



# Virtual Reality in Healthcare

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## Abstract

The term "virtual reality" describes a computer-generated simulation that enables a person to replicate an interesting environment or experience utilising a VR headset. An simulated three-dimensional environment can be interacted with using a variety of electrical equipment with the aid of VR, such as special eyewear with a screen or gloves with sensors. Healthcare professionals and patients can interact with virtual reality systems that are designed for medical education (including training in simulative surgery), pain management, or rehabilitation.

Healthcare is one of the top three areas that continues to lead the adoption of VR technology and will do so until 2025, according to the Goldman Sachs Global Investment Research.

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## Introduction:

According to Accenture, 82% of healthcare workers concur that using virtual reality makes it easier to acquire and learn from knowledge provided by medical students and working healthcare professionals. 62% of patients, according to the organisation, would be open to using virtual reality medical services in place of more conventional ones.

The following are the main forces behind the expanding use of VR in healthcare:

- There is an urgent need for top-notch medical care.

- The need to lower healthcare expenses
- Increasing influence of linked devices in healthcare

## Virtual Reality for Medical Education and Training

Students studying medicine and new healthcare workers benefit more from virtual reality when learning theory. With VR, "students can examine 3D medical models in detail—something that is impossible to do with physical models—or practise speaking with AI-controlled virtual patients, whose attitudes and behaviours can be easily changed for a variety of



educational goals (such as speaking with patients who don't speak English as their first language)”.

Any virtual learning session may be held in a group or on an individual basis, and it can be facilitated by either a real tutor who is also linked to the VR app or a virtual pre-programmed tutor managed by the AI algorithms.

It can be used for:

- i. Anatomy learning
  - ii. Medical social skills learning
- Medical school alums and healthcare professionals alike can gain practical skills in risk-free settings with the use of VR software that is primarily focused on practical medical training. With this kind of VR technology, it is possible to simulate situations that would be expensive, risky, or difficult to replicate in the actual world.
  - When using a VR app to replicate a medical environment, “a user must immediately join a training scenario where they are expected to follow specified actions, such as carrying out a medical procedure or managing medical equipment. This is crucial for the success of any VR-based medical training projects. A different analytical module continuously logs the actions conducted and evaluates the performance of a medical expert in accordance with predetermined standards”. These are a few of the cases:
    - Simulated medical procedures
    - Simulated emergency situations
    - Instruction in using medical equipment

#### **Use of Virtual Reality for Surgery**

- i. VR helps erase practical skill deficiencies more quickly by enabling surgeons to practise various mock surgeries in the virtual environment. Without the utilisation of pricey, one-time-use mannequins for training, surgeons can develop into experienced specialists. With the aid of haptic controllers, virtual reality surgery allows a surgeon to execute a virtual operation in a virtual operating room. Software takes a user step-by-step through the required processes, helping them to remember the proper order of events. Patients can be given an explanation of the surgical procedure using the VR app.
  - i. Training in surgery
  - ii. Preoperative planning
  - iii. Promotion of medical device.

#### **Use of Virtual Reality for Pain Management**

By successfully deflecting a patient's attention, virtual reality pain treatment apps assist in reducing the intensity of pain or intense discomfort. The use of potentially dangerous painkillers is minimised and healthcare costs are decreased because to this sort of VR.

VR is effective for treating pain. A patient who has been immersed in a VR simulation has the option of participating in an interactive gamified experience or being transported to a highly realistic setting with a calming ambience that, along with aural stimulation, helps the patient relax. It is actively employed when:

- i. Consistent pain
- ii. Severe pain
- iii. Pain from a medical procedure
- iv. Anxiety and mental suffering

#### **Use of VR for Rehabilitation**



It has been noted that, “shifting rehabilitation activities into the virtual world transforms patient therapy sessions into a gamified experience that inspires users to strive for greater results through virtual goals and achievements”. Instead of an actual therapist, software's integrated artificial intelligence may offer thorough direction and motivational assistance, making individual rehabilitation more affordable and flexible in terms of time.

The VR app leads a patient through their personal training programme that is saved in the software database. This is how virtual reality for rehabilitation works. Through the analytics section of the app or by virtually participating in the VR session as an instructor, a therapist can modify the programme at any time and control the outcomes. It is employed in the following situations:

- i. Rehabilitation for neurological conditions
- ii. Physical treatment
- iii. Cognitive therapy

#### **Use of VR for Physical Therapy**

Virtual physical therapy can provide patients with a variety of exercises, from general orthopaedics to injury recovery. The exercises can be tailored to particular age groups as well, aiding in the motor skill development of children and the agility maintenance of elderly people. For those who are learning to use a cane or a prosthetic limb, special programmes can also be developed.

- i. How virtual reality (VR) for physical therapy works: Every exercise can be guided by a real teacher who joins the VR sessions remotely or by a virtual instructor who is powered by artificial intelligence. In order to ensure that the workouts do not in any way

jeopardise the patient's health, a thorough analytics system continuously checks the patient's state.

- i. Sporting accidents
- ii. Geriatrics and childcare
- iii. Prosthetic or assistive device adaptation

#### **Use of VR for Stroke Rehabilitation**

Effective stroke rehabilitation requires patients to relearn how to perform everyday activities in a digital setting. There is a wide variety of exercises available to patients that can aid in the recovery of motor control and the improvement of spatial orientation without putting the patient, any bystanders, or the object(s) in question in danger. It is possible to perform rehabilitation from a distance, which would drastically cut down on medical and transportation costs.

When post-stroke patients execute repetitive exercises in the VR environment, the embedded machine-learning algorithms continuously analyse their performance and automatically change the difficulty to ensure progress. This is how VR works for stroke rehabilitation. To see how far their patients have come or what exercises they are having trouble with, therapists can access the admin panel. It is applied in situations like:

- i. Recovery of bodily functions.
- ii. Enhanced cognitive capacities

#### **Using VR to Help Autistic Children and Adults**

A neuro-behavioral condition of life is autism. People today have the least social growth and engagement. The developmental condition known as autism presents chronic difficulties in social

interaction, verbal and nonverbal communication.

Numerous health organisations have been investigating ways to use virtual reality (VR) technologies to enhance autistic children's education for the past 20 years. The goal of this technology is to give users exposure to the "real world" while developing their social skills in a virtual setting.

For kids and adults on the autistic spectrum, VR-HMD has been the main focus. We can make sure that autistic children and adults receive the final, appropriate suggestion for VR training by implementing this technology in educational settings.

#### **Using Healthcare Real-Time Conferences with VR**

VR also creates a useful replacement for conferencing. People can be more productive and engaged when interacting in VR. Participants in VR conferences offer user-friendly environments that maximise learning, connection, and connectedness, in contrast to conventional techniques like phone calls, video chats, or instant messages. Because when individuals are wearing VR headsets, they are totally focused on what they are doing. Additionally, VR conferencing provides individuals with a singular way to pay attention and be alert while learning from others. A new level of connectivity is provided to users by VR. By examining another person's body language while utilising VR, consumers can evaluate an engagement.

#### **Using VR in Health Education**

For students, teachers, and the health education system, VR offers clear advantages. Learning about anatomy is

greatly aided by VR, which also makes it straightforward to obtain clinical experiences. Before engaging in actual patient care, virtual reality assists students in developing communication strategies with a variety of patients to better comprehend their medical conditions.

Doctors can reduce skill deficiencies with the aid of VR by offering risk-free, practical training. Additionally, VR flattens the learning curve and guarantees safe instruction.

#### **The Extent to Which VR is Impacting the Fitness World**

Numerous fitness apps have used virtual reality to make exercising more enjoyable and to encourage daily exercise. But more enjoyment calls for more exercise. Today There are already dozens of fitness apps available in online app stores and markets. Various publications claim that VR may also do these beneficial mind games.

Virtual reality's tsunami is now permeating the fitness industry. The VR Health Institute was established by the Kinesiology Department at San Francisco State University, and it is now working on methods to evaluate the potential of VR, particularly games that measure how many calories gamers or athletes burn throughout a session.

#### **Use of VR in Healthcare Marketing**

Modern medicine involves a lot of marketing. Businesses may close the marketing gap between experience and action by utilising virtual reality. Simply put, VR provides a digital experience in place of a physical one to advertise the goods and services of your business.

Additionally, it promotes the already successful products. VR can help you refine your marketing approach, create new



opportunities for customer engagement, and raise brand awareness.

### **The Dual Faces of Virtual Reality in Healthcare**

The main objective is to deliver virtual reality to the human senses in a manner that is consistent with how they are shown to us in the actual world for doctors and surgeons. A medical avatar might act as a substitute since it will be possible to represent a patient more accurately.

In this scenario, the VR system provides avatars with real-based bodies that can communicate with outside objects like surgical tools in a manner that is quite similar to real-world models.

Thankfully, there is still one more method that VR might be utilised in counselling offices and rehabilitation facilities. The human-computer interaction paradigm is provided by their professionals using VR. Due to computer-generated three-dimensional virtual environments, it allows the users become active participants rather than external spectators.

The patients receive excellent care because they have full control over this tool without being constrained by computer systems.

### **Drawbacks of Virtual Reality in Healthcare**

Some of the drawbacks are:

**(i) The high cost of VR equipment and software:** The first disadvantage is the expensive price of VR hardware and software. To improve the patient's experience when using VR in medical, complex hardware and software are needed. Many of the expensive projects are out of the ordinary, even though some of them are sponsored. Nevertheless, it is essential to use ready-made VR software development

kits to cut the cost of software development, even though it could be difficult to adapt them.

**(ii) Virtual Reality Addiction:** Doctors have started to recognise VR addiction as an issue, and it is one of their main concerns. Patients who struggle to interact with the outside world most often have dementia. Patients with these severe impairments also struggle with VR addiction and reject VR-based therapies.

**(iii) Disoriented Users:** Vertigo, disorientation, nausea, and other related user sensations are some of the well-known side effects of VR, even when used for gaming. Critical health situations typically make patients more vulnerable to these impacts.

**(iv) Lack of Proper Trials:** Due to the fact that technologies related to virtual and augmented reality are still undergoing intensive development, the new treatment approaches necessitate a lot of time and tight follow-up measures. Running fair trials and using them for experiments is difficult.

**(v) Insufficient Training:** Virtual reality (VR) is undoubtedly amazing for instructional reasons, but it is difficult to match with a real-life practise that demands expert medical training. To use medical VR technology, even doctors and surgeons require thorough training. And while engaging in virtual reality medical instruction, things can be confusing.

### **Virtual Reality and The Transformation of Medical Education**

The medical curriculum is evolving. The cornerstone of clinical training is



increasingly simulation, which, while efficient, requires a lot of resources. Virtual reality (VR) is emerging as a new technique for delivering simulation in response to mounting budgetary and standardisation challenges. With its on-demand, affordable, repeatable, and standardised clinical instruction, virtual reality (VR) offers advantages to both students and teachers.

There is a lot of data to back up the use of VR simulation in various fields, including healthcare. Despite not being a cure-all, virtual reality (VR) is a potent teaching tool for clearly defined learning objectives, and its use is expanding globally. The continued inclusion of VR in school curricula and technology advancements that enable group sharing of virtual clinical experiences are what will determine VR's future. As a result, we will be able to give high-quality interprofessional education on a large scale, regardless of geography, and this will revolutionise the way we train future clinicians.

### **Virtual Reality for Health Professions Education**

A systematic review looked at how well VR interventions work for education in the health fields. We found evidence that VR interventions led to a small increase in knowledge and a moderate to large increase in skills, compared to traditional learning or other digital types of learning. Compared to VR interventions with less interaction, those with more interaction seem to improve participants' understanding and skills a little bit. Because there isn't enough information about mood and satisfaction, the results aren't clear. Neither the patients nor the students in the included studies

experienced any negative or unexpected outcomes as a result of using virtual reality. Two studies considered the costs of implementing and sustaining VR, although they did not directly compare the different scenarios.

The overall risk of bias in most research was deemed questionable (due to a lack of data). There was a potential for attrition, reporting, and other sorts of bias in several studies. Knowledge, abilities, attitudes, and contentment outcomes have a moderate to low level of support from the available research. This is due to the fact that there is a great deal of uncertainty and inconsistency on the dangers of bias and inconsistency, and because study outcomes, participant categories, interventions, and outcome measurement technologies vary.

No papers were considered that were published before 2005, indicating that VR is a relatively new instructional method that is gaining momentum. Most of the participants in the research who made the cut were medical professionals or those in training to become one. There is a need for greater research into the usage of VR among pharmacists, dentists, and other allied health professionals because there have been so few studies focusing on them. In addition, most of the therapies that were examined were not part of a standard curriculum, and no studies referenced employing learning theories in the creation of the VR-based intervention or the improvement of clinical abilities. This is crucial when developing a curriculum, but it also means that the included studies may only be applicable to their present context and not to other locations or socioeconomic settings.



Although the included research included a wide variety of people and interventions, it is difficult to draw significant conclusions due to the lack of uniform methodological techniques and studies conducted within a single health care profession. Low- and middle-income country data are also noticeably lacking, limiting the generalizability of findings to settings that could benefit the most from novel pedagogical approaches.

In addition, just two research looked at how much it would cost to implement and maintain the VR-based intervention, while not a single one considered cost-effectiveness. That means we can't draw any judgements about pricing or efficiency just now either. There was also a need to address the absence of data on learner and patient outcomes, changes in behaviour, and any negative side effects of virtual reality.

There is a need to investigate further the impacts of VR with varying degrees of immersion and interaction on the outcomes of interest, as the majority of the included research evaluated the efficacy of non-immersive VR. The majority of the studies in our evaluation that looked at attitude and satisfaction results reported either insufficient or non-comparable outcome data, highlighting the need for primary research on this topic. Lastly, "there is a need to standardise the methods for reporting meaningful and the most accurate data on the outcomes, as most of the included studies reported post intervention mean scores rather than change scores on the outcomes, which reduces the reliability of the reported outcomes".

### **Strengths and Limitations of the VR**

### **Utilization**

In this research, we compile the most recent data available on the efficacy of several VR applications in the training of healthcare professionals. For this systematic review, we used the Cochrane standard as our guide and searched a variety of databases in addition to traditional sources of grey literature. There was a lack of pre-post data for most of the included trials, making it impossible to determine whether or not the intervention groups were comparable at baseline with respect to key characteristics and end measure scores. Since primary studies provided insufficient information, we also couldn't do the planned subgroup analysis.

### **Conclusions**

Virtual reality (VR) is a novel and adaptable technology with the potential to revolutionise the way medical students learn. Our research suggests that post-intervention knowledge and skills may be enhanced by VR when compared to traditional education or other forms of digital education, such as online or offline digital education. Virtual reality (VR) with more engagement was more successful in improving post-intervention knowledge and skills than VR with less interactivity. More research is needed to determine the efficacy of more immersive and interactive VR in a range of settings, looking at factors including attitude, satisfaction, unintended impacts of VR, cost-effectiveness, and changes to clinical practise or conduct.

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