

Review Article

Immersive horizons: navigating ethical terrain and practical boundaries in the use of virtual reality for cancer symptom management - a comprehensive narrative review

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ABSTRACT

Cancer is a significant healthcare problem. However, advancements in diagnostic procedures and therapeutic modalities have led to a decline in cancer mortality rates by 1% annually in most countries. Cancer patients often experience symptoms such as pain, cancer-related fatigue, anxiety, and lymphedema. To counter these side effects, there have been tremendous efforts. One such effort is the use of virtual reality (VR) technology, which is an interactive technology. VR has played a significant role in managing disorders such as phobias and anxiety disorders, and support for patients with cognitive and physical rehabilitation, acute and chronic pain management, and emotional support in different settings such as during hospitalizations. Our team conducted an extensive search for electronic literature on virtual reality in various databases, such as Medline, PubMed, Google Scholar, and Psych INFO, up to July 2023. We used keywords like "virtual reality," "cancer care," "depression," "cognition," "pain," "telemedicine," "rehabilitation care," "physical therapy," "radiotherapy," "telerehabilitation," "avatar," "video games," and "visual aid" as our search criteria. VR interventions for cancer patients include exposure therapy, psycho-education, and relaxation techniques, which have been shown to reduce symptoms significantly. VR distraction can also mitigate pain during medical procedures. Studies suggest that VR holds promise in rehabilitation and oncologic treatment, as it can improve function metrics, range of motion, and motivation for treatment. The review scrutinizes the use of digital information and virtual reality technology to alleviate cancer-related distress by providing remote care.

Keywords: Virtual reality, Cancer care, Rehabilitation therapy, Cancer-related fatigue, Pain

INTRODUCTION

With a staggering 19.3 million new cases worldwide in just 2020, cancer has become a leading healthcare problem, with projections of new cases rising to 28.4 million by 2040.¹ On the contrary, cancer mortality rates have been declining by 1% per year, in most countries and for both sexes due to advancements in diagnostic procedures and therapeutic modalities.² As a result, the number of cancer survivors is rising rapidly and can reach 26.1 million people in the US in 2040.³ However, these cancer survivors have to deal with frequent follow-ups and hospitalizations as they are subjected to treatments that can cause various symptoms and other psychological issues.⁴

One of the most common symptoms cancer survivors' experiences is pain, with the prevalence of cancer-related pain (CRP) ranging from 39.3% in patients after curative treatment to 55% in patients on anticancer treatments, which significantly increases to 71% in patients with advanced or metastatic cancer.^{5,6} Moreover, up to half of such patients do not receive adequate pain management which poses difficulty with cancer management and may lead to health deterioration.^{7,8} Anxiety, which could be the result of cancer diagnosis, severe pain, long-term treatment, or treatment's side effects, also has detrimental consequences that lead to delays in the improvement of a patient's health and prolong the length of hospital stay.^{9,10} Cancer-related fatigue (CRF), with a varied prevalence depending on the type of cancer, treatment, and age, is another extremely common symptom in cancer patients.¹¹ Another common symptom cancer patients have to endure is lymphedema, secondary to surgical removal of lymph nodes, radiation and/or chemotherapy, or a combination of such.¹² An important side effect of chemotherapy is chemotherapy-induced peripheral neuropathy (CIPN), which encompasses different types of nerve damage depending on the exact chemical compound.¹³

To counter these side effects, there have been tremendous efforts in managing cancer-related symptoms with relaxation techniques such as yoga, acupuncture, massage, biofeedback, acupressure, hypnosis, transcutaneous electrical nerve stimulation, and distraction.¹⁴ However, this can become mundane for the patients due to its repetitiveness and thus, can lead to loss of interest and motivation.¹⁵ With rapid advancements in technologies, more ways to combat symptoms and rehabilitation of cancer patients are being studied, the newest of which is virtual reality (VR), which has shown great potential in managing cancer-related symptoms.^{14,15}

VR technology - an interactive technology having three dimensions of width, height, and depth generated in a digital environment is used as a form of distraction.¹⁶ VR systems are categorized into two types, immersive and non-immersive. Immersive VR is characterized by full immersion, which is reached by a head-mounted display, distracting the patient by presenting them with a view of a computer-generated world instead of the real world. The

non-immersive type is characterized by a computer screen where the user can communicate with the external world at the same time he is connected to the virtual world.¹⁷

VR has played an extensive role in the management of disorders such as phobias and anxiety disorders, cognitive and physical rehabilitation, acute and chronic pain management, and support for patients with cancer in different settings such as during hospitalizations, to name a few. This technology has been widely successful due to extensive personalization, the safety of simulated environments, and increased patient motivation and engagement.¹⁸ In this study, we discuss the importance of VR technology in relieving cancer patients' distress and increasing chemotherapy compliance, which in turn, improves quality of life and increases patient survival.

METHODS

Our team conducted an extensive search for electronic literature on virtual reality in various databases, such as Medline, PubMed, Google Scholar, and Psych INFO, up to July 2023. We used keywords like "virtual reality," "cancer care," "depression," "cognition," "pain," "telemedicine," "rehabilitation care," "physical therapy," "radiotherapy," "telerehabilitation," "avatar," "video games," and "visual aid" as our search criteria. The first author carried out independent research, while the first and second authors assessed the titles, abstracts, and reference lists based on specific eligibility criteria. To be included, studies had to meet specific PICO criteria, such as having a population with cancer, being a clinical trial or RCT study on virtual reality, or a review article on virtual reality. Furthermore, all the selected studies were published in English, and we excluded any studies involving populations without any cancer history. Figure 1 presents the selection process in the form of a PRISMA flowchart.

RESULTS

Researchers have been exploring the potential benefits of VR in cancer care, VR has shown promise in providing immediate relief through palliative care and long-term support through life-long counseling options. Additionally, researchers are testing whether VR can enhance postoperative upper limb rehabilitation outcomes by optimizing motor skill acquisition following surgery. Studies have shown that immersing cancer patients in virtual reality settings can significantly alleviate mental anguish, dread, and anxiety responses. It has also been observed to bolster cognitive faculties and physical resilience while offering tailored treatment platforms. Data suggests that pediatric malignancy sufferers participating in chemical medication-backing treatments experience an upgrade in physical capacity, improved living standards, and reduced anxiety levels with VR. This research emphasizes the effectiveness of virtual reality therapy, particularly in younger cancer patients. It also suggests using VR during conscious patient brain tumor surgery for

brain mapping and cognitive tests. Recent investigations suggest a framework that describes five different methods to use VR for visualizing cognitive abilities during operating procedures. Therefore, recommended assignments and fields aim to close this gap by providing an expansive analysis of cognitive performance during

alert neurosurgery. Integrating virtual reality into cancer care can significantly improve patients' emotional state. However, further research is needed to appreciate virtual reality's potential gains and drawbacks for cancer treatment.

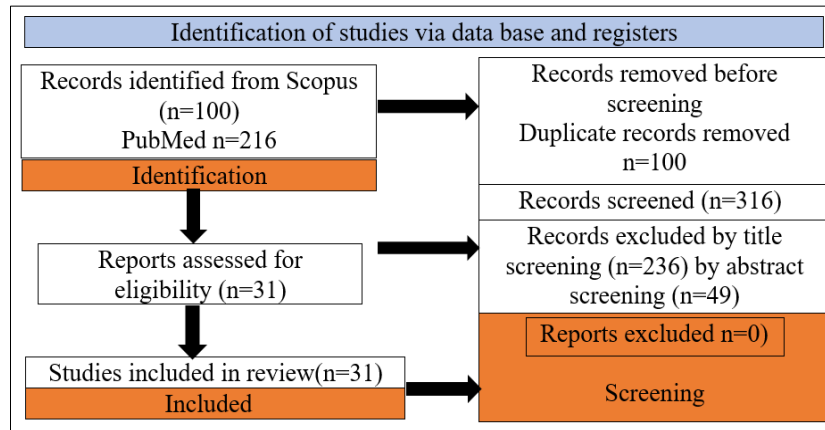


Figure 1: PRISMA flowchart of the study selection.

DISCUSSION

Interventions utilizing virtual reality in cancer care

VR technology has shown the potential to effectively manage chemotherapy-related distress, anxiety, depression, fatigue, and pain in cancer care. Studies have shown that immersive VR experiences like ocean rifts or beach settings can divert attention away from pain and induce positive emotions to alleviate pain and anxiety.¹⁹ VR interventions for anxiety and depression in cancer patients include exposure therapy, psycho-education, and relaxation techniques, significantly reducing symptoms. VR distraction can mitigate pain during medical procedures and burn injury care, complementing traditional pharmacotherapies and reducing procedural pain.²⁰ Digital health technologies (DHT) are revolutionizing healthcare delivery by providing accessible and informed cancer screening, patient education, promotion of healthy behaviors, patient symptom monitoring and intervention, psychological care, and survivorship care. DHT platforms like smartphones, wearables, and chatbots provide tailored cancer education, real-time tracking, and personalized interventions. Continuous monitoring of patient-reported outcomes (PROs) via DHT improves cancer treatment outcomes by detecting warning signs. VR technology and AI-powered chatbots provide remote psychological support. Telemedicine and virtual visits offer patient education, follow-up, and caregiver support. Nurse-led phone follow-up and telehealth platforms provide psychological support and information to caregivers.²¹ VR interventions have shown great potential in reducing pain, anxiety, and depressive symptoms among cancer patients, specifically in pediatric and adult populations.^{22,23} VR technology, alongside standard care, has effectively reduced pain and anxiety associated with procedures such as port access and

lumbar punctures in children and adolescents.^{21,22}

Additionally, VR interventions combined with standard care have been more effective in reducing pain and anxiety during anti-cancer treatments and hospitalization in adults and elderly patients. While there is a lack of evidence regarding VR's effectiveness during painful procedures for this age group, previous research highlights VR's power in managing anxiety, time perception, pain, fatigue, and depression severity. Studies suggest that VR can trigger physiological responses, such as blood pressure, heart rate reductions, and increased oxygen levels. Moreover, immersive VR interventions have demonstrated statistically significant decreases in distress-related heart rate and bio-physiological parameters.²⁴⁻²⁶ Furthermore, VR interventions utilizing commercially available technology are acceptable and feasible in clinical settings, with patients reporting high satisfaction. Therefore, VR technology can be considered an effective intervention for pain and anxiety management in cancer care, potentially enhancing patient well-being and addressing psychosocial challenges associated with cancer treatment.

Benefits of virtual reality in cancer care

VR technology has proven to be an effective and safe non-pharmacological method for reducing anxiety, fatigue, depression, and pain among cancer patients, particularly those undergoing chemotherapy.²⁷ Various studies have highlighted the benefits of VR interventions in cancer care, such as enhancing the management of anxiety, depression, and cancer-related fatigue, mitigating pain perception during medical procedures, improving patient well-being, adherence to treatment protocols and emotional support, in improving the mood changes of cancer patients during chemotherapy treatment, and positively impacting

psychological and physical outcomes.^{19,20,26,28-30} Immersive and interactive VR interventions have been found to significantly reduce anxiety and negative mood states, with a more significant reduction in fatigue levels than mindfulness training and increased upper limb mobility, specifically for breast cancer patients undergoing chemotherapy.^{15,19,31} VR distractions have also reduced pain during medical procedures and burn injury care.^{20,21} All participants positively received the introduction of VR intervention in a pediatric oncology ward, and it was easily feasible using available technology. This approach, when compared to pharmacological pain management, demonstrates the growing evidence for VR's effectiveness in medical procedures within oncology contexts. Patients, particularly adolescents, have shown a strong inclination to use VR distraction during future procedures like chemotherapy and lumbar punctures, highlighting its potential as a preferred alternative to conventional care methods.^{22,23} Various studies suggest that VR holds promise in rehabilitation and oncologic treatment, as it can improve function metrics, range of motion, and motivation for treatment.

Virtual reality interventions have demonstrated the potential for physiological advantages, including notable reductions in blood pressure and heart rate, alongside elevations in oxygen levels. These findings suggest that independent of psychological effects, VR can significantly induce physiological responses, particularly in reducing bio-physiological markers associated with distress, notably a decrease in heart rate.^{25,27,32} Additionally, cognitive decline significantly diminishes the quality of life in patients, surpassing the impact of cancer recurrence and metastasis. Several researches underscore the favorable impact of VR on patients' cognitive health.^{29,33} Life review with avatars has assisted with life review for cancer patients, where avatars aid in navigation and gestures improve communication.²⁷ Moreover, VR can potentially divert focus away from stimuli and create a relaxing environment that might decrease the fear response in a pre-procedural setting.³⁴ Patient education has been reported to have a substantial influence on lowered anxiety scores, primarily when delivered before treatment, and positively impacts emotional well-being of patients using VR during education sessions.³⁵ Overall, the positive outcomes align with previous research on the pain-reducing efficacy of VR in different medical contexts, emphasizing its potential to alleviate distressing symptoms in cancer patients and improve their quality of life.

Ethical considerations in the use of virtual reality in cancer care

VR in cancer care has potential ethical implications regarding patient consent, privacy, and psychological effects.¹⁷ Therefore, patient autonomy and informed consent are critical ethical considerations for VR interventions in cancer care. Privacy and data security concerns in virtual healthcare environments, as well as equity and accessibility issues, must also be considered

when implementing VR interventions.^{19,21,36} While VR can benefit pain and anxiety management, addressing topics such as potential desensitization to real-world experiences is essential.¹⁴ Finally, there is a need for greater standardization in research methodology to accurately assess the benefits and limitations of VR in cancer care.²⁵

Challenges and limitations of virtual reality in cancer care

VR has the potential to provide immediate relief from symptomatology and enhance the well-being of advanced cancer patients. However, technical limitations, hardware requirements, and motion sickness and discomfort during VR experiences pose challenges to implementing VR interventions in cancer care.^{19,36} Patient acceptance and willingness to adopt VR interventions and integrate VR with conventional cancer treatment modalities are also areas of challenge.^{19,24} The variability in VR elements, device preferences, and ethical considerations, including patient autonomy, informed consent, privacy, and data security, must also be considered.²⁰ While the usefulness of smart glasses has been demonstrated in surgical planning and guidance, VR's potential as an emotion-focused distraction intervention to manage chemotherapy-related symptom distress and address psychological distress in oncology needs to be further investigated.²⁶ Finally, the potential desensitization to real-world experiences and the need to ensure equitable access to VR-based interventions and address potential disparities are also areas of concern that require further exploration.²¹

Future directions and research implications

The study's limitations emphasize the need for further research to understand advanced VR systems' long-term effects, physiological responses, and potential side effects in cancer care.^{17,20,21} The results of this study suggest that VR has promising potential to be used alongside pharmacological interventions to enhance pain relief and emotional well-being, opening up new avenues for future investigations in this field. More research is needed to determine the ideal duration of VR interventions for symptom management and improve their effectiveness in cancer care.¹⁹ It is crucial to understand the long-term effects and sustainability of VR interventions for their continued integration into cancer care. Comparative studies comparing VR interventions with traditional approaches can provide valuable insights into their efficacy and benefits. The role of healthcare professionals in guiding patients through VR-based therapies and interventions should also be explored.^{21,26,36} The limitations of heterogeneity in the analyzed studies highlight the importance of continued research and exploration in this domain.²⁵ Future research should consider larger patient cohorts and methodological standardization to provide more robust evidence. Immersive VR shows promise as an effective intervention for managing chemotherapy-related symptoms and mood

changes in cancer patients, with potential applications beyond symptom management.^{8,24}

The review recommends integrating VR interventions into breast cancer care, including post-surgery stages, and suggests extending therapy beyond hospital settings through home-based VR programs.²⁴ Future research should involve larger samples, longer interventions, and higher methodological quality.^{21,36} Exploring cyber sickness symptoms and cost-effectiveness is also advised.²⁴ VR could offer innovative palliative care approaches for terminal cancer patients, including multimedia content to maintain engagement.³⁰ Future research should explore innovative applications of VR technologies in cancer care, potentially revolutionizing treatment approaches.

CONCLUSION

In conclusion, the rising global incidence of cancer necessitates innovative approaches to address the diverse challenges faced by cancer survivors. VR technology emerges as a promising tool in cancer care, demonstrating its efficacy in managing symptoms, enhancing emotional well-being, and potentially revolutionizing treatment approaches. From alleviating pain and anxiety to improving cognitive function and overall quality of life, VR interventions present a multifaceted solution. However, ethical considerations, challenges like technical limitations and patient acceptance, and the need for further research to understand long-term effects underscore the ongoing evolution of VR in cancer care. As we delve into the future, continued exploration, methodological standardization, and integration into broader healthcare strategies will be crucial to unlock the full potential of VR in providing holistic support for cancer patients.

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