entrance, outside space, patient beverage bay facilities, waiting areas, changing rooms and the treatment room. PPI was key to the co-production of the VT, from the initial scoping for the project to co-developing and reviewing the VT and data collection plans. Once agreed upon by the TRs, researchers and PPI group, the script was recorded in a studio at the City of Liverpool College by a TR with a Liverpool accent; this provided an authentic virtual experience reflective of the majority of Merseyside staff/patient dialects and demographics. The recording was synchronised with the motion capture, creating an informative VT providing key information that patients require before treatment.

Recruitment

Patients were invited to participate and sequentially recruited into non-VT and VT groups when attending their radiotherapy planning appointment at either the Wirral or Liverpool site. The VT group was recruited first, followed by the non-VT group. Inclusion/exclusion criteria are detailed in Table 1. All patients were given a participant information leaflet and consent form. The consent form required a mobile telephone number for the patient to be sent a text message via Envoy Messenger, with a link to watch the VT online and a second link to complete the survey.

Service evaluation design

A mixed-methods evaluative approach was utilised to gain both quantitative and qualitative data. For this service evaluation of the VT, patients were split into two groups (VT and non-VT):

(1) Patients in the non-VT group were asked to complete an online survey to assess knowledge and understanding of key information about the department.
(2) Patients in the VT group accessed the VT online and then completed the same survey.

The Jotform survey platform was used to create the survey for all participants; questions are shown in Table 2. A 5-point Likert scale (Strongly Agree (SA), Agree (A), Neither (N), Disagree (D), Strongly Disagree (SD)) was used for quantitative responses to the questions; free-text comments were permitted for each question

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Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
'Planned' treatment with radical intent	Single session RT
'Planned' treatment with palliative intent	Oncological Emergencies
Capacity to consent (not consent form 4)	Attended Radiotherapy floor at CCCL previously
Over 18yrs at planning appointment	Received previous RT at any centre

Table 2. Survey questions—for both non-VT and VT groups

Q1 I feel anxious about attending the radiotherapy department for the first time
Q2 I am worried about my radiotherapy treatment
Q3 I know where to go for my appointments
Q4 I understand the queue calling system
Q5 I understand how the changing rooms work
Q6 I know who to ask for help if I have any problems or questions when I am in the department
Q7 I know what to expect when I enter the treatment room
Q8 Other comments

and Q8, to enrich the data with qualitative responses and inform future development. Demographic data were requested (not mandatory) for the following age brackets: 18–24; 25–34; 35–44; 45–54; 55–64; 65–74; 75+.

Data collection

Data were collected completely anonymously between August 2022 and October 2022. Links to access the VT and the Jotform online survey were sent via text message. Messages were sent bi-weekly to remind patients to view the VT (VT group) and complete the online survey (both groups) after their planning appointment and prior to commencing their first treatment. During the recruitment phase, it was noted that the conversion rate of consenting patients to the number of completed survey responses was very low, as might be expected for text message surveying. As a result, consenting patients were provided with a department iPad to facilitate viewing of the VT and survey completion. Patients using the iPad to watch the VT (VT group) or complete the survey (both groups) were required to do so after their radiotherapy planning appointment, before leaving the department.

Data analysis

Quantitative data were analysed by descriptive statistics and comparative analysis, using Microsoft Excel. Analysis of the frequency distribution of Likert responses permitted identification of patterns/trends within the data.

Qualitative data from the free-text responses were analysed using a conventional content analysis as described by Hsieh and Shannon.[34] This inductive approach was selected to allow codes and themes to emerge directly from the data without the constraints of a pre-existing theoretical framework. Researchers independently read and re-read the responses to familiarise themselves with the content, identify common recurring words, phrases and descriptions, and develop initial codes. The codes were then collaboratively reviewed and grouped into broader themes until data saturation was reached, capturing the central concepts expressed by participants. As these themes emerged from only a small sample of patients, it is understood that these may not be representative of a wider patient population, and further work is required with larger patient cohorts.

Table 3. Qualitative comments coded into key themes

Thematic Coding
Theme 1 – Anxiety/worry
• Better with video • Not now I've seen the video • The centre looks friendly and has put me at ease • Video helped • Video helped • I am worried about potential damage to my heart and lung • I am not worried about my treatment video put me at ease • Excellent idea. Alleviates the concerns about where to go and what to expect ahead of that first visit. • Just the unknown (Non-VT) • My appointment letter didn't arrive and although very friendly a lady who I'd spoken to on the telephone to check wasn't sure (Non-VT)
Theme 2 – Knowing what to expect: Department
• Would be useful before entering hospital • The video was very helpful with plenty of information • Plenty of people to ask • Easy to follow instructions • It was helpful but didn't mention about bringing someone along. • Better information and directions to actual department (Non-VT) • Better signs (Non-VT) • Not yet used (Non-VT) • My appointment letter didn't arrive and although very friendly a lady who I'd spoken to on the telephone to check wasn't sure (Non-VT)
Theme 3 - Knowing what to expect: Treatment Room
• Just not sure what I change into
Theme 4 – Futures/improvements
• Don't like music • Possibly a during treatment survey to follow up if the video lived up to real life • Excellent idea. Alleviates the concerns about where to go and what to expect ahead of that first visit • It was helpful but didn't mention about bringing someone along • No I think everything was clear and easy to understand • Fabulous idea, very clear • Why could it not be a real person video showing you around the actual hospital? • I am worried about potential damage to my heart and lung • Just not sure what I change into

Results

Twenty-three survey responses were completed by patients: 9 patients in the non-VT group and 14 patients in the VT group. From those who had supplied age demographics, within the non-VT group, one was aged 45–54; three were aged 65–74 and two were 75+. For the VT group, one was aged 55–64; two were aged 65–74 and one was 75+.

Based upon analysis of both quantitative Likert-scale responses and qualitative free-text data, several themes were identified, as shown in Table 3 and outlined below:

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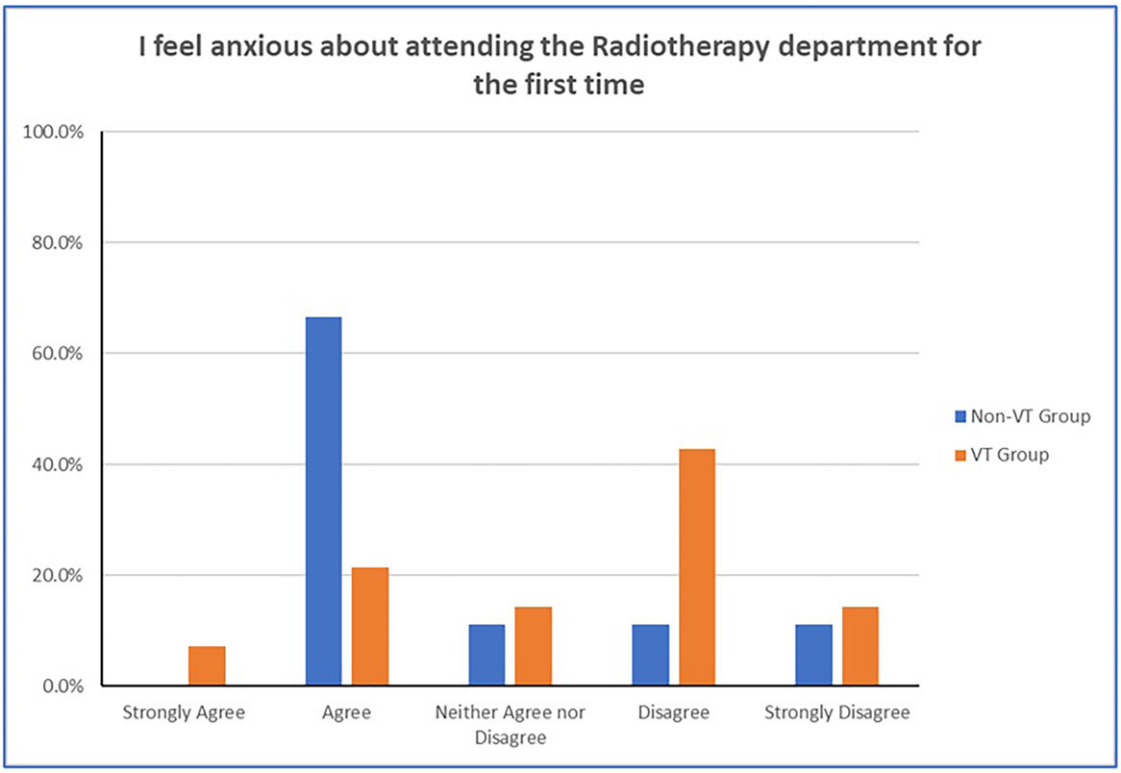

Figure 3. Patient reported anxiety rating prior to first visit.

Theme 1: reduced feelings of anxiety

From Q1, 67% of patients in the non-VT group reported feeling anxious, with comments related to *'the unknown'*. This reduced to 29% in the VT group, with comments including *'not [anxious] now that I've seen the video'* and *'the centre looks friendly and has put me at ease'*. Figure 3 shows the change in anxiety rating in patients in the VT group compared to the non-VT group.

For Q2, 56% expressed anxiety about their treatment (combined SA and A) in the non-VT group, compared with 43% in the VT group (Figure 4).

Theme 2: knowing what to expect in the department

Patients in the VT group scored higher on their understanding of practical information regarding their radiotherapy treatment. Within the cumulative SA & A scores (Q3), only 33% of patients in the non-VT group reported knowing where to go for their appointments, compared to 86% of patients in the VT group. From Q4 & Q5, only 56% of patients in the non-VT group understood the queue calling system and the changing room system, compared to 93% in the VT group. From Q6, only 56% of patients in the non-VT group reported knowing who to ask for help in the department, compared with 100% of patients in the VT group (Figure 5).

Theme 3: knowing what to expect in the treatment room

From Q7, only 33% of patients from the non-VT group felt they knew what to expect in the treatment room, compared to 86% of the VT group (Figure 6). This complements qualitative comments (Table 3) such as the *'video helped'*, and *'Excellent idea. Alleviates the concerns about where to go and what to expect ahead of that first visit'*.

Discussion

Anxiety and fear are common experiences for patients on their cancer journey[1–13,15]; there is an imperative that patients are adequately prepared and informed on what to expect before commencing treatment. Here, the authors demonstrate the feasibility of a novel 'patient familiarisation' virtual tour to facilitate information provision prior to attending the radiotherapy department. Patients who had utilised the VT exhibited reduced feelings of anxiety and greater understanding of what to expect in the department and from their radiotherapy treatment.

Theme 1: reduced feelings of anxiety

Crucially, use of the VT prior to attending treatment was shown to alleviate anxiety in the majority of patients within the VT group, compared with those in the non-VT group (Figures 3 and 4). Patients within the VT group disclosed that they were '*. . . not worried about my treatment - video put me at ease*', and '*not now I've seen the video*'; whilst those in the non-VT group reported higher rates of anxiety related to '*just the unknown*'.

Previous studies conducted globally have reported similar findings following the use of various VR technologies to prepare patients for radiotherapy treatment. Stewart-Lord et al.[35] reported that following a Virtual Environment for Radiotherapy Training (VERT) session, 100% of patients reported reduced anxiety associated with their upcoming treatment.[35] However, the VERT session also included education on possible side effects and pre-treatment preparation required for prostate cancer radiotherapy,[35] thus the focus of the intervention differed slightly from that of our VT. Conversely to these findings, a previous study comparing use of a multimedia presentation and written leaflets to educate head and neck cancer patients prior to receiving radiotherapy concluded that written

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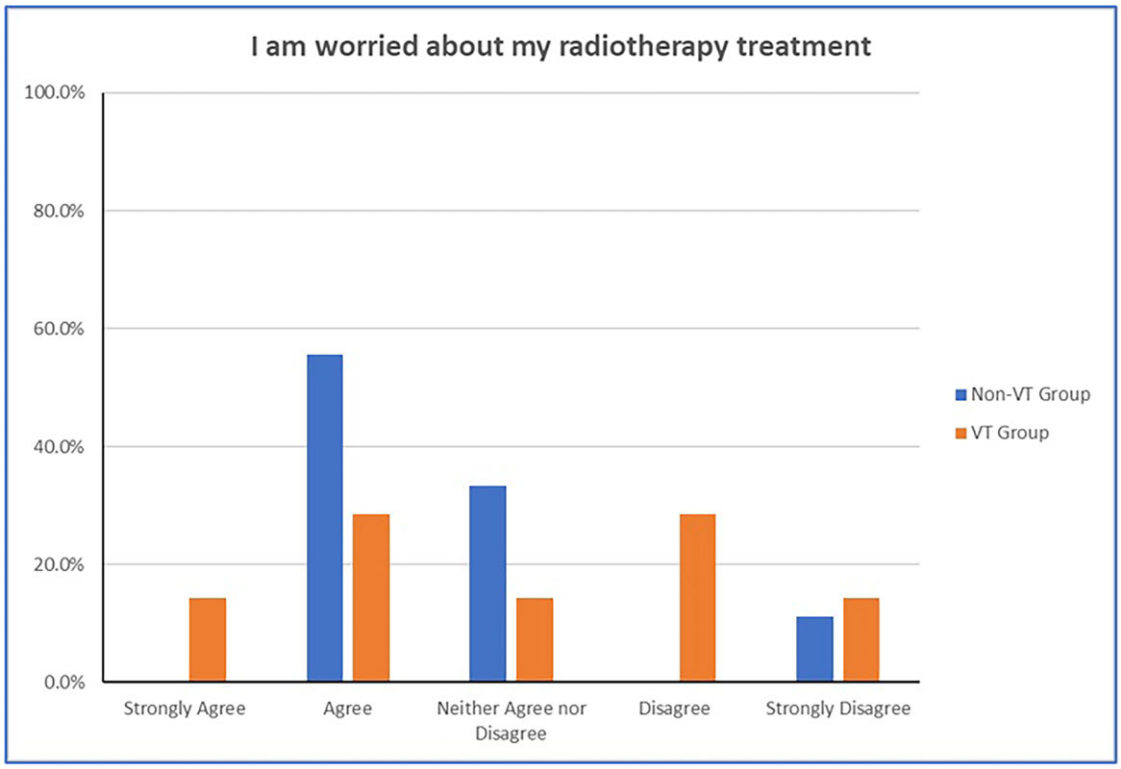

Figure 4. Variation in levels of worry about radiotherapy treatment.

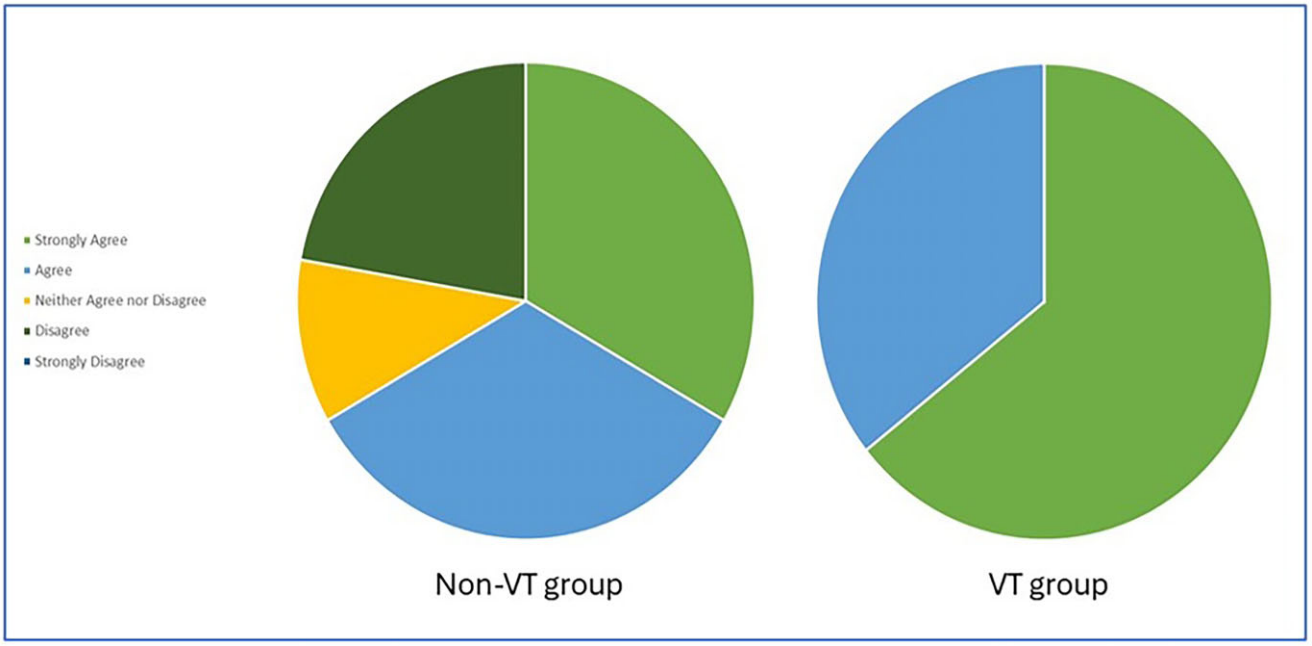

Figure 5. Patient knowledge of who to ask for help in the department (non-VT and VT groups' responses).

materials were more effective in reducing pre-treatment anxiety than multimedia resources.[11] Such findings may be reflective of patients' preference of receiving information, particularly concerning the pace of information delivery and the ability to revisit information on printed leaflets. Our VT provided similar functionality, whereby patients in the VT group could watch, pause and rewind the VT video at any point to view the information again at their own pace.

Despite several patients in our study reporting reduced anxiety regarding visiting the radiotherapy department for the first time following use of the VT, one patient attending the pre-treatment planning appointment expressed concerns specifically related to side effects: '*I am worried about potential damage to my heart and lung*'. This is unsurprising, as studies assessing patients' pre-treatment information needs report that the most common

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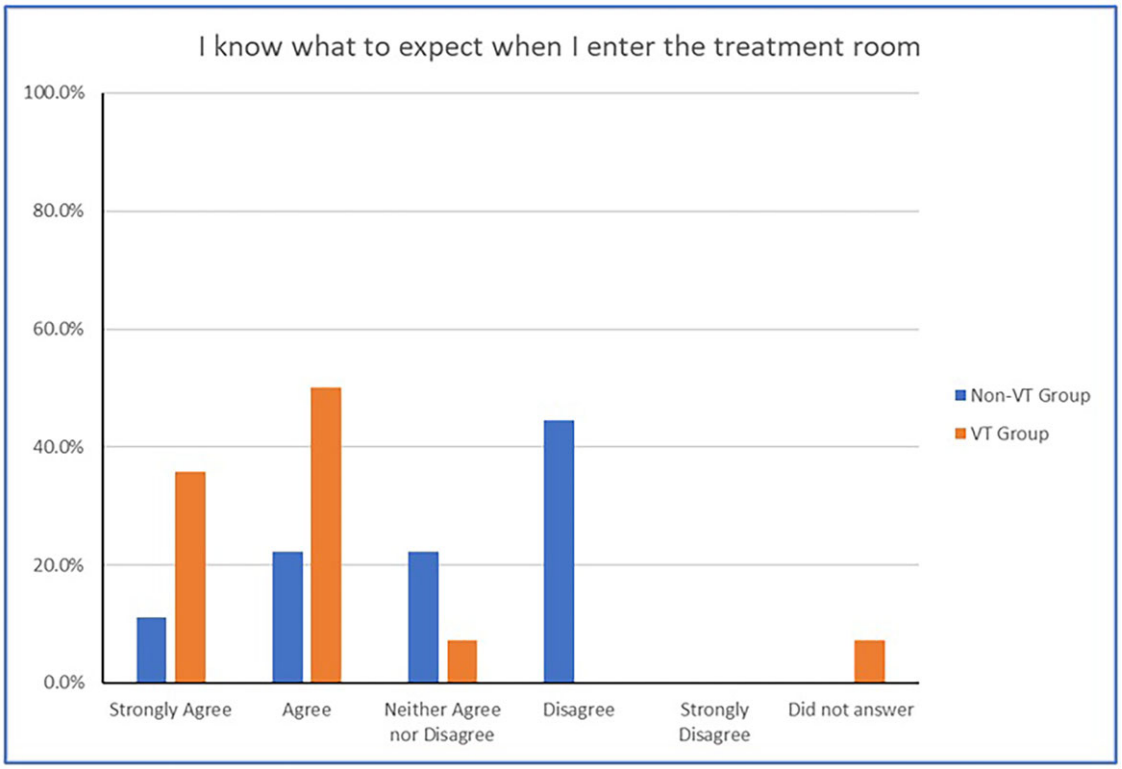

Figure 6. Patient knowledge of what to expect in the treatment room.

concerns include side effects.[36,37] In a study involving 118 patients with breast cancer scheduled to receive radiotherapy, side effects were the most common concern reported by 82% of patients.[37] Likewise, in a study of 159 patients undergoing radiotherapy treatment for various diagnoses, the majority disclosed that the topics they wished to be fully informed about were toxicities in the short-term (72%) and long-term (71%).[38] Research[6,20] using 3D VR devices to prepare patients for treatment have reported greater reductions in anxiety than the present study, however this may be attributed to the inclusion of information regarding treatment and side effects[6]; we did not include this information within our VT, due to concerns regarding the quantity of information patients receive at the start of treatment and the potential for the VT to become overwhelming. Instead, our VT focused on preparing patients for attending the radiotherapy department for the first time, including practical issues that may be encountered such as navigating changing rooms and the queuing system to help patients feel more comfortable when starting their treatment. As the VT did not provide information on potential toxicities, it is understandable that several patients in our study had concerns about such treatment-related factors. Evidently, future iterations of virtual information interventions may benefit from including toxicity information to further alleviate patients' anxiety, as demonstrated within previous studies.[6,35] Further PPI work may be beneficial to understand whether these features would be considered useful for patients to know prior to starting treatment.

Although several previous studies' results corroborate our findings, it is clear that anxiety is a highly subjective concept and thus challenging to quantify. Where possible, validated Patient-Reported Outcome Measures tools such as the Hospital Anxiety and Depression Scale should be utilised to more accurately record changes in patients' anxiety levels.[36]

Themes 2 & 3: knowing what to expect in the department and treatment room

Patients' reports of reduced anxiety in our study may have been the result of their perceived improvements in knowledge on what to expect when attending the radiotherapy department. Participants in the VT group demonstrated a greater awareness of the location of their appointments, where to seek help, how the queue calling system and changing rooms operate, and what to expect when entering the treatment room compared to the non-VT group. However, two comments made by patients within the VT group highlight missing information regarding changing clothes prior to treatment: '*just not sure what I change into*' and support: '*. . . didn't mention about bringing someone along*'. Although the VT was co-produced with a PPI group, such aspects were not initially considered; thus, it is imperative to utilise this patient feedback to inform future iterations of the VT.

A clear advantage of the VT included patients' ability to navigate around the radiotherapy department, with patients in the non-VT group stating that '*better signs*' and '*better information and directions to the actual department*' were required. Patients struggling to find their way in new hospital environments may experience distress,[39] thus provision of a VT prior to attending the department provides a potential solution to alleviate such concerns. Similar findings were reported in a study using VR to provide an introductory 360° 'tour' of a hospice,[40] which concluded that use of the VR tour reduced fears associated with the 'unknown'. Similar findings and methods were shown within our present study, whereby patients and families were able to access the VT resource in a comfortable setting prior to their first radiotherapy appointment, without the need to attend an additional hospital visit for orientation. Clearly, improving patient

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knowledge of the department and treatment processes using VR technology poses benefits in further reducing anxiety by providing patients with an awareness of 'what to expect', and perhaps improving their confidence when attending the department for the first time. Such advantages may be extended to other patient groups, including those with additional accessibility needs who may benefit from familiarisation with a setting prior to visiting.

Previous studies conducted in other healthcare settings corroborate these findings; use of a 'virtual operating room tour' to prepare patients for surgery with anaesthesia was shown to be effective in providing information and reducing pre-treatment uncertainty.[41] Likewise, a study assessing the feasibility of a 360° video tour prior to proton therapy showed positive findings, with patients evaluating the tour as 'valuable preparation' for treatment.[14] Positive findings have been further demonstrated within the paediatric radiotherapy setting; a pilot study testing feasibility of VR use prior to a planning CT scan and radiotherapy treatment concluded that following the intervention, children showed increased health literacy regarding CT and RT procedures.[19]

Theme 4: futures/improvements

This service evaluation has demonstrated the benefits of a virtual RT tour in ameliorating patient anxiety and increasing knowledge of the pre-treatment process. Based upon patient feedback (Table 3), future iterations of this VT should incorporate disease site-specific information, including potential side effects, to inform patients on the topics considered of greatest concern. Inclusion of pre-treatment bladder and bowel preparation for pelvic RT patients may also enhance the patient experience. To maximise patient information provision, incorporation of site-specific 'first day consultations' could benefit both patients and services, improving efficiency during first day appointments. Feedback from patients also requested a '. . . *real person* . . .' as opposed to an avatar; a video of a staff member is perhaps more suited for first-day consultation videos, which may inform future developments of the virtual tour. In future, video tour footage tailored to those with additional needs would improve accessibility and inclusion of all patient groups. The staff focus groups to evaluate this VT have been conducted,[33] suggesting expansion into areas such as pre-treatment and brachytherapy (which is currently in production).

Although one of the qualitative comments asked the question as to '*Why could it not be a real person video . . .*' (Table 3), digital technologies (such as this VT) are a central component of the NHS Long Term Plan,[42] underpinning efforts to transform care delivery and patient engagement. The Independent Cancer Taskforce[43] emphasised the transformative potential of digital solutions in enhancing patient information, experience and recovery. Supporting this, Ashmore et al.[44] found that patients undergoing radiotherapy perceived digital interventions as an 'invaluable support' during their treatment journey. Having said this and despite the ongoing drive toward a more digitally enabled and standardised NHS, as outlined in the NHS Long Term Plan[42] and Radiotherapy Service Specification,[45] it remains essential to acknowledge and accommodate individual patient preferences, ensuring that digital interventions are both acceptable and effective. This includes providing various formats for patients[16] and especially ones for those unable or unwilling to engage with digital solutions. This VT should be seen as being complementary to such offerings from our NHS Trusts.

Limitations

In order to test feasibility of our VT, our service evaluation was limited to a small sample size ($n = 23$). Statistical analysis was not conducted due to sample size limitations; future iterations of this work could include pre- and post-VT assessments with more detailed statistical analysis. Limitations regarding digital accessibility are recognised; therefore, dissemination of the virtual tour now includes display on large television screens in all waiting areas, the pre-treatment scanning and treatment delivery departments, maximising engagement, but still with normal Trust provision to capture patient feedback and therefore hear directly from the patient voice. Patient demographic data were limited only to age, in order to consider potential age-related digital exclusion; collection of further demographic data may reveal other trends. One disadvantage was the use of Short Message Service data collection, particularly for those with poor digital literacy or accessibility to technology or the internet. However, this has now been overcome with the VT being shown on department TV screens with closed captions available.

Conclusions

In conclusion, the patient responses within this service evaluation fully support the introduction of the VT as a foundation for providing further key information prior to treatment start, alleviating anxiety and improving the patient experience and all-round care at CCCL. This service evaluation has been highly positive from our initial patient responses, showing increased confidence and knowledge in practical matters such as queue and changing room systems, as well as generally knowing better what to expect within the department and treatment room. This work builds a platform for similar patient-informed service evaluations of future iterations of the VT, such as pre-treatment and brachytherapy.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1460396925100228.

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