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Perspectives on the use of Virtual Reality within a public hospital setting: surveying knowledge, attitudes, and perceived utility among health care professionals

Christine T. Shiner[1,2*], Gabrielle Croker[1,3], John McGhee[4] and Steven G. Faux[1,2]

Abstract

Background Virtual reality (VR) is a burgeoning technology within healthcare, though routine implementation of VR within hospital settings remains limited. Health professionals are key stakeholders in knowledge translation, though limited research has explored their knowledge and attitudes towards using VR for different purposes within healthcare. This study aimed to scope health professionals' knowledge of, and attitudes towards, the use of VR applications in a public hospital setting.

Methods A cross-sectional survey of multidisciplinary health professionals (medical, nursing, allied health professionals) was conducted in a major metropolitan public hospital in Australia. The custom survey was comprised of 28 mixed categorical and free-text fields designed to scope levels of knowledge, prior experience, and interest in VR; the perceived utility of VR within a hospital context; and perceived barriers and enablers of VR use within the hospital setting. Data were analyzed via descriptive and non-parametric statistics.

Results One hundred and thirty-seven health professionals participated (38% allied health, 37% nursing, 24% medical). The majority had no prior exposure to VR in clinical (95%) or recreational (67%) settings; and only 16% were aware of any clinical research evidence for VR. Despite limited awareness, participants expressed support for VR use in hospitals. 99% reported VR had potential utility in healthcare, most commonly for clinical simulations (81%), clinical education (80%) and as a physical therapy tool (68%). Participants identified multiple barriers to VR implementation most commonly relating to perceived cost, lack of required infrastructure, time, knowledge and technical skill. Prominent enablers related to increasing capability at provider and system levels. Participants' familiarity with VR was associated with stronger support for its' use ($Rho = 0.4$, $p < 0.001$).

Conclusions Health professionals in the hospital workforce reported limited knowledge and familiarity with VR; yet they perceived VR had broad utility and expressed overall support for different VR applications within hospitals. Health professionals appear interested in VR though face multiple barriers to its use in a hospital context. Increasing

*Correspondence:
Christine T. Shiner
christine.shiner@svha.org.au
Full list of author information is available at the end of the article

capability among multidisciplinary health providers and the wider hospital system appear to be important considerations for the success of future VR implementation in public hospitals.

Keywords Virtual reality, Health care, Health professional, Digital health, Implementation, Knowledge translation, Barriers and facilitators, Acceptability, Technology

Introduction

Virtual reality (VR) is an advancing technology with increasing applicability in the field of healthcare [1–4]. Broadly, VR refers to technology that enables a user to visualize and interact with a simulated environment via advanced computing. VR encompasses a range of different modalities, typically categorized as either 'immersive' or 'non-immersive', depending on the extent to which the user perceives they are located within the virtual environment rather than their physical surroundings. Immersive applications typically use a head-mounted display to replace the user's real-world surroundings with a view of an artificial world. Use of motion-tracking, sensory stimuli and haptic feedback (via devices such as hand-held controllers) can allow users to interact with their virtual environment and enhance their sense of 'presence' and 'immersion' [5–9].

The potential utility of VR within healthcare has been a subject of growing interest, evidenced by rapid expansion of published literature over recent years [2, 10–12]. Immersive VR applications have been explored for a range of different purposes within healthcare, including for therapeutic treatment, education, training, simulation and planning. The use of VR as a therapeutic modality has been most widely studied to date within the fields of psychology, rehabilitation and pain medicine [3, 11, 13–17]. There is growing evidence to support the utility of immersive VR as an adjunct psychological tool for exposure therapy and treating phobias [15, 18–21]; as a physical therapy tool in rehabilitation [17, 22–28]; and to assist with managing pain or providing distraction during painful medical procedures [16, 29–35]. More recently, there has also been interest in using VR as a clinical education and training tool for health care providers [36–41]; for clinical simulations [42–44]; and for non-clinical applications within a healthcare environment, such as communication, design planning and orientation [45–50]. VR appears to be beneficial across many of these domains, given it can expose users to realistic simulated situations in a safe, controlled, yet engaging way [1, 4, 24, 51].

Despite an expanding evidence-base, the implementation of VR applications within the routine clinical environment remains challenging [12, 52–54]. It has been noted that much of the existing evidence remains exploratory, with methodological variability and limited consensus to guide clinical application of VR beyond a research setting [3, 16, 22, 35, 36, 42]. Clinical stakeholders have also identified barriers to widespread VR adoption spanning financial, environmental, technical and attitudinal domains [53, 54]. Several studies have scoped attitudes towards VR among sub-populations of clinicians; recognised as key potential implementers of VR within healthcare. Studies to date have focused primarily on allied health professionals (namely psychologists, physical and occupational therapists), and explored views on specific VR applications within psychological therapy [55–61] and neurological rehabilitation [62–70]. While therapists often expressed positive interest in VR technology [56, 58, 62, 63, 69, 70], common barriers to adopting VR as a therapy tool have been cited, including perceived cost, lack of technical competency, limited access to resources, time barriers, lack of space/infrastructure, and client suitability [53, 55, 61, 62, 69–72]. Clinicians also expressed a need for professional education and training to support decision-making around VR adoption within clinical practice [53, 62, 70].

There is limited research quantifying levels of knowledge and experience with VR among practising clinicians; in particular, no studies to date that have focused on the tertiary, public hospital workforce. Similar research conducted with private hospital and community therapy providers suggests that many health professionals remain unfamiliar with VR [56, 62, 73]. As VR technologies become more widely and commercially available, there is a need to better understand levels of VR awareness and experience across the clinical workforce; and in turn, how this may influence perceived attitudes and the likelihood of VR implementation among public health professionals.

No studies to date have evaluated attitudes towards VR in a large cross-section of the public healthcare workforce (including multiple clinical disciplines), nor considered attitudes towards a range of different VR applications. To address this, the present study sought to explore attitudes among hospital clinicians towards the broad use of immersive VR technology in a clinical setting. Specifically, this study aimed to:

i) Quantify levels of experience and exposure to VR technologies among the clinical public hospital workforce;

ii) Examine levels of support for using VR technology for varied clinical applications among health care professionals;
iii) Identify perceived barriers and/or enablers of VR implementation in the public hospital environment.

Methods

Research design and setting

A prospective, cross-sectional survey of health care professionals was conducted at a single adult public hospital in metropolitan Sydney, Australia. The study site is a tertiary referral centre, accredited teaching hospital and forms part of a collaborative academic research precinct. This study has been reported in accordance with the consensus-based Checklist for Reporting of Survey Studies (CROSS) [74].

Participants

A single participant group of health care professionals was recruited over a 4-month period (February to May 2021), via convenience sampling. To be considered eligible, participants had to be: aged ≥ 18 years; employed as a clinical staff member at the study site (that is, a healthcare professional of any medical, nursing or allied health discipline); and able to communicate in English. Inclusion criteria were deliberately broad to capture a wide participant demographic. No prior knowledge or experience of VR were required in order to participate. The survey was anonymous and did not involve collection of identifiable information from participants, to encourage the provision of honest feedback and minimize the potential for desirability bias.

The study was reviewed and approved by the Human Research Ethics Committee of St Vincent's Hospital, Sydney (2019/ETH00423). All participants provided informed consent to participate after reviewing a study information sheet. Participants were advised that completion of the survey was taken to indicate their consent to participate. This was deemed appropriate by the approving Human Research Ethics Committee in line with the Australian National Statement on Ethical Conduct in Human Research [75], given the non-identifiable and non-sensitive nature of data collected. No financial incentives or compensation were offered to those who participated.

Survey design

An English language survey was developed by the research team (Supplementary File 1). The survey was comprised of 28 largely categorical and scale-based fields; with the option to provide open, free-text comments. The survey was designed to scope participants': prior knowledge and experience of using VR technology; attitudes and perceptions of VR technology; perceived barriers and enablers of using VR in clinical settings; and perceived clinical utility of VR technology in a hospital environment. The survey was structured into five sections, with the following data collected via each section:

i) *Participant demography*—including age, sex, professional discipline, years of clinical experience, and area of clinical specialty.
ii) *Knowledge, familiarity and prior experience with VR* – including prior recreational and/or clinical experience using VR technology; awareness of clinical VR applications; and awareness of research and/or clinical evidence to support the use of VR applications. Participants were asked to rate their familiarity with VR technology on a Visual Analogue Scale (VAS), from to 0 to 10, where 0 represented 'very unfamiliar' and 10 represented 'very familiar'.
iii) *Perspectives on the suitability and utility of VR technology for use in a hospital setting* – participants were asked to rate how strongly they agreed (or disagreed) with statements regarding the use of VR in hospital, regarding perceived safety, risk of harm, potential clinical benefits, potential for engagement, required skills/resourcing and levels of interest in VR technology. Each statement was rated from 0 to 10 on a VAS, with the scale ranging between two anchor points of 'strongly disagree' (0) and 'strongly agree' (10).
iv) *Perceived applications or beneficial uses of VR within the hospital setting* – participants were asked to identify possible ways in which they perceived VR could be of benefit when used in a hospital setting, via selection from a multiple-choice list, and the opportunity to provide free comment.
v) *Perceived barriers and enablers of VR within the hospital setting* – participants were asked to identify perceived barriers and enablers of using VR technology in a hospital environment, via selection from a multiple-choice list, and the opportunity to provide free comment.

For multiple-choice questions, the response items listed were based on review of theoretical and empirical literature on VR (for reviews, see [3, 36, 52, 53] and the consensus expertise of the research team that included health professionals, health services academics and design academics with experience in visualization and VR development. Categorical survey questions were supplemented with free-text fields to enable respondents to provide 'other' comments where desired and to ensure unique insights were captured. The survey questions and response items were reviewed and discussed to

consensus by all authors. Prior to data collection (January 2021), a preliminary version of the survey was pilot tested with two health professionals (one nursing, one allied health professional) to scope the clarity of content and acquire objective feedback. Minor grammatical refinements, but no major changes to survey questions or content, were suggested and incorporated into the final version of the survey after pilot testing. Data from pilot participants were not included in the study analyses.

Sampling and data collection

The survey was disseminated to staff at the study site via in-person and asynchronous advertisement methods. Paper-based study information and copies of the survey were made available to staff at an open information booth manned by the research team within a common area of the hospital. Paper copies were also provided in staff rooms located throughout the hospital, for staff to review and consider at their leisure. For those who wished to participate, completed paper copies of the survey could be returned anonymously to the research team via internal mail. The survey was also advertised electronically to hospital staff via an internal hospital emailing list (managed independent of the research team). Due to the nature of survey advertisement and sampling methods, it was not feasible to accurately record the total number of individuals who viewed the study advertisements or the proportion who did not wish to participate (for example, those who reviewed study information in a staff room when the research team were not present). For this reason, data have only been reported for those surveys returned to the research team.

Surveys could be completed anonymously in either paper-based or electronic format (via an interactive PDF form). Survey data were collated by a member of the research team (GC) into an electronic database that was imported into statistical analysis software for analyses.

Data analyses

Data analyses were conducted using SPSS software (version 26, IBM computing). Participants who responded to at least one section of the survey focused on VR (sections ii-v) were included in the analyses; those who provided demographic information only were excluded (see Supplementary File 2). For each survey section, analyses were performed on available data; missing values were not imputed ($\leq$2% of cases, Supplementary File 2). Descriptive statistics were used to summarise the demography of the cohort. Counts and percentages were used to describe dichotomous fields and to summarise multiple-choice responses to barriers, enablers and clinical uses of VR. Proportions are expressed relative to the total number of respondents who completed each respective survey section (see Supplementary File 2).

Where participants provided free-text responses, these were reviewed by two authors (CS, GC) and analysed via an iterative framework analysis approach [76, 77]. Responses were first mapped deductively to the categorical fields listed within a given question, where appropriate. Free-text responses were then reviewed inductively to identify any additional themes not captured via pre-specified fields. Themes were reviewed and discussed to consensus by two authors (CS, GC), and have been described categorically throughout the results denoted as 'other' findings.

Continuous data collected via visual analogue scales were determined to be non-normally distributed; therefore, non-parametric statistical methods were used. Median VAS scores were compared between demographic participant subgroups, using independent samples Mann Whitney-U tests for binary variables (sex, prior VR experience), and Kruskal Wallis tests for categorical variables with three or more groups (age, clinical profession, years of clinical experience).

Correlation analyses were performed to determine whether there was an association between clinicians' self-rated familiarity with VR and their overall support for using the technology (both rated on a VAS scale). Spearman's rank order correlation was used, given the non-parametric data distribution. Data are presented throughout the results as number (percent) and median [interquartile range]. Results were considered significant where $p < 0.05$.

Results

Participant demographics

A total of 137 health care professionals responded to the survey; of whom, 134 (98%) completed the entirety. The majority of participants were female ($n = 98$, 72%), aged less than 45 years ($n = 104$, 76%) and held a tertiary qualification (see Table 1). The cohort included health care professionals from a range of clinical disciplines, including doctors ($n = 33$, 24%), nurses ($n = 51$, 37%) and allied health professionals ($n = 52$, 38%); and with varied clinical experience, from early career (< 5 years) to senior (> 20 years) clinicians. Participants had a wide variety of clinical specialties including acute medical, surgical, critical care, rehabilitation, aged care and palliative care specialties (Table 1).

Knowledge of and familiarity with VR technology

Participants reported modest familiarity with VR technology, providing a median rating of 5 [3-7] out of 10. The majority of the cohort ($n = 86$, 63%) had never personally used or engaged with VR before. Forty-five

Table 1 Participant demography

Characteristics	Total = 137 N (%)
Age *(years)*	
18–24	11 (8)
25–34	69 (50)
35–44	24 (18)
45–54	18 (13)
55–64	15 (11)
Gender	
Female	98 (72)
Male	36 (26)
Prefer not to say	3 (2)
Highest level of education completed	
Certificate/diploma	6 (4)
University undergraduate	84 (61)
University post-graduate Masters	46 (34)
No response	1 (1)
Clinical Profession	
Nursing	51 (37)
Medicine	33 (24)
Allied Health	52 (38)
Physiotherapy	*17 (12)*
Pharmacy	*9 (7)*
Phlebotomy	*7 (5)*
Dietetics	*5 (4)*
Sonography/radiography	*5 (4)*
Occupational Therapy	*4 (3)*
Psychology	*3 (2)*
Speech pathology	*1 (1)*
Social work	*1 (1)*
No response	1 (1)
Department/specialist discipline	
Acute Medical[a]	39 (28)
Rehabilitation	24 (18)
Critical Care[b]	18 (13)
Medical Imaging, Diagnostics, Pharmacy	16 (12)
Aged Care, Palliative Care	13 (10)
Surgical[c]	11 (8)
No response	16 (12)
Years of clinical experience	
0–5	42 (31)
6–10	43 (32)
11–15	19 (14)
16–20	7 (5)
More than 20	25 (18)
No response	1 (1)

[a] Acute medical disciplines included: neurology, haematology, cardiology, thoracic medicine, dermatology, endocrinology, nephrology, gynaecology, psychiatry, toxicology and addiction medicine

[b] Critical care disciplines included: Intensive care, anaesthetics and emergency medicine

[c] Surgical disciplines included: neurosurgery, vascular surgery, urology, gastrointestinal surgery

Table 2 Prior experience, familiarity and awareness of VR

	Total = 137 N (%)
Prior use of VR – recreationally	
No	92 (67)
Yes	45 (33)
- Once	*28 (20)*
- Occasionally	*16 (12)*
- Regularly	*1 (1)*
Prior use of VR – clinically	
No	130 (95)
Yes	7 (5)
- Once	*4 (3)*
- Occasionally	*3 (2)*
- Regularly	*0 (0)*
Aware of clinical use/s of VR?	
No	103 (75)
Yes	34 (25)
Aware of clinical research on VR?	
No	115 (84)
Yes	22 (16)
Perceived time until routine use of VR in clinical settings	
1–2 years	42 (31)
3–5 years	54 (40)
5–10 years	31 (23)
10 + years	9 (7)
Never	0 (0)

participants (33%) reported using VR previously in a recreational setting, although most ($n = 28$) had only used VR once. Only 7 participants (5%) reported having previous experience of using VR in a clinical setting; of these, three reported occasional use, four reported a single use and no respondents reported frequent clinical use (see Table 2).

A quarter of respondents indicated that they were aware of VR technology being used in a clinical setting in some way ($n = 34$, 25%). Fewer participants ($n = 22$, 16%) reported being aware of any research or clinical evidence that supported the use of VR in a clinical or hospital setting (see Table 2).

Despite limited prior exposure or awareness, all participants ($n = 137$, 100%) indicated that they believed VR technology would become routinely implemented within hospital environments; the majority of participants ($n = 96$, 71%) perceived this would occur within the next 1 to 5 years (Table 2).

Perspectives on the clinical utility of VR

Overall, participants indicated support for using VR technology within the hospital setting, with a median agreement rating of 7[5-7] out of 10. Participants expressed

positive views on the utility and potential benefits of VR, as rated out of 10 and summarized in Fig. 1. At a patient level, clinicians provided average ratings suggestive of agreement that VR would provide benefits to patients beyond routinely available therapies (median 7[5-8] out of 10); that VR would improve the overall hospital experience for patients (median 7[5-8]); and that VR could help to improve patient engagement while in hospital (median 7[5-8]). On a professional level, the opportunity and desire to learn new skills related to VR were both rated by clinicians as median 8 out of 10, suggesting agreement.

When asked whether they had sufficient time to learn about using VR, clinicians gave variable responses, with a neutral median value of 5[3-7]. When asked whether they had access to the support and resources required to utilize VR in their clinical practice, clinicians provided a median rating of 2[1-4] out of 10, suggesting disagreement. Clinicians also suggested disagreement that VR would introduce risks of harm to patients if used in hospital (median rating 4 [3-5] out of 10).

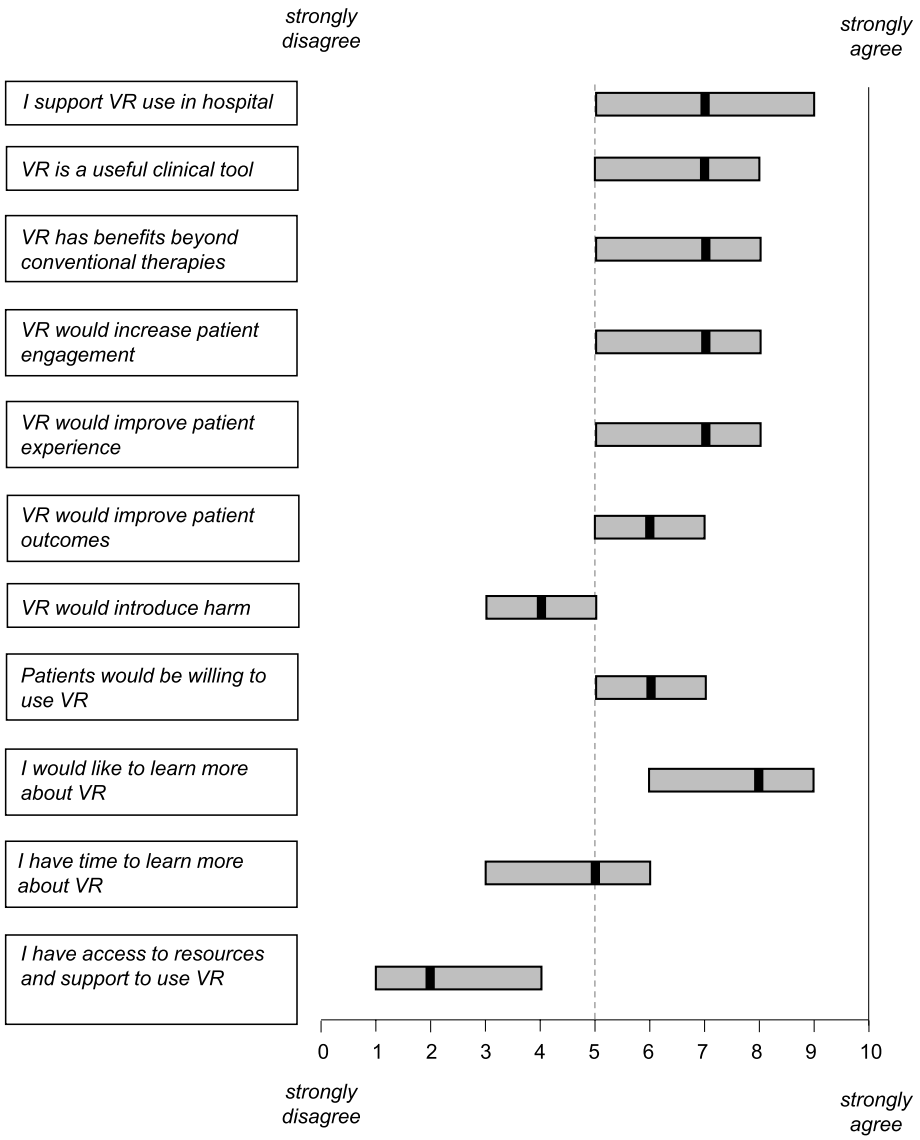

Fig. 1 Clinician perspectives on the clinical utility of VR. Boxes represent the interquartile range of scores for each statement, with dark vertical line indicating the median. Statements were scored on a visual analogue scale from 0–10, with anchor points 'strongly disagree' (0), and 'strongly agree' (10). A score of 5 indicated a neutral response (dashed vertical line). Responses greater than 5 indicated overall *agreement* with the statement, and responses less than 5 indicated overall *disagreement*

Possible applications of VR technology in a hospital setting

Clinicians identified a variety of potential ways in which they believed VR could be utilized within a hospital setting (Table 3 and Supplementary File 3). Educational applications were the most commonly indicated by clinicians of all disciplines; these included using VR as a tool for clinical workplace simulations ($n=111$, 81%), and as a teaching tool for clinical learning ($n=109$, 80%). Participants also identified potential therapeutic applications of VR, including for physical therapy ($n=93$, 68%); patient education ($n=90$, 66%); counselling and psychological therapy (77, 56%); for aiding surgical procedures ($n=71$, 52%); and for pain management ($n=68$, 51%). Logistical applications were also noted, related to hospital design, planning, orientation and familiarization to clinical environments. Of the 136 participants who responded to this survey section, only 2 (1%) indicated that they perceived VR would have no useful applications in a hospital setting.

The pattern of responses was similar across professional disciplines (medical, nursing and allied health professionals) (Supplementary File 3). Exploratory subanalyses suggested some minor inter-discipline differences; with a higher proportion of medical participants identifying utility for surgical procedures and pain management, and a higher proportion of nurses identifying environmental and design-related applications (Supplementary File 3).

Perceived barriers and enablers of VR use

Participants identified a variety of perceived barriers to VR use in a hospital setting (see Table 4). The most commonly cited barriers were logistical in nature, and related to the perceived costs of VR ($n=105$, 78%); lack of sufficient information technology (IT) infrastructure and support ($n=96$, 72%); limited operational knowledge of VR among staff ($n=91$, 68%); time constraints for clinicians ($n=87$, 65%) and limited physical space within the hospital environment ($n=49$, 36%). Barriers related to patient and/or provider preferences were also noted, but less frequently. Approximately half the cohort ($n=64$, 48%) indicated that patient resistance

Table 3 Perceived utility of VR within a hospital environment

Category of use	Potential applications of VR technology	Example/s	N (%)
Clinical education and skill development	Simulations and workplace training	Simulated emergency response training	111 (82)
	Educational clinical learning	Immersive anatomy, physiology, and/or surgical tutorials	109 (80)
Therapeutic applications	Rehabilitation or physical therapy	To enable patients to undertake physical therapy tasks in a simulated virtual environment	93 (68)
	Education of patients and their families	To help explain medical conditions, surgical procedures and/or treatments to patients and their families	90 (66)
	Counselling and/or psychological therapy	Delivery of graded exposure therapy, in a virtual environment	77 (56)
	Surgical procedures	To assist with planning and/or conducting complex procedures	71 (52)
	Pain management	As an adjunct form of analgesia for people with painful conditions (e.g. phantom limb pain) or during painful procedures (e.g. dressing changes)	68 (51)
	Other[a]	- Virtual, end of life experiences (such as visiting remote locations) in Palliative Care - Diversional therapy - Dementia care - For virtual care interactions between patients and providers	14 (10)
Logistical, design and infrastructure	Hospital tours/hospital orientation	Conducting virtual hospital orientation for patients and/or visitors	64 (47)
	Familiarisation to clinical environments	Familiarising patients to radiological equipment prior to receiving scans and/or treatment	58 (42)
	Hospital design and planning	For viewing and appraising proposed hospital renovations and redesign plans	55 (40)
None	No possible uses	-	2 (1)

Participants were asked to identify ways they perceived VR could be used and beneficial in a hospital environment. N refers to the number of participants (out of $n=136$ total respondents) who selected each option. Participants could select multiple options; therefore, the total number of responses is larger than the number of participants

[a] Other beneficial applications were those identified by participants that did not appear in the multiple-choice list of responses

Table 4 Perceived barriers and enablers of using VR technology in a hospital setting

Barriers	**N (%)**
Cost	105 (78)
Insufficient IT support	96 (72)
Insufficient clinician skill/knowledge to operate VR	91 (68)
Lack of clinician time to learn how to use VR	87 (65)
Additional time required to use VR in a treatment session	73 (54)
Patient resistance or reluctance	64 (48)
Insufficient or no available treatment space/s to use VR	49 (37)
Insufficient or poor quality evidence to support the use of VR	39 (29)
Safety concerns (such as infection and/or injury risk)	32 (24)
Lack of suitability for some patient groups (such as older adults, those with cognitive impairment, vestibular problems)	26 (19)
Clinicians not interested in using VR technology	18 (13)
Concerns for VR technology replacing the role of clinicians	15 (11)
Other[a]	14 (10)
Enablers	**N (%)**
Training courses for clinical staff on VR use	114 (85)
Designated IT support personnel	107 (80)
Access to portable and/or wireless VR technology to use in hospital (such as Smartphone VR applications)	89 (66)
Designated VR treatment space in the hospital	82 (61)
Clinical evidence summaries or guidelines on VR use	82 (61)
Access to VR software developers and/or design experts	76 (57)
Local VR champions within the clinical setting	75 (56)
The ability to record and store data for tracking patient progression	70 (52)
The ability to develop customised VR programs/software	67 (50)
Instructional brochures or pamphlets	61 (46)
Subsidised access to VR devices	62 (46)
Financial incentives for VR treatment	59 (44)
Other[b]	8 (6)

N refers to the number of participants (out of $n = 134$ total respondents) who selected each option. Participants could select multiple options; therefore, the total number of responses is larger than the number of participants

[a] Other barriers identified by participants included: resistance to change; lack of organisational and/or senior leadership support; uncertainty around clinical benefits; and concern that VR would reduce human interaction between patients and care providers to negatively impact rapport

[b] Other enablers identified by participants included: organisational endorsement from senior leadership; and development of a hospital-wide policy or strategy

or reluctance to use VR may be a barrier; while few ($n = 18$, 13%) reported that they as clinicians were not interested in using VR technology. Clinical barriers were noted by some participants relating to safety concerns, the perceived appropriateness of VR technology for some patient groups, limited clinical evidence to support VR implementation, and the concern that adopting VR may encroach on the role of clinicians, and/or limit the amount of interpersonal contact between clinicians and patients (see Table 4).

The most prominent enablers identified related to capability (at both the individual and service level) to deliver VR interventions in a clinical environment (see Table 4). These included: training courses for clinical staff ($n = 114$, 85%), the provision of dedicated IT support services ($n = 107$, 80%); access to easily portable VR technology ($n = 89$, 66%); and access to dedicated VR treatment spaces within the hospital ($n = 82$, 61%). Knowledge of current clinical evidence for VR was also noted as important, with 60% of clinicians ($n = 82$) indicating that collated, evidence summaries and/or guidelines would be an enabler. The presence of local VR champions within the hospital setting, and access to specialist VR developers for custom content creation were noted by approximately half the cohort as enablers. While perceived cost was the most frequently identified barrier, subsidized access to VR devices and/or financial incentives for VR treatment were less commonly identified as enablers (see Table 4).

Relationship between VR familiarity and perceptions

Clinician's self-reported familiarity with VR was found to correlate significantly with their overall support of VR (Spearman $Rho = 0.4$, $p < 0.001$), whereby those more familiar with VR technology expressed stronger support

for its use in a clinical setting. Further, those participants who reported being aware of clinical VR applications had significantly higher scores of support for VR, compared to those who were not aware of any clinical uses (median 8[7-10] and 6[5-8], respectively, $p=0.002$). Age, years of clinical experience, professional discipline and/or gender did not significantly affect participants' self-rated support for VR, nor their perspectives on VR utility.

Discussion

In this study, we surveyed multidisciplinary health professionals to scope their knowledge, experience, and attitudes towards using VR technology within a public hospital setting. Despite burgeoning commercial popularity, health professionals reported modest familiarity with VR technology, limited knowledge of clinical VR applications and little prior exposure to VR in clinical or recreational settings. This is congruent with research conducted with mental health [56, 73] and rehabilitation professionals [62] demonstrating the majority of clinicians continue to have limited knowledge and no prior experience of using VR. Nonetheless, health professionals in this study appeared to support the potential utility of VR across educational, therapeutic, and environmental activities within hospital. These findings suggest there is an appetite for VR capability within the public hospital workforce; but coupled with limited experience and perceived barriers to use including cost, technical limitations, time pressures and knowledge gaps.

Participants (99%) identified a broad range of applications where they perceived VR may benefit healthcare providers, patients, and/or the wider hospital system. Interestingly, health professionals most often cited utility at the provider level, where they perceived VR could support their own clinical education and training. This is congruent with a growing body of literature that suggests VR can be a useful educational tool to improve learning outcomes and increase student engagement in general clinical education [36, 39, 78–80] or specialty disciplines such as anatomy [38] and surgery [43, 81]. Our findings support that healthcare professionals of multiple disciplines are open to using novel technologies like VR in their professional education. They suggest a desire for augmented training opportunities among the hospital workforce, and that further research on VR applications targeted toward assisting health care providers – in addition to health consumers – is warranted. At a service level, participants also noted that VR may be of wider use to hospital organizations by aiding hospital design, logistical planning and allowing safe orientation to clinical environments. These applications have been less well explored to date, though some studies have suggested VR can be successfully used as a co-design or engagement tool with patients and health care providers alike [47–50, 82].

With respect to clinical utility, health professionals identified a variety of ways in which they believed VR could be applied therapeutically to augment patient outcomes and/or experiences. This was interesting given their limited knowledge and exposure to VR in clinical settings, with only 25% reporting awareness of clinical uses of VR and only 16% being aware of related evidence. Using VR for physical therapy and rehabilitation, psychotherapy, patient education, pain management and as a procedural tool were noted by more than half the cohort. Despite most participants (> 80%) being unaware of published evidence, their responses aligned with literature to date which has primarily focused on VR applications within these fields [3, 4, 11, 13]. Some participants noted other potential uses of VR which have been less widely explored, including for diversional therapy, end-of-life care, dementia care, and to enhance virtual clinical consultations, which may warrant further consideration. The variety of applications identified by health professionals demonstrates that VR may have utility across different types of clinical interactions. These findings may also suggest that health professionals perceive VR could exert therapeutic effects via different mechanisms, such as via distraction, sensory modulation, immersion and/or engagement; which continue to be explored [83–85].

Whilst varied applications were posited, health professionals perceived these would likely be appropriate for some, but not all, patients. Approximately half the cohort perceived that patients' may be resistant or reluctant to use VR, while some noted safety concerns and/or uncertainty regarding VR's suitability for certain patient populations such as older adults and those with cognitive impairment. Similar perceived barriers to VR have been noted in previous studies of health professionals [62, 69, 71–73], highlighting the importance of considering the eligibility and accessibility of different VR applications during their design and trial. Further research is needed to explore whether comparable views are held by patients themselves, or whether their perceptions toward VR interventions differ.

In this study, the most prominent barriers and enablers to using VR in a hospital setting perceived by health professionals were at the system and provider levels. The most cited barrier by health professionals was the perceived cost of VR technology. This finding aligns with previous research [55, 60, 62] and emphasises the importance of financial considerations for providers working in the public hospital sector. It is important to note that this study focused on perceptions of cost and did not quantify actual monetary resources available to participating staff. As more affordable, low-cost VR infrastructure continues

to become available, it may be interesting to explore whether providers' perceptions of cost change. Understanding the relative nature of up-front versus longer-term costs associated with VR applications may also warrant consideration. In a healthcare context, research suggests that high up-front costs may prohibit uptake of new VR technologies by providers [55, 86]; although longer-term cost savings may be experienced if VR applications can successfully be implemented [87, 88].

The portability and space required to operate VR technology were noted as important practical considerations for health professionals, whereby access to wireless VR hardware and dedicated treatment spaces within the hospital environment were identified as enablers. Health professionals also emphasized the importance of readily available and appropriate IT support to facilitate VR use, noting insufficient IT support as a major barrier within the hospital setting. These represent important considerations for public health services wanting to trial or implement VR applications within service delivery in future.

Our findings illustrate that health professionals' knowledge and perceived capability are likely key drivers of VR use. In keeping with previous research [53, 62, 63, 72], having insufficient technical knowledge or skill to operate VR was cited as a major barrier by two thirds of current participants. Providers' knowledge of relevant clinical evidence to guide practice also appeared to be salient; with clinical evidence summaries or guidelines noted to be enablers. Despite having limited awareness of existing research and concerns about the evidence-base, it was surprising to observe general support towards VR among participants, including the perception that VR would be routinely implemented in hospital settings within several years. This somewhat incongruous finding may reflect wider public enthusiasm towards novel technology such as VR, which has been observed via analyses of social media commentary previously [89]. Similar findings were also reported in a survey of staff working in private psychiatric hospitals, where staff rated the acceptability of VR highly despite having low levels of awareness and no prior experience of using VR therapeutically [73]. Together, these observations suggest there is strong public interest in VR which extends to the healthcare workforce and may be driven to a large extent by enthusiasm for the novel technology, as opposed to knowledge of its clinical effectiveness. Supporting health professionals to make evidence-informed decisions when implementing VR applications will be an important consideration moving forward, together with further research to enhance the empirical evidence-base for VR's efficacy and safety.

This study included a diverse population of allied health, medical and nursing professionals; noting the latter two groups are under-represented in VR research to date which has focused primarily on allied health perspectives [56, 59–62, 70]. We found that participants' professional discipline, years of clinical experience, age and gender did not appear to influence their perspectives on VR. However, participants' familiarity with VR was associated with their attitudes whereby those who were more familiar and/or aware of clinical VR applications reported stronger support for its use in hospital. This aligns with previous research where health professionals who had greater knowledge or prior experience with VR were found to report more positive attitudes and greater likelihood to use VR technology [56, 59, 60, 63]. Taken together, these findings suggest that supporting health professionals' knowledge, familiarity and awareness of new technologies like VR may influence their perceptions, level of support and likely intention to use such technology in future. VR education and familiarization could be embedded into training courses tailored for health professionals, given training was identified as the most prominent enabler of future VR use in the present study, and previously [62, 70, 72, 73].

Health professionals have an important role to play as potential adopters and implementers of novel technologies like VR. In line with previous studies, the enablers cited by health professionals here were multifactorial and spanned providers' capability, opportunity and motivation to use VR [53, 54, 62, 72]. This suggests multiple strategies will be required in future to support providers who wish to implement VR in a public hospital context, and may include targeted training, familiarization exercises, clinical evidence summaries, access to expert support and guidance, organizational support, review of hospital infrastructure and collaborative partnerships with VR specialists. Participants in the present study expressed a desire to learn about VR, although they had reservations about having the necessary time, resources and support to do so. Some clinicians also articulated concerns that VR technology may encroach on or hamper patient-provider relationships in healthcare. This observation highlights the importance of involving health care professionals throughout the development of clinical VR applications to ensure they enhance clinical care rather than detract from fundamental therapeutic relationships.

Limitations

This study used broad selection criteria to capture perspectives from a wide cross-section of the health care workforce. This resulted in an ecologically valid sample, however the degree of heterogeneity precluded detailed subgroup analyses. While this study included health professionals of varied disciplines, seniority levels and specialties which is a strength, the recruited sample was predominately comprised of younger females

(aged < 35 years). The perspectives of this group may not reflect those of the wider clinical workforce, however the sample demographically mirror the health workforce in Australia at large (known to be predominantly women aged 20–34 years) [90].

No prior knowledge or experience of VR was required to participate, though it is possible that selection bias influenced recruitment whereby health professionals with stronger interest and/or opinions about VR may have been more likely to complete the survey. It is also worth noting that this study was conducted at a single site, namely a metropolitan teaching hospital with strong academic affiliations. The results may not generalize to other hospital settings, particularly those in regional, remote or resource-limited areas. Further research to explore attitudes and perceived barriers to VR in different geographical and healthcare contexts, including community and primary care settings, may be warranted. In addition, research is needed to scope the views of other key stakeholder groups regarding VR implementation in public hospital settings, such as patient end-users, information technology personnel, infrastructure teams, work health and safety officials, hospital administrators, finance and executives.

Finally, the study survey was exploratory in nature and designed largely by consensus of the research team. Formal psychometric validation of the survey content was not undertaken, and thus the results must be interpreted as preliminary. Nuanced qualitative exploration of participant attitudes and/or perceptions underlying survey responses was not possible in this cross-sectional study, though may be informative to elucidate via interviews or focus groups in future.

Conclusions

Among multidisciplinary health care professionals working in a public hospital setting, levels of knowledge and prior experience with VR technology were low. Despite this, health professionals expressed largely positive attitudes towards VR and identified numerous educational and clinical activities where they believed VR would be of benefit; most prominently, for health professional education and training. Attitudes towards VR did not differ according to demography or clinical specialty, however those with greater familiarity with VR reported stronger support for its use. The most prominent perceived barriers to VR use were at the system and provider levels, including perceived cost, insufficient IT support, lack of technical knowledge, skill, and time pressures. Prominent enablers related to the knowledge and capability of health care providers, including training, designated IT support, clinical evidence summaries and access to suitable infrastructure within the hospital. Together these findings demonstrate interest in VR within the hospital workforce, though highlight the logistical, technical and capability barriers that remain for health care providers when considering the implementation of VR in public hospital settings. Further research is needed to expand the empirical evidence-base for VR and explore how targeted implementation strategies might support health professionals in future to utilize evidence-informed VR applications within their workflow.

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

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Authors' contributions

CS and SF conceived the study; CS, GC and SF contributed to study design; all authors (CS, GC, JMcG SF) contributed to development of the survey; CS and GC performed data collection and analysis; all authors (CS, GC, JMcG, SF) contributed to interpretation of the results; CS and GC contributed to drafting the manuscript; all authors critically reviewed and approved the final manuscript.

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Availability of data and materials

The data generated and analyzed in the current study are not publicly available due to institutional conditions of ethical approval. They are available from the authors upon reasonable request, and with permission of St Vincent's Hospital Sydney.

Declarations

Ethics approval and consent to participate

The study was reviewed and approved by the Human Research Ethics Committee of St Vincent's Hospital Sydney (2019/ETH00423). All participants provided informed consent to participate after reviewing a detailed study information sheet. Participants were advised in the Participant Information Sheet that completion and return of the survey was taken to indicate their consent to participate. The study was conducted in accordance with relevant ethical guidelines and in line with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details
[1]Department of Rehabilitation, St Vincent's Hospital Sydney, Sydney, NSW, Australia. [2]School of Clinical Medicine, University of New South Wales, Sydney, Australia. [3]University of Melbourne, Victoria, Australia. [4]Faculty of Arts, Design & Architecture, University of New South Wales, Sydney, Australia.

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