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Virtual Reality in EU Healthcare: Empowering Patients and Enhancing Rehabilitation

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Abstract

In recent years, virtual reality simulation gained interest as a novel technique for healthcare education, empowering patients, and enhancing rehabilitation. There is a shortage of evidence to evaluate the effectiveness, acceptability, and usefulness of virtual reality simulation, despite a handful of articles investigating virtual reality simulation on motivation, knowledge, and satisfaction. The study aimed to evaluate the efficacy of virtual reality in EU healthcare regarding empowering patients and enhancing rehabilitation.

In our review, we involved English studies from common databases such as Pubmed/MEDLINE, Web of Science, Scopus, and the Cochrane Library with the keywords "virtual reality," "healthcare," and "Patients," combined with keywords, involving "Rehabilitation." The end date for this review is July 2023. Virtual reality is being used by medical professionals to improve patient care and enhance training for physicians and medical students. In terms of skills, knowledge, empathy, and confidence, several studies based on medical education have demonstrated beneficial results. In addition, virtual reality has become a viable tool for clinical patient care. Virtual reality provides positive results in rehabilitation programs and mental health.

Keywords: Virtual reality, Healthcare, Rehabilitation, Training, Education

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Introduction

Medical practice is changing at an accelerated rate. Today's healthcare systems are significantly more complex than they were 20 years ago due to the complex needs of an aging population, the variety of treatment options available, the interprofessional nature of care, and other factors (Pawassar & Tiberius, 2021; Lie *et al.,* 2022). Therefore, we had to modify how we train future clinicians. It's not a matter of whether someone can remember or access information anymore; it's a matter of how they use, assess, and apply it to patient care (Wong *et al.,* 2018). The teaching of communication skills, problem-based learning, and simulation-based learning have all been incorporated into curricula (Rakhimov & Ibragimov, 2021). Considering the growing need for clinical learning experiences and the challenges that come with them, simulation, in particular, has gained popularity as a way to give experiential learning (Bond *et al.*, 2021; Lie *et al.*, 2023).

In recent years, virtual reality has become a popular new technology in the health sector and is utilized to treat a variety of illnesses (Maltsev & Bokova, 2022). In actuality, this technology combines communication through a receiver with the simulation of the outside world using a computer (You *et al.*, 2005). Virtual reality is made up of input devices and power transmitters, as well as a graphical production system for the virtual environment and information software (Rakhimov & Mukhamediev, 2022). According to the ability of the individual and the type of treatment, all activity characteristics, including severity, duration, and feedback type, can be adopted in a virtual environment (Weiss *et al.*, 2003). Individuals can also view their motor outcomes and make any necessary corrections (Svačina, 2020).

A simulation is a teaching method that involves simulating real-world scenarios, letting learners behave as they would in those situations, giving feedback, and debriefing on performance (Kyaw *et al.*, 2019). It has been discovered that simulation is better than traditional clinical education in several areas. It also produces potent educational interventions that have both immediate and long-lasting effects (Lüddecke & Felnhofer, 2022). Since its inception in the 1960s, when it was first used for computer graphics, virtual reality has steadily expanded to a variety of fields, from home gaming equipment to professional and academic tools (Cipresso *et al.*, 2018). Since industry leaders like Google, Sony, and Samsung began making significant investments in the virtual reality area and several articles from the interdisciplinary research community were published, virtual reality has advanced remarkably over the last few decades (Bui *et al*., 2021).

The American Board of Internal Medicine (ABIM) has stated that residents should get training in these methods before trying any patient interventions as the tools of simulation have been effective in doing invasive hemodynamic monitoring, standardized educational intervention, and mechanical ventilation (Samadbeik *et al.*, 2018).

Suture training with a simulator, according to Stefanidis *et al*., enhances practitioners' mobility and speed during operations. Similar to this, Lin *et al*. found that learning via tactical and virtual surgery simulation with evaluation can be a safe, repeatable, and cost-effective alternative to traditional approaches, provided that performing bone surgery or bone cut requires high levels of sensitivity and experience (Samadbeik *et al.,* 2018).

One sector where virtual reality has had a big role is healthcare, where technology has demonstrated its potential for use in clinical assessment, medical education, and the provision of healthcare services (Chang *et al.,* 2022). Due to the COVID-19 pandemic's onset and the limitations of traditional face-to-face teaching techniques, educators were searching for alternative approaches to medical training and education (Kamel, 2023). During their clinical rotations, healthcare and medical trainees have few opportunities to put their occupational skills into practice due to a lack of supervision and optimal practice settings (Jiang *et al.,* 2022).

The use of virtual reality as a therapeutic tool is also possible (Budko *et al*., 2023). Improvement of mental health is considered one of the main clinical uses of virtual reality, which includes reducing stress, anxiety, and depressive symptoms while receiving medical treatment (Mekbib *et al.,* 2020). In rehabilitation programs, particularly those for motor performance and cognitive function, where the emphasis is on patient recovery (Sikora *et al*., 2023), virtual reality has also shown considerable levels of effectiveness (Beverly *et al.,* 2022). Patients have access to a variety of sensory data from several modalities while undertaking specific therapeutic tasks in a virtual world (Pot-Kolder *et al.*, 2018; Karaman & Taşdemir, 2021).

It's acceptable that virtual reality will be applied soon to deliver standardized clinical training in clinical settings. But for it to be successful, it must be determined which tools or technologies best satisfy the needs of both therapists and patients. Future research in this area will be required given the use of virtual reality in numerous healthcare settings (Bannikov *et al.*, 2022). Collaboration between researchers, therapists, clinical users, and software developers is necessary (Demers *et al*., 2017). The target of our study is to determine the efficacy of virtual reality in EU healthcare regarding empowering patients and enhancing rehabilitation**.**

Materials and Methods

Search Strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for scoping review (PRISMA-ScR) guidelines were followed in the strategy of our search (Tricco *et al*., 2018). A thorough literature search was done to find scientific articles that evaluated virtual reality-based training and treatments intended for healthcare providers and patients. In our review, we involved English studies from common databases such as PubMed/MEDLINE, Web of Science, Scopus, and the Cochrane Library with the keywords "virtual reality," "healthcare," and "Patients," combined with keywords, involving "Rehabilitation." The end date for this review is July 2023.

Inclusion Criteria

Our review involved the recently published articles that met our eligibility criteria.

1. Focused on virtual reality-based patient empowering, rehabilitation enhancement, and medical education training.
2. Involved patients or medical professionals taking part in a virtual reality simulation.
3. Used virtual reality-based devices and systems such as HMDs, virtual reality glasses, motion tracking technology, virtual reality robotics systems, virtual reality controllers, virtual reality headsets, headphones, or any other types of virtual reality tools for patient empowerment, rehabilitation enhancement, and medical education training.
4. Study designs such as randomized clinical trials (RCTs), systematic reviews, case-control studies, and retrospective or prospective cohort studies were included while studies and/or articles that weren't subjected to peer review, as well as proposals, procedures, reviews, letters, and opinions, were excluded.

Clinical Outcomes

Primary Outcomes

The reported outcomes in our review were patient empowerment, rehabilitation enhancement, therapeutic care, and medical education. To assess the effectiveness of virtual reality as a teaching medium, we gathered information on the following primary outcomes: learners' abilities, confidence, knowledge, attitudes, and self-efficacy. We also gathered information on the patient's clinical progress in rehabilitation (cognitive/motor function) and mental health outcomes (stress, skills, pain, anxiety, mood, motivation, depression, and mentalization) to assess the therapeutic effectiveness of virtual reality. Every piece of information was delivered descriptively.

Secondary Outcomes

User experience, viability, acceptability, and adherence were evaluated for the secondary outcomes that were part of this review. Personal interviews, survey responses, and drop-out rates were used to evaluate these outcomes. Different tests help in the evaluation of the rule of virtual reality in empowering patients and enhancing rehabilitation. To assess motor impairment, the Fugl-Meyer assessment (FMA) (Hernández *et al.*, 2021), which includes wrist and hand sections, was utilized (maximum score = 24). The Wolf Motor Function Test (WMFT) (Morris *et al.,* 2001), which includes four items requiring distal control (lifting a pencil, stacking a checker, lift paper clip, and turn a key in the lock; max = 20), and the Test Evaluant les Membres Superieurs des Personnes Agees (TEMPA) (Nedelec *et al*., 2011), which includes four items also requiring distal control (prehension: picking up, handling coins, and moving small objects; the precision of fine motor movements: picking up, handling coins, and moving small objects), were used to measure upper-extremity function. The number of blocks moved from one side to the other during the Box and Blocks Test (BBT) (Hashim *et al*., 2021) was used to assess manual dexterity.

Research Result

The result of the search using our search strategy was 1013 articles. We screened these articles to choose the articles related to our topic. We did a full-text screening of 82 articles after excluding the remaining articles by title and abstract screening. Finally, we used 11 articles to gather information about our topic and write this review **(Figure 1)**.

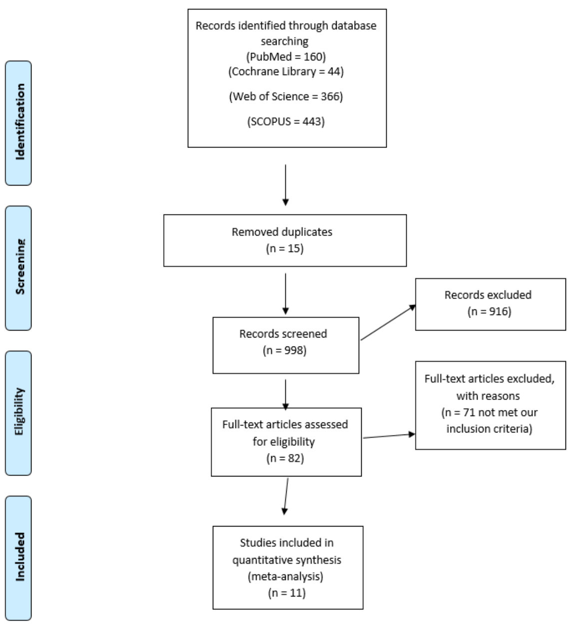

Figure 1. PRISMA flow diagram of our literature search

Results and Discussion

Our study aimed to determine the effectiveness of virtual reality in EU healthcare regarding empowering patients and enhancing rehabilitation**.** After using our search strategy, we found several studies that focus on evaluating the impact of virtual reality in several medical conditions of different systems such as the cardiovascular system, central nervous system, and other systems.

Kyaw *et al*. (2019) performed a systematic review and meta-analysis that assessed the impact of virtual reality on health professions education. They concluded that there was an improvement in the skills and knowledge of the included participants but they did not evaluate the patients' related outcomes or the changes in the behavior of the patients.

Bergmann *et al.* (2018) tried to determine the role of virtual reality in enhancing the motor performance and motivation of non-ambulatory patients with subacute stroke. In this RCT, they used Questionnaire and walking time evaluated during physiotherapy sessions as assessment tools and they found that there was an improvement in the patient's physical abilities, such as upper extremity, walking time, fine motor recovery, dexterity functions, gripping, balance, gait resistance, mobility, and the duration to which they can independently do daily activities (Bergmann *et al*., 2018). Al-Sharman *et al.* (2019) assessed the efficacy of virtual reality on patients with multiple sclerosis (Al-Sharman *et al*., 2019). They found the same results as Bergmann *et al.* (2018) (Bergmann *et al*., 2018) as their results showed an improvement in motor performance.

To ascertain if virtual reality is useful for patients with moderate cognitive impairment, Thapa *et al.* (2020) conducted an RCT. Their results prove that The virtual reality-based training program improved physical and cognitive function in individuals suffering from mild degrees of cognitive impairment. Additionally, they reported that advising patients to perform virtual reality and game-based training may help in the prevention of cognitive decline (Thapa *et al.*, 2020). Mekbib *et al.* (2021**)** performed a study that assessed the effect of virtual reality on upper extremity rehabilitation in patients with stroke. They investigated the treatment efficacy using the Fugl-Meyer Upper Extremity (FM-UE), Barthel Index (BI), and resting-state fMRI. They discovered that following the intervention, neuronal activity increased, particularly in regions of the brain associated with mirror neurons, such as the primary motor cortex. Overall, their findings indicated that employing a virtual reality system could provide significant advantages for upper extremity rehabilitation (Mekbib *et al.*, 2021). Mekbbib *et al*. (2020) performed a meta-analysis that assessed the effectiveness of virtual reality for upper limb rehabilitation in patients with stroke. A total of twenty-seven studies were involved in this meta-analysis. They found that Individuals may benefit from using virtual reality therapy to enhance upper limb functionality. Their findings indicate that virtual reality may be able to reduce upper limb motor deficits as well as promote social interaction and motor activity. According to subgroup analysis, individuals with stroke may benefit more from participating in virtual reality training over a longer therapy period (more than 15 hours of intervention) compared to a shorter length of time if they want to improve their upper limb motor deficits and activity limitations. Additionally, patients with subacute stroke may gain more from virtual reality therapy than those with chronic stroke (Mekbib *et al*., 2020). In their research, Yeh *et al.* (2017) sought to determine whether virtual reality was effective in stroke recovery. They measured different outcomes such as Test Evaluant les Membres supérieurs des Personnes Agees (TEMPA), Fugl-Meyer assessment (FMA), Box and Block test (BBT), Wolf motor function test (WMFT), and Jamar grip dynamometer. They found that with virtual reality there was significant progress in TEMPA, FMA, JAMAR, and BBT, with the scores progressing by 8%, 30%, 24%, and 19%, respectively (Yeh *et al.*, 2017).

Karaman and Taşdemir (2021) assessed the efficacy of virtual reality on anxiety and pain during breast biopsy using fine needle aspiration. They found that there was a significant improvement in average state anxiety and mean pain score ($P < .001$) (Karaman & Taşdemir, 2021). Vázquez *et al.* (2019) used virtual reality during ambulatory surgery to cause pain distraction. They concluded that mobile less expensive virtual reality platforms have a positive effect on reducing the pain sensation and causing pain distraction during surgery (Mosso Vázquez *et al.,* 2019). Osmanlliu *et al.* (2021) performed a clinical trial to assess the effectiveness of virtual reality on pain distraction for children undergoing intravenous procedures in the emergency department. According to their findings, parents, patients, and healthcare professionals expressed a high degree of satisfaction. There were no significant negative outcomes. Of the 30 patients who were exposed to virtual reality, five patients (16.7%) reported minor side effects (Osmanlliu *et al*., 2021). Distress as a consequence was examined in two studies (Osmanlliu *et al.,* 2021; Beverly *et al*., 2022). Frontline healthcare workers in the facilities of COVID-19 treatment who participated in the intervention showed significantly less psychological stress, according to (Beverly *et al*., 2022). While the other article revealed no appreciable progress in the reduction of stress (Osmanlliu *et al.,* 2021). Virtual reality simulation training is suggested to be essential for providing services of healthcare during the COVID-19 pandemic, enhancing both clinical and operational care (Cheung *et al.*, 2020).

According to Co and Chu (2020), web-based surgical skills learning (WSSL) may be a viable alternative to in-person surgical skills education. Another article with comparable findings suggests that virtual reality skill training is an advantageous replacement for conventional learning methods for surgical residents (Gallardo *et al*., 2020). Technologies for remote communication are being investigated as potential solutions for assisting with medical rehabilitation therapies (Mantovani *et al*., 2020; Groenveld *et al*., 2022). Therefore, in light of the current situation, quick action in the system of healthcare delivery is required to deal with issues resulting from the COVID-19 pandemic. Patients with different ailments received substantially less treatment during this time since medical facilities were temporarily closed (Mateen & Kan, 2021). The use of digital technology in the delivery of healthcare and education, however, was also made possible by this. When the globe strives to find new ways to provide education, many institutions now employ pre-recorded or live videoconferencing services as educators (Mateen & Kan, 2021). Only 10 studies, all published before COVID-19, specifically addressed the use of virtual reality in medicine. We discovered that 18 studies were carried out during and after COVID-19, and the number is steadily increasing. One of the studies looked at how frontline COVID-19 healthcare providers could use virtual reality to lessen their stress and anxiety (Beverly *et al.*, 2022).

Sevcenko and Lindgren (2022) performed a systematic review to assess the impact of virtual reality on Parkinson's disease and stroke rehabilitation. They concluded that virtual reality training may be just as successful as conventional training in helping Parkinson's disease and stroke patients enhance their functional abilities. Improvements in upper extremity functional mobility, activities of daily living, balance, gait, psycho-emotional state, quality of life, and cognition may be made with the addition of virtual reality training to a rehabilitation program. High patient engagement and satisfaction are the benefits of inspirational virtual reality training. Patients with Parkinson's disease and stroke can benefit from this intervention provided disorder-specific deficiencies and technological issues are considered before participation. If safety precautions are taken, the virtual reality training is appropriate for use in clinics and as a telerehabilitation tool at home (Sevcenko & Lindgren, 2022).

Chen *et al*. (2021) conducted a meta-analysis that included 48 studies. They assessed the effectiveness of immersive virtual reality-supported therapies in enhancing health outcomes for people with illnesses or impairments was investigated in this review. Immersive virtual reality is a functional tool for assisting in the delivery of treatments and therapies. Their findings showed that research on anxiety disorders has been considerably broader and that using immersive virtual reality has been linked to reductions in anxiety-related symptoms. Immersive virtual reality has also shown success in treating amblyopia, unilateral vestibular hypofunction, mild cognitive impairment, post-stroke motor impairment, and psychotic illnesses (Chen *et al*., 2021).

Mallik *et al.* (2022) explored the impact of virtual reality on clinical diabetes training. They found that 94.87% of the participants felt it was interesting, 79.5% found it practical, 69.2% found it valuable, 56.4% felt it was challenging, 2.5% felt it was confusing, 33.33% found it comprehensive, 43.6% found it thought-provoking, 7.7% felt it was complicated, and 38.5% felt it was inspiring. They concluded that VR is a practical and well-liked instructional tool for clinical trainees that helps them feel more confident in handling situations related to diabetes (Mallik *et al.*, 2022).

Strengths

Our review concentrates on patient care, which includes therapeutic patient care as well as medical education for students. In addition, the included studies used different methods of virtual reality such as semi-immersive, non-immersive, and immersive. In both patient care categories, the majority of articles revealed an improvement in outcome measurements. Studies investigated the viability of employing virtual reality systems as well as how learners' abilities or patients' therapeutic results could be improved. The results suggested that the virtual reality system was secure, enjoyable, and useful for individuals. Despite the advantages of employing virtual reality technology in healthcare, our analysis found several disadvantages, which are detailed below.

Conclusion

Virtual reality is being used by medical professionals to improve patient care and enhance training for physicians and medical students. The literature highlights the growing use of virtual reality as a teaching tool for medical students as well as for managing health and rehabilitation in patients with a wide variety of medical diseases. In terms of skills, knowledge, empathy, and confidence, several studies based on medical education have demonstrated beneficial results. In addition, virtual reality has become a viable tool for clinical patient care. Virtual reality provides positive results in rehabilitation programs and mental health. To determine whether virtual reality therapies are better or more effective, additional research comparing intervention groups to control groups should be conducted soon. Future research should place a strong emphasis on creating guidelines that specifically define virtual reality procedures concerning study designs, immersion levels, intervention treatment periods, and virtual reality content. Therefore, there is a pressing need for cooperation between virtual reality simulation organizations and healthcare practitioners to provide virtual reality content that is more targeted and effective. Finally, more research is needed to determine the viability and user experience of virtual reality in healthcare for patients as well as healthcare providers.

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