



## Using virtual reality in palliative care: a systematic integrative review

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Exploring the use of Virtual Reality in palliative care from patients,  
families, and healthcare professionals' perspective: a systematic  
integrative review.

[sj.mcilfatrick@ulster.ac.uk](mailto:sj.mcilfatrick@ulster.ac.uk)  
h.carmont@ulster.ac.uk

**Abstract**

**Background:** Recently, healthcare services have witnessed an exponential increase in the use of immersive and non-immersive virtual reality (VR) technology to improve health related outcomes. However, the use of VR in palliative care remains relatively unexplored.

**Aims:** To review and synthesise evidence regarding the experiences of patients, families and healthcare professionals in palliative care who have engaged with immersive/non-immersive VR technology.

**Methods:** A systematic integrative review using pre-defined MeSH search terms to identify eligible studies from five electronic databases (Cochrane Library, CINAHL, OVID Medline, Pubmed and Scopus) between April 2020 and February 2021.

**Findings:** In total, 1066 articles were reviewed, 55 articles were considered eligible and subject to further analysis, while a total of 16 articles met the inclusion criteria and were subject to critical appraisal. Rigorous analysis of eligible articles resulted in the identification of five overarching and interconnected themes: Connection, VR as an emergent technology, Perceptual change, Safety, and Future research.

**Conclusion:** This review identified that VR could support patients, families and healthcare professionals in palliative care. Due to the COVID-19 pandemic, the findings could prove particularly significant for facilitating connection. However, further research is necessary to explore the full scope of VR use in this speciality.

**Key words**

Virtual Reality, Healthcare Technology, Palliative Care, End of Life Care, Digital Health

**Key points**

TBA

**CPD reflective questions**

TBA

## Introduction

Globally, the use of immersive and virtual reality (VR) technology to improve health related outcomes has increased significantly in recent years (Aboalsamh et al, 2011; Li et al, 2011; Fernández-Aranda et al, 2012; Mirelman et al, 2013; Scapin et al, 2018; Martin and Lake, 2019; Stewart et al, 2019). Virtual reality is defined as ‘the use of computer technology to create a simulated environment’ (Department for Business, Energy and Industrial Strategy, 2020). Virtual reality technology is situated within the broader context of Digital Health (DH), which explores the increasing role of technology in healthcare provision (Mills, 2019). As digitisation becomes increasingly evident in numerous aspects of daily living, DH technology presents innovative opportunities for healthcare advancement, including the use of emergent technologies to improve patient outcomes and service delivery (Mills, 2019). Within palliative care, DH offers a unique opportunity for human connection and the prospect of enhanced quality of life (Mills, 2019). However, to ensure DH technology is used correctly within palliative care, further research and thoughtful consideration is required (Mills, 2019). Indeed, an expansive body of research supports the use of VR within healthcare, which has been associated with the alleviation of pain, anxiety and distress among burn patients, people with psychological conditions, including obsessive-compulsive disorder, post-traumatic stress disorder and attention deficit disorder, patients with heart failure, Parkinson’s disease, dementia and palliative care needs (Scapin et al, 2018; North and North, 2016; Stewart et al, 2019; Martin and Lake, 2019; Perna-Forrest, 2017; Perna-Forrest and Minton, 2019).

While research pertaining to VR use within palliative care has increased in recent years, a lack of evidence examining its use and impact remains (Perna-Forrest and Minton, 2019). To date, no integrative review has been conducted on the use and impact of VR in palliative care. Such information would be helpful to inform clinical practice not only for palliative care clinicians, but also patients and families, educators and health service managers, researchers and commercial companies interested in developing VR applications specific to end of life care. The aim of this integrative review was to appraise and synthesise the current evidence regarding the use of VR for patients, families and healthcare professionals.

### 1.1 Review Questions

Several review questions were developed. These included:

1. Could VR prove to be effective in symptom management for patients?
2. Could VR prove beneficial to family members experiencing emotional pain and feelings of grief?

3. Could VR enhance the healthcare professional's role in palliative care or improve training prospects within this specialism?

## 1.2 Search strategy

A comprehensive literature search was undertaken in April-May 2020 and February 2021, to ascertain the role of VR in palliative care and to identify a knowledge gap that future research could fulfil. Systematic integrative review guidelines by Whitemore and Knafl (2005) were followed to ensure continuity and rigour. A variety of databases were searched including Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINAHL), OVID Medline, Pubmed and Scopus. Key search terms were selected and utilised across all databases to ensure uniformity of results (Table 1.2.1). Truncation and boolean logic were applied to create various term combinations and to facilitate a comprehensive review of the literature (Robb and Shellenbarger, 2014; Grewal et al, 2016).

?	Virtual Reality/VR
?	Virtual technology
?	End of Life Care
?	Palliative Care
?	Palliati*
?	Death
?	Dying
?	Terminal illness
?	Terminally ill
?	Cancer

(Figure 1.2.1- Search terms)

## 1.3 Inclusion/Exclusion criteria

The formulation of inclusion and exclusion criteria enabled the researcher to appropriately assess eligibility (Meline, 2006; Cronin et al, 2008; Stern et al, 2014; Creswell and Creswell, 2018). The SPIDER tool was used for this purpose as it has been used extensively before and is considered a useful tool when assessing eligibility of studies. (Table 1.3.1) (Cooke et al, 2012).

	<b>Inclusion Criteria:</b>	<b>Exclusion Criteria:</b>
Sample	Adult participants/population	Paediatric participants/population
Phenomenon of Interest	Immersive and Non-Immersive Virtual Reality based research within advanced stages of illness/palliative care diagnoses.	Informatics research without an established virtual reality intervention OR Virtual reality usage among other patient populations (burns, psychological disorders, surgical rehabilitation etc.)
Design	All types of study designs	None

Evaluation	All types of health and other outcomes	None
Research type	Qualitative, Quantitative and Mixed Methods Studies AND Articles published from 1990 – 2020	Articles published before 1990 (excluded due to the technological rise of virtual reality from 1990 onwards)

Table 1.3.1 -SPIDER tool

#### 1.4 Screening

The initial literature search identified 1066 academic articles. The title and abstract of each paper were then reviewed against the inclusion and exclusion criteria to determine eligibility. However, while many articles had a focus upon improving outcomes for palliative care populations, few included the use of virtual reality to achieve this. Upon further analysis, 55 ( $n=55$ ) papers met the eligibility criteria and were appropriate for inclusion. EndNote X9 was used to manage data, identify duplicated sources and support further analysis. Following deduplication, 38 articles ( $n=38$ ) were incorporated into the next stage of the integrative review, an in-depth critical analysis.

#### 1.5 Critical analysis and appraisal

The full text version of all eligible articles were located using the University of Edinburgh and Ulster University online library services, or via individual journal websites. Several articles proved difficult to locate ( $n=6$ ) and were requested through an inter-library loan system. Four articles were successfully retrieved and included for critical analysis, two articles were irretrievable ( $n=2$ ), and thus excluded. Exactly 36 journal articles were read in entirety and analysed against the pre-determined inclusion and exclusion criteria for eligibility (Figure 1.3.1). Following this, 16 articles met the eligibility criteria and were included in the integrative review. A PRISMA diagram was utilised to guide the screening process and demonstrate transparency (Figure 1.5.1). While search, screening and selection was undertaken independently by one author (HC), any queries were discussed by the other members of the team.

Figure 1.5.1 – PRISMA Diagram

Eligible articles included qualitative, quantitative and mixed method studies. Due to the broad range of epistemological and methodological approaches identified through the relevant studies and to ensure that the integrative review process was suitably rigorous, critical appraisal tools were used. One reviewer (HC) independently appraised all papers prior to their inclusion in the review using suitably determined critical appraisal tools. Chosen critical appraisal tools included the Mixed Methods Appraisal Tool (MMAT) (2018); the Critical Appraisal Skills Programme (CASP) randomised controlled trial checklist (2018d), case-control study checklist (2018a), cohort study checklist (2018b) and qualitative study checklist (2018c), and the Joanna Briggs Institute Checklist for Quasi-Experiment/Non-Randomised experimental studies (2017). Following critical analysis, all articles were discussed and reviewed within the research team, and deemed to be appropriate for inclusion.

Please insert Table 1 here.

#### 1.6 Data analysis and synthesis

Following the critical appraisal of chosen articles, in-depth analysis and synthesis of eligible studies was conducted, to collate information and to understand the pre-existing knowledge base (Paré and Kitsiou, 2017). Content analysis was used to aid this process due its relevance, flexibility and applicability to both quantitative and qualitative studies, alongside the ability to identify key concepts, create codes and to identify emergent themes (Vaismoradi et al, 2016; Krippendorff, 2018; Luo, 2019). This resulted in 5 themes being identified.

## 1.7 Results

Sixteen studies underwent further analysis. The articles included qualitative ( $n=1$ ), quantitative ( $n=9$ ) and mixed method studies ( $n=6$ ). The focus of the research and participant population varied between articles also, nine focused upon the patient experience (Espinoza et al, 2012; Baños et al, 2013; Hoffman et al, 2014; Håkanson and Öhlén, 2014; Bani Mohammad and Ahmad, 2018; Johnson et al, 2020; Niki et al, 2019; Ferguson et al, 2020; Mackey et al, 2020), one on the family experience (Knowles et al, 2017) and six on the healthcare professional or student experience (Driver et al, 2004; Andrade et al, 2010; Tan et al, 2013; Lee et al, 2019; Sanborn et al, 2019; Taubert et al, 2019).

All studies were isolated to one geographical location and did not include intercontinental comparative studies. The United States of America (USA) were responsible for the highest proportion of studies ( $n=7$ ), (Andrade et al, 2010; Hoffman et al, 2014; Knowles et al, 2017; Johnson et al, 2019; Lee et al, 2019; Sanborn et al, 2019; Ferguson et al, 2020), three studies took place in the United Kingdom (UK) (Driver et al, 2004; Taubert et al, 2019; Mackey et al, 2020), two in Spain (Espinoza et al, 2012; Baños et al, 2013), and one each in Canada (Tan et al, 2013), Japan (Niki et al, 2019), Jordan (Bani Mohammad and Ahmad, 2018) and Sweden (Håkanson and Öhlén, 2014).

The majority of articles were based upon the results of feasibility, preliminary or pilot studies ( $n=11$ ), which demonstrated the infancy of VR use in palliative care while also emphasising its emergence within this specialist field of healthcare (Andrade et al, 2010; Espinoza et al, 2012; Baños et al, 2013; Tan et al, 2013; Knowles et al, 2017; Johnson et al, 2019; Lee et al, 2019; Sanborn et al, 2019; Taubert et al, 2019; Ferguson et al, 2020; Mackey et al, 2020). Only one article adopted a qualitative approach, with a phenomenological epistemology, which reiterated the need for further exploration into the lived experience of VR among palliative care populations and demonstrated a potential research gap (Håkanson and Öhlén, 2014).

**Please insert Table 2 here.**

It is recognised that advanced stages of disease and terminal illness are often associated with pain, cachexia, fatigue, anxiety and stress (Bani Mohammad and Ahmad, 2018; Niki et al, 2019). It was found that while VR has gained prevalence and incorporation into medicine, it is not frequently utilised within palliative care, though the ability to immerse oneself in a different environment could help to alleviate symptoms associated with palliation (Niki et al, 2019). While pharmacological sources of pain relief have proven to relieve pain and anxiety, side effects can include nausea, vomiting and drug dependency (Bani Mohammad and Ahmad, 2018). Complimentary therapies, including VR, offer the possibility for symptom relief with the reduced risk of harmful side effects (Bani Mohammad and Ahmad, 2018).

Six studies examined the propensity of VR for the purposes of symptom management. Study results demonstrated that immersive VR provided a sense of escapism and decreased symptoms attributed to terminal illness, including pain, anxiety and fatigue (Espinoza et al, 2012; Baños et al, 2013; Bani Mohammad and Ahmad, 2018; Niki et al, 2019; Ferguson et al, 2020; Johnson et al, 2020). Three studies explored the use of VR technology among patient

populations in alternative ways, including exercise tolerance and connection facilitation (Hoffman et al, 2014; Håkanson and Öhlén, 2014; Mackey et al, 2020).

Only one eligible study focused upon the familial experience, specifically widowers, to assess the role of VR within the grieving process (Knowles et al, 2017). The study design was based upon a comparison between a grief-based website and an online virtual experience. Study authors hypothesised that the virtual experience would prove to be more beneficial, yet this was only identified among depressive symptoms and not among other feelings typically associated with the grieving process. However, the transient nature of grief, the relatively small scale of the study and the discrepancy between the number of participants within the VR group ( $n=16$ ) and the grief website group ( $n=12$ ), could have affected the efficacy of results.

Six studies explored VR use among healthcare professionals and students (Driver et al, 2004; Andrade et al, 2010; Tan et al, 2013; Lee et al, 2019; Sanborn et al, 2019; Taubert et al, 2019). Two studies were based upon interprofessional collaboration (Lee et al, 2019; Sanborn et al, 2019), while two articles explored how a virtual environment could be used to increase familiarisation with palliative care, empathetic presence and effective communication (Andrade et al, 2010; Tan et al, 2013). One study sought to increase healthcare students' understanding of the lived experiences of palliative care through highlighting the potential side effects of cancer treatment, which included nausea and vomiting (Taubert et al, 2019) and another explored the use of virtual technology for tumour visualisation (Driver et al, 2004).

## **1.8 Theme development**

**Please insert Table 3 here.**

Throughout the course of the analysis of the eligible articles, the presence and emergence of themes was ever apparent. Various themes and subthemes were identified within the literature for each population group - see Table 3. On further review, areas of overlap were identified, which resulted in the identification of five overarching themes across all groups including Connection; VR as an emergent technology; Perceptual change; Safety and Future research prospects.

### **1.8.1 Theme One – Connection**

The theme 'connection' resulted from the cumulation of the subthemes 'connection' and 'person-centred care'. Connection is inherently linked to palliative care and is considered to be interdependent upon personhood, a person understanding themselves and their values (Håkanson and Öhlén, 2014). Person-centredness has an overarching emphasis upon knowing oneself and being able to successfully ascertain what elements of a person's lived experience are important to facilitate and maintain connection (Håkanson and Öhlén, 2014; McCormack and McCance, 2016).

Connection is considered to be a multidimensional concept (Håkanson and Öhlén, 2014) and thus, can elude to many elements including connection to emotion (Baños et al, 2013; Håkanson and Öhlén, 2014), to significant others (Hoffman et al, 2014; Håkanson and Öhlén, 2014; Knowles et al, 2017; Mackey et al, 2020), to nature (Baños et al, 2013) to feelings of familiarity or belonging (Håkanson and Öhlén, 2014), faith (Håkanson and Öhlén, 2014), nostalgic memories (Niki et al, 2019; Johnson et al, 2020; Mackey et al, 2020) or society (Håkanson and Öhlén, 2014; Mackey et al, 2020). It is important to consider the multiple ways in which VR can help to facilitate connection. Håkanson and Öhlén (2016) and Mackey et al

(2020) identified that VR can aid emotional connection, even when physical distance must be maintained; a revelation which arguably has proven to be even more relevant as a result of the COVID-19 pandemic and the encouragement of social distancing measures (Wang et al, 2020).

In order to understand the relevance of connection within palliative care, it is important to consider the adverse impact of disconnection. The progression of advanced disease and impending mortality can exacerbate disconnection through the onset of anticipatory grief, arguably at a time when support and connection is vital (Håkanson and Öhlén, 2014). Disconnection is common due to physical and emotional declination, while admittance to a palliative care facility has also been considered a contributory factor, due to the alienation from familiar surroundings (Håkanson and Öhlén, 2014). While temporary disconnection and anger are considered normal within the grieving process, prolonged disconnection adversely impacts quality of life (Knowles et al, 2017; Mackey et al, 2020). However, the integration of VR within palliative care settings could reduce disconnection considerably (Mackey et al, 2020).

### **1.8.2 Theme Two – VR as an emergent technology**

Virtual reality emergence was the most prevalent theme, covered in some aspect by each article. It was evident from the chosen literature that VR is a novel technology within palliative care, and it is being used in various ways. For example, this included both a complementary therapy for patients and families, and as an educational resource for healthcare professionals (Driver et al, 2004; Andrade et al, 2010; Espinoza et al, 2012; Baños et al, 2013; Tan et al, 2013; Knowles et al, 2017; Bani Mohammad and Ahmad, 2018; Johnson et al, 2019; Lee et al, 2019; Niki et al, 2019; Sanborn et al, 2019; Taubert et al, 2019; Ferguson et al, 2020; Mackey et al, 2020). This theme can be illustrated within four subthemes including symptom management, novel approach, flexibility, and barriers to usage.

VR is being increasingly used among palliative care populations for symptom management, including pain (Bani Mohammad and Ahmad, 2018; Niki et al, 2019; Johnson et al, 2020), emotional distress, depression and anxiety (Espinoza et al, 2012; Baños et al, 2013; Bani Mohammad and Ahmad, 2018; Niki et al, 2019; Johnson et al, 2020), fatigue (Johnson et al, 2020), shortness of breath (Johnson et al, 2020) and for the grieving process (Knowles et al, 2017). Furthermore, this innovative therapy has been praised as an alternative form of analgesia which can ease emotional distress alongside physical symptoms (Baños et al, 2013; Bani Mohammad and Ahmad, 2018; Ferguson et al, 2020).

Flexibility was demonstrated in two ways, through the ability to alter VR use to meet the needs of a specific population and through an expansive range of experiences which promoted individual choice. Study participants were availed through a variety of immersive experiences that included exploring Google Earth (Niki et al, 2019), scenes of nature (Espinoza et al, 2012; Baños et al, 2013; Ferguson et al, 2020), videocalls (Mackey et al, 2020), meditation, space exploration, theme parks and sea voyages (Bani Mohammad and Ahmad, 2018; Johnson et al, 2020). Non-immersive experiences included Nintendo Wii Fit (Hoffman et al, 2014) and video conferencing technology (Håkanson and Öhlén, 2014).

However, it is important to consider the barriers which could inhibit VR usage and uptake among palliative care populations. Such considerations will help identify the limitations of the technology and in turn identify solutions. Numerous studies reported discomfort and nausea while using immersive VR headsets (Baños et al, 2013; Bani Mohammad and Ahmad, 2018; Taubert et al, 2019; Ferguson et al, 2020; Johnson et al, 2020). Furthermore, the infancy and

subsequent unfamiliarity of VR use within palliative care settings occasionally resulted in technological difficulties and frustration (Tan et al, 2013). For example, Knowles et al (2017) recorded that one study participant declined to participate further in the study when technical difficulties were encountered. In relation to healthcare education, barriers included lack of personal interaction and the ability to respond to body language in comparison to in-person communication (Andrade et al, 2010; Lee et al, 2019; Sanborn et al, 2019). The use of virtual technology does not guarantee improved clinical outcomes and upon occasion, proved inhibitory to the learning experience (Driver et al, 2004; Sanborn et al, 2019).

### **1.8.3 Theme Three – Perceptual change**

Perceptual change was an unexpected emergent theme identified among healthcare professionals and students, which demonstrated the efficacy of VR use within education. Perceptual change was noted in two ways. Firstly, in relation to the healthcare professional's understanding of the patient experience and secondly, through enhanced interprofessional communication and effectual collaboration. Palliative care environments are considered to be highly emotive and require an empathetic presence and compassionate communication (Tan et al, 2013). However, the ability to provide exposure to medical students is placement dependent and largely sporadic (Tan et al, 2013). It was found that the use of immersive VR provided a unique opportunity for a wide range of healthcare students to encounter the patient experience and to engage with challenging circumstances in a safe learning environment (Tan et al, 2013; Lee et al, 2019; Sanborn et al, 2019; Taubert et al, 2019). This approach is considered to be innovative and compelling within palliative care education and an alternative way to gain experience in palliative care (Lee et al, 2019; Andrade et al, 2010; Tan et al, 2013). The use of VR technology encouraged teamwork and interprofessional collaboration, developed communication and interpersonal skills, and helped participants to challenge interprofessional biases (Lee et al, 2019; Sanborn et al, 2019). These are all important factors for the future development of palliative care practice and education.

### **1.8.4 Theme Four – Safety**

The importance of safety among healthcare professionals, namely students, was another prominent theme. The use of VR apps presented an opportunity for academic advancement without the fear of causing harm to another person, particularly when approaching emotive topics of conversation. Feelings of safety were expressed in several ways. These included the use of VR apps as a communicative buffer and the ability to express oneself through a virtual avatar (Andrade et al, 2010; Lee et al, 2019; Sanborn et al, 2019), the ability to broach tumultuous situations without the risk of negative consequences (Tan et al, 2013), the capacity to make mistakes without inflicting pain or harm (Sanborn et al, 2019) and the ability to learn how to communicate and collaborate in a sensitive and interprofessional manner (Lee et al, 2019; Sanborn et al, 2019).

### **1.8.5 Theme five – Call for Future Research**

Further research into the use of VR in palliative care was the second most prevalent theme and spanned across patient, family and healthcare professional populations (Driver et al, 2004; Andrade et al, 2010; Espinoza et al, 2012; Baños et al, 2013; Tan et al, 2013; Knowles et al, 2017; Bani Mohammad and Ahmad, 2018; Johnson et al, 2019; Lee et al, 2019; Niki et al, 2019; Taubert et al, 2019; Ferguson et al, 2020; Mackey et al, 2020). The recommendation for further exploration into the use of this innovative technology demonstrated the potential for uptake and use among appropriate participant populations. Furthermore, as almost 69% of eligible articles were based upon preliminary, pilot or feasibility studies, the request for

further exploration is both self-explanatory and necessary if familiarity of VR is to increase (Andrade et al, 2010; Espinoza et al, 2012; Baños et al, 2013; Tan et al, 2013; Knowles et al, 2017; Johnson et al, 2019; Lee et al, 2019; Sanborn et al, 2019; Taubert et al, 2019; Ferguson et al, 2020; Mackey et al, 2020).

Recommendations for further research included exploring the impact of regular VR use upon symptom management and pain control (Baños et al, 2013; Niki et al, 2019; Johnson et al, 2020), investigating VR use among vulnerable societal groups (Ferguson et al, 2020), exploring the scope for VR use within palliative care (Mackey et al, 2020), assessing the impact which VR applications could have on mental wellbeing (Baños et al, 2013) and comparing VR usage against other complementary therapies (Bani Mohammad and Ahmad, 2018). Further qualitative exploration into the lived patient experience and the long term impact of VR use on pain and anxiety was also suggested (Bani Mohammad and Ahmad, 2018). Further research recommendations among healthcare professionals and student populations included exploring various modes of VR in order to identify those which could maximise educational outcomes (Tan et al, 2013), expanding the remit of VR use within palliative care (Taubert et al, 2019) and identifying how it could be used to improve communication in difficult circumstances (Andrade et al, 2010). Several common recommendations transcended across all participant groups, including the need to conduct larger scale studies and incorporate control groups and heterogenous sampling (Driver et al, 2004; Andrade et al, 2010; Espinoza et al, 2012; Baños et al, 2013; Knowles et al, 2017; Lee et al, 2019; Niki et al, 2019; Johnson et al, 2020), as well as determine whether the effects of VR applications are transient or sustainable (Tan et al, 2013; Niki et al, 2019).

## **1.9 Discussion**

The review of the current literature demonstrated the positive use which VR has within palliative care and provides direction for future research. The versatility of virtual technology is evident through its use among patient, family and healthcare professional populations. For patients, symptom management and connection during the palliative phase of life is paramount. While physical proximity from significant others could be restrictive due to immunosuppression, social isolation or through personal choice, VR represented an unconventional way to re-establish connection. For family members experiencing anticipatory or imminent grief, virtual technology enabled connection to others experiencing similar circumstances and provided resources to help participants to understand grief. For healthcare professionals, VR imagery enhanced the visualisation of tumour markers and improved the targeting of palliative lung radiotherapy (Driver et al, 2004). In addition, healthcare students learnt how multidisciplinary collaboration and communication aid in the pursuit of optimum patient outcomes within palliative care (Lee et al, 2019; Sanborn et al, 2019).

Evidently, VR could be considered a valuable resource within healthcare. In reference to the research questions outlined in section 2.1, VR shows promise as a prospective, nonpharmacological analgesic and has been attributed to the successful management of pain and anxiety symptoms among patients (Espinoza et al, 2012; Baños et al, 2013; Bani Mohammad and Ahmad, 2018; Niki et al, 2019; Johnson et al, 2020). While research surrounding VR use among family members was sparse and requires further investigation, the use of both a virtual interactive platform and a grief intervention website helped widowers during the grieving process (Knowles et al, 2017). Finally, VR appeared to significantly enhance the role of the healthcare professional and student, both in terms of

providing targeted treatment (Driver et al, 2004), insight into the patient experience and enhanced training prospects (Tan et al, 2013; Lee et al, 2019; Sanborn et al, 2019; Taubert et al, 2019).

### **1.9.1 Strengths and Limitations**

Strengths of this integrative review include the use of multiple healthcare databases to locate the appropriate literature, a rigorous analytical and critical appraisal process and the use of content analysis to identify emergent themes. Eligible studies featured a broad scope of participant groups and successfully demonstrated the flexibility which can be used with VR technology to create meaningful experiences.

However, the limitations of this review deserve consideration in order to guide new research and it is important to consider how the infancy of VR use within healthcare could potentially affect study outcomes. Despite a rigorous database search, there is a possibility that new, applicable studies were omitted. Nine of the eligible studies were based upon one virtual reality session only (Driver et al, 2004; Andrade et al, 2010; Bani Mohammad and Ahmad, 2018; Johnson et al, 2019; Lee et al, 2019; Niki et al, 2019; Taubert et al, 2019; Ferguson et al, 2020; Mackey et al, 2020) and there are queries concerning whether VR use has a transient or sustainable impact with long term engagement (Niki et al, 2019). Therefore, it is questionable whether single interventions or short-term studies effectively demonstrate the efficacy of VR interventions. Furthermore, in studies which featured a range of VR sessions, there were recurrent incidences of participant dropout (Espinoza et al, 2012; Baños et al, 2013; Håkanson and Öhlén, 2014), thus rendering it difficult to determine if sustained VR sessions were beneficial.

### **1.9.2 Research implications**

To the researchers' knowledge, this is the first comprehensive literature review conducted in the use of virtual reality applications among multiple populations within palliative care. This helps to guide the direction of future research. As a result of this integrative review, it has been established that further research is required in a broad range of areas. This is further reiterated through the number of preliminary and pilot studies that have been conducted. Almost 69% of articles were based upon the findings of preliminary, pilot and feasibility studies, which further emphasises the infancy of VR use within palliative settings. This integrative review strengthens the rationale of further exploration and could advocate for the use of VR within palliative care settings.

### **1.10 Conclusion**

This integrative review has provided an analysis of the current evidence surrounding virtual reality, demonstrated the potential relevance of VR use within palliative care settings and reiterated the need for further exploration. With future research, it would be possible to determine the extent of VR efficacy among patients, families and healthcare professional populations in such settings. For patients, further exploration of the use of VR as a viable complementary or alternative therapy is required, alongside the comparison of occasional and regular VR engagement on symptom management. VR has a potential role in the delivery of new models of care than can impact palliative care in the future. For patients and families, VR was noted to facilitate connection, which during the COVID-19 pandemic has proven to be particularly relevant when social distancing must be maintained to protect vulnerable societal groups. For healthcare professionals, VR provided a unique insight into the lived experiences of a person receiving palliative care and reiterated the need for compassionate and

empathetic presences throughout their experience, particularly during their difficult moments.

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## Table 1

## Appendix B – Critical appraisal of selected studies:

Critical Appraisal Skills Programme (CASP) Checklist for Qualitative Studies:

Study Authors:	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10
Håkanson and Öhlén (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	This study reiterates the integral importance of connection during end of life care. Future research opportunities identified.

Questions:

Q.1: Was there a clear statement of the aims of the research?

Q.2: Is the qualitative methodology appropriate?

Q.3: Was the research design appropriate to address the aims of the research?

Q.4: Was the recruitment strategy appropriate to the aims of the research?

Q.5: Was the data collected in a way that addressed the research issue?

Q.6: Has the relationship between researcher and participants been adequately considered?

Q.7: Have ethical issues been taken into consideration?

Q.8: Was the data analysis sufficiently rigorous?

Q.9: Is there a clear statement of findings?

Q.10: How valuable is the research?

CASP Checklist for Randomised Controlled Trials:

Study Authors:	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	Q.11
Mohammad and Ahmad (2018)	Yes	Yes	Yes	No	Yes	Yes	Sig*	P-value <0.001 for intervention and control groups for anxiety and pain	Yes	No	Yes

\*significant effect

Questions:

Q.1: Did the trial address a clearly focused issue?

Q.2: Was the assignment of patients to treatments randomised?

Q.3: Were all of the patients who entered the trial properly accounted for at its conclusion?

Q.4: Were patients, health workers and study personnel 'blind' to treatment?

Q.5: Were the groups similar at the start of the trial?

Q.6: Aside from the experimental intervention, were the groups treated equally?

Q.7: How large was the treatment effect?

Q.8: How precise was the estimate of the treatment effect?

Q.9: Can the results be applied to the local population, or in your context?

Q.10: Were all clinically important outcomes considered?

Q.11: Are the benefits worth the harms and costs?

CASP Checklist for Cohort Studies:

Study Authors:	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	Q.11	Q.12
Hoffman et al (2014)	Yes	Yes	Yes	Yes	a)Yes b)Yes	a)Yes b)Yes	See be- low	See be- low	Yes	Yes	Yes	See be- low

Q.7: 88% adherence rate- exercise tolerance @ week one- 48.7% /exercise tolerance @ week sixteen- 93%

Q.8: Results subjective to participant's experience and perceived self-efficacy. No confidence intervals noted. Substantial risk of bias.

Q.12: Study researchers concluded that the use of a virtual reality rehabilitation programme at home was beneficial for both the physical and emotional recovery of patients post-thoracotomy.

Questions:

Q.1: Did the study address a clearly focused issue?

Q.2: Was the cohort recruited in an acceptable way?

Q.3: Was the exposure accurately measured to minimise bias?

Q.4: Was the outcome accurately measured to minimise bias?

Q.5: a) Have the authors identified all important confounding factors?

b) Have they taken account of the confounding factors in the design and/or analysis?

Q.6: a) Was the follow up of subjects complete enough?

b) Was the follow up of subjects long enough?

Q.7: What are the results of this study?

Q.8: How precise are the results?

Q.9: Do you believe the results?

Q.10: Can the results be applied to the local population?

Q.11: Do the results of the study fit with other available evidence?

Q.12: What are the implications of this study for practice?

CASP Checklist for Case Control Studies:

Study Authors:	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	Q.11
Driver et al (2004)	Yes	Yes	Can't tell	Yes	Yes	a)Yes b)Can't tell	Sig*	Precise	Yes	Yes	Can't tell
Knowles et al (2017)	Yes	Yes	Can't tell	No	Yes	a)Yes b)Yes	Min**	Imprecise	No	Can't Tell	Can't tell

\*Significant

\*\*Minimal

Questions:

Q.1: Did the study address a clearly focused issue?

Q.2: Did the authors use an appropriate method to answer their question?

Q.3: Were the cases recruited in an acceptable way?

Q.4: Were the controls selected in an acceptable way?

Q.5: Was the exposure accurately measured to minimise bias?

Q.6: a) Aside from the experimental intervention, were the groups treated equally?

b) Have the authors taken account of the potential confounding factors in the design and/or in their analysis?

Q.7: How large was the treatment effect?

Q.8: How precise was the estimate of the treatment effect?

Q.9: Do you believe the results?

Q.10: Can the results help locally?

Q.11: Do the results of this study fit with other available evidence?

The Joanne Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies):

<b>Study Authors:</b>	<b>Q.1</b>	<b>Q.2</b>	<b>Q.3</b>	<b>Q.4</b>	<b>Q.5</b>	<b>Q.6</b>	<b>Q.7</b>	<b>Q.8</b>	<b>Q.9</b>
Andrade et al (2010)	Yes	N/A*	N/A	No	Yes	Yes	N/A	Yes	Yes
Espinoza et al (2012)	Yes	N/A	No	No	Yes	Yes	N/A	Yes	Yes
Mackey, Bremner and Giuliani (2020)	Yes	Yes	Yes	Yes	N/A	Unclear	Yes	Yes	Yes
Niki et al (2019)	Yes	N/A	No	No	Yes	Yes	No	Yes	Yes

\*Non-applicable

Questions:

Q.1: Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?

Q.2: Were the participants included in any comparisons similar?

Q.3: Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?

Q.4: Was there a control group?

Q.5: Were there multiple measurements of the outcome both pre and post the intervention/exposure

Q.6: Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?

Q.7: Were the outcomes of participants included in any comparisons measured in the same way?

Q.8: Were outcomes measured in a reliable way?

Q.9: Was appropriate statistical analysis used?

Mixed Methods Appraisal Tool (MMAT), version 2018:

Study Authors:	SQ.1	SQ.2	Q.1.1	Q1.2	Q.1.3	Q.1.4	Q.1.5
Baños et al (2012)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ferguson et al (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Johnson et al (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lee et al (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sanborn et al (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tan et al (2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Taubert et al (2019)	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes
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#### Screening Questions:

SQ.1: Are there clear research questions?

SQ.2: Do the collected data allow to address the research questions?

#### 1. Qualitative Questions:

Q.1.1: Is the qualitative approach appropriate to answer the research question?

Q.1.2: Are the qualitative data collection methods adequate to address the research question?

Q.1.3: Are the findings adequately derived from the data?

Q.1.4: Is the interpretation of results sufficiently substantiated by data?

Q.1.5: Is there coherence between qualitative data sources, collection, analysis and interpretation?

Study Authors:	Q.3.1	Q.3.2	Q.3.3	Q.3.4	Q.3.5	Q.5.1	Q.5.2	Q.5.3	Q.5.4	Q.5.5
Baños et al (2012)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ferguson et al (2020)	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Johnson et al (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Lee et al (2019)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes
Sanborn et al (2019)	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tan et al (2013)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes
Taubert et al (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

### 3. Quantitative non-randomized Questions:

Q.3.1: Are the participants representative of the target population?

Q.3.2: Are measurements appropriate regarding both the outcome and intervention (or exposure)?

Q.3.3: Are there complete outcome data?

Q.3.4: Are the confounders accounted for in the design and analysis?

Q.3.5: During the study period, is the intervention administered (or exposure occurred) as intended?

### 5. Mixed Methods Questions:

Q.5.1: Is there an adequate rationale for using a mixed methods design to address the research question?

Q.5.2: Are the different components of the study effectively integrated to answer the research question?

Q.5.3: Are the outputs of the integration of qualitative and quantitative components adequately interpreted?

Q.5.4: Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?

Q.5.5: Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?

**Table 2: Study Breakdown**

<b>Author(s)</b>	<b>Number of participants (n)</b>	<b>Study Location</b>	<b>Study Aims/Population</b>	<b>Study type</b>	<b>Duration of intervention</b>
Andrade et al (2010)	10	USA	To assess whether the use of virtual reality (via avatar interaction) could enhance the communicative abilities of medical students when breaking bad news.	Quantitative-feasibility study	One VR session
Baños et al (2013)	19	Spain	To explore the use of immersive VR to promote feelings of joy and relaxation among patients with advanced cancer.	Mixed methods-pilot/feasibility study	One – four VR sessions (dependent upon individual participant circumstances)
Driver et al (2004)	10	UK	To determine if virtual simulation could enhance tumour visualisation among medical staff during treatment of palliative lung radiotherapy.	Quantitative-case-control study	One virtual simulation session (reviewed independently by one registrar and one consultant)
Espinoza et al (2012)	33	Spain	To assess the efficacy of VR use to promote	Quantitative-feasibility study	One- four VR sessions

			feelings of joy and relaxation among oncology patients.		(dependent upon individual participant circumstances)
Ferguson et al (2020)	25	USA	To determine the efficacy of VR use among hospice patients living with dementia.	Mixed methods-feasibility study with semi-structured interviews	One VR session
Håkanson and Öhlén (2016)	9	Sweden	To explore the significance of connection and ways to maintain this during End-of-Life care.	Qualitative-phenomenological approach	One – six sessions (dependent upon individual participant circumstances)
Hoffman et al (2014)	7	USA	To determine whether the use of virtual reality technology can improve exercise tolerance among post-thoracotomy patients.	Quantitative-single arm study	Sixteen-week study
Johnson et al (2019)	12	USA	To assess the efficacy of VR use for symptom management among palliative care patients.	Mixed methods-prospective, multi-centre, single arm study	One VR session
Knowles et al (2017)	30	USA	To determine whether VR and the use of online avatars could promote feelings of inclusion and help widowers to process feelings of grief in comparison to an online grief website	Quantitative-pilot/case-control study	Eight-week study

			without a VR component.		
Lee et al (2019)	35	USA	To determine whether VR technology could promote interprofessional collaboration among healthcare students within a palliative care context.	Mixed methods-feasibility/acceptability study	One session
Mackey, Bremner and Giuliani (2020)	26 (study conducted with 13 pairs)	UK	<p>To assess whether immersive VR and the use of robotics could facilitate connection and enhance communication between palliative care patients and their families in comparison to non-immersive virtual reality technology.</p> <p>*This study is based upon a preliminary study conducted among a cohort of university staff and students prior to clinical conduction.</p>	Quantitative-preliminary study	One session
Mohammad and Ahmad (2018)	80	Jordan	To determine whether the use of VR could reduce pain and anxiety among patients with breast cancer.	Quantitative-randomised controlled trial	One session
Niki et al (2019)	20	Japan	To determine if the use of VR	Quantitative-prospective,	One session

			could reduce adverse effects and symptoms among palliative care patients.	multicentre, single arm study	
Sanborn et al (2019)	34	USA	To examine whether virtual simulation could enhance interprofessional communication among healthcare students.	Mixed methods-feasibility study	Six-week study
Tan et al (2013)	137	Canada	To determine if a virtual patient case study could provide medical students with the appropriate insight into End-of-Life care and promote empathetic communication when breaking bad news.	Mixed methods-feasibility study	Eight-week study
Taubert et al (2019)	72	UK	To assess the feasibility of using immersive VR to enhance medical students' perceptions of palliative care.	Mixed methods-pilot study	One session

**Table 3 – Themes & subthemes**

<b>Author(s)</b>	<b>Participant population:</b>	<b>Emergent Subthemes:</b>	<b>Emergent Themes:</b>
Andrade et al (2010)	Medical students	<ul style="list-style-type: none"> <li>- Educational/professional development</li> <li>- Feelings related to security/safety through avatar usage</li> <li>- Novel approach</li> <li>- Barriers to usage</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Perceptual change</li> <li>- Safety</li> <li>- Future research</li> </ul>

		<ul style="list-style-type: none"> <li>- Further research required</li> </ul>	
Baños et al (2013)	Patients	<ul style="list-style-type: none"> <li>- Connection</li> <li>- Symptom management</li> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Barriers to usage</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- Connection</li> <li>- VR emergence</li> <li>- Future research</li> </ul>
Driver et al (2004)	Medical staff	<ul style="list-style-type: none"> <li>- Novel approach</li> <li>- Barriers to usage</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Future research</li> </ul>
Espinoza et al (2012)	Patients	<ul style="list-style-type: none"> <li>- Symptom management</li> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Future research</li> </ul>
Ferguson et al (2020)	Patients	<ul style="list-style-type: none"> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Barriers to usage</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Future research</li> </ul>
Håkanson and Öhlén (2016)	Patients	<ul style="list-style-type: none"> <li>- Connection</li> <li>- Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>- Connection</li> <li>- VR emergence</li> </ul>
Hoffman et al (2014)	Patients	<ul style="list-style-type: none"> <li>- Connection</li> <li>- Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>- Connection</li> <li>- VR emergence</li> </ul>
Johnson et al (2019)	Patients	<ul style="list-style-type: none"> <li>- Connection</li> <li>- Symptom management</li> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Barriers to usage</li> <li>- Person-centred care</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- Connection</li> <li>- VR emergence</li> <li>- Future research</li> </ul>
Knowles et al (2017)	Family	<ul style="list-style-type: none"> <li>- Connection</li> <li>- Symptom management</li> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Barriers to usage</li> <li>- Person-centred care</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- Connection</li> <li>- VR emergence</li> <li>- Future research</li> </ul>
Lee et al (2019)	Healthcare students	<ul style="list-style-type: none"> <li>- Educational/professional development</li> <li>- Feelings related to security/safety through avatar usage</li> <li>- Novel approach</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Perceptual change</li> <li>- Future research</li> </ul>

		<ul style="list-style-type: none"> <li>- Teamwork/collaboration</li> <li>- Flexibility</li> <li>- Perceptual change</li> <li>- Barriers to usage</li> <li>- Further research required</li> </ul>	
Mackey, Bremner and Giuliani (2020)	University staff and students	<ul style="list-style-type: none"> <li>- Connection</li> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- Connection</li> <li>- VR emergence</li> <li>- Future research</li> </ul>
Mohammad and Ahmad (2018)	Patients	<ul style="list-style-type: none"> <li>- Symptom management</li> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Barriers to usage</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Future research</li> </ul>
Niki et al (2019)	Patients	<ul style="list-style-type: none"> <li>- Connection</li> <li>- Symptom management</li> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- Connection</li> <li>- VR emergence</li> <li>- Future research</li> </ul>
Sanborn et al (2019)	Healthcare students	<ul style="list-style-type: none"> <li>- Educational/professional development</li> <li>- Feelings related to security/safety through avatar usage</li> <li>- Novel approach</li> <li>- Teamwork/collaboration</li> <li>- Flexibility</li> <li>- Perceptual change</li> <li>- Barriers to usage</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Perceptual change</li> <li>- Safety</li> </ul>
Tan et al (2013)	Medical students	<ul style="list-style-type: none"> <li>- Educational/professional development</li> <li>- Virtual simulated scenarios used to improve communication</li> <li>- Novel approach</li> <li>- Flexibility</li> <li>- Perceptual change</li> <li>- Barriers to usage</li> <li>- Further research required</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Perceptual change</li> <li>- Safety</li> <li>- Future research</li> </ul>
Taubert et al (2019)	Medical students	<ul style="list-style-type: none"> <li>- Educational/professional development</li> <li>- Novel approach</li> <li>- Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>- VR emergence</li> <li>- Perceptual change</li> <li>- Future research</li> </ul>

		<ul style="list-style-type: none"> <li>- Perceptual change</li> <li>- Barriers to usage</li> <li>- Further research required</li> </ul>	
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