How effective is Virtual Reality as a tool for cognitive and motor rehabilitation in patients with traumatic brain injuries?

Jet Chang, Trinity Edl, Harini Mohan, Minsoo Park, Shreya Perumal

Abstract

Introduction

Traumatic Brain Injuries are one of the main causes of neurological conditions, with patients often experiencing cognitive, motor and behavioral impairments. VR based rehabilitation uses interactive 3D environments to engage patients through simulating real-life activities, with the goal of improving long-term cognitive function. The review to be conducted will examine the effectiveness of Virtual Reality (VR) in providing rehabilitation for patients who have incurred Traumatic Brain Injuries (TBI). The objectives of this review are to: (1) evaluate VR's impact on improving specific cognitive and motor functions; (2) identify the forms of VR which best support cognitive rehabilitation; and (3) assess patient engagement and adherence to VR-based treatments.

Methods and Analysis

This review will include studies focused on the applications of VR in rehabilitating cognitive and motor function in TBI patients. Literature will be systematically searched for on reputable online scholarly databases, while filtering for relevant studies published in the past fifteen years, studies conducted in clinical settings, and studies involving non-neurodegenerative TBI patients. The selected research will include randomized trials, cohort studies, and case-control studies that highlight the correlation between VR usage and TBI rehabilitation. Key data from relevant sources will be documented into a spreadsheet, noting important details of the study, participant demographics, and other relevant information. This review will synthesize findings primarily through qualitative analysis, with supporting quantitative data where applicable.

Introduction

Brain injuries are prominent in this day in age, and are accompanied with life-lasting effects on cognitive abilities and physical functioning. There are almost 3 billion people worldwide living with a neurological condition, and illness and death caused by it has increased by 19% since 1990 [1]. Traumatic brain injury (TBI), defined as brain damage due to external forces, is one of the main causes of these conditions. In 20~22% of TBI cases, patients suffer physical, cognitive and behavioral symptoms or even global dysfunctions [2]. These symptoms occur due to the damage in frontal and temporal lobes specifically in the basal areas and in the subcortical white matter which are directly responsible for memory, attention, behavior, etc. With the increasing incidents of TBIs and their significant impact on the patient's quality of life, rehabilitative

strategies have to be applied in order to adapt and match patients to the worsening symptoms as they suffer the injury. During rehabilitation, regeneration mechanisms are triggered through stimulating the sensory and motor neuronal circuits [2]. However, current therapeutic strategies have shown unsatisfactory stimulation results. To address this, innovative rehabilitation techniques regarding VR are in development. VR is a simulated three-dimensional (3D) environment that allows the patient to interact with computer-generated graphics, which are perceived through senses as it would in reality. VR allows the usage of customizable and engaging real-life activities, providing a far more flexible rehabilitation process that is subject to the patient's needs. Despite the perception of VR being an excessive and costly technology to use, recent advancements have made VR more accessible and affordable. This review aims to explore current applications of VR in brain injury rehabilitation, assess its effectiveness, and identify future directions in clinical practice.

Methods and Analysis

Research Question:
How effective is Virtual Reality as a tool for cognitive and motor rehabilitation in patients with traumatic brain injuries?

Objectives:

- Assess the impact of virtual reality therapy on specific cognitive and motor functions in patients affected by traumatic brain injury.
- Examine the most effective applications of virtual reality that contribute to cognitive and motor rehabilitation.
- Determine how patient engagement and adherence levels with VR-based rehabilitation compare to traditional forms of therapy.

Search Strategy and Information Sources:

Google Scholar, PubMed, Scopus, and ClinicalTrials.gov will be used to gather any literature applicable to the research question identified in the previous section of this review. These databases will be searched between the dates of October 27th 2024 and November 14th 2024. Only literature published in English within the last 15 years will be considered. This will ensure all potential publications to be included in the review contain the most current content pertaining to the chosen research topic. The following key terms will be used to find relevant research papers during the search and screening stage: Traumatic brain injury, virtual reality, VR therapy, cognitive impairment, and simulated 3-D environment.

Screening Process and Inclusion Criteria:

<u>Design/Type</u>

Research extending the understanding of virtual reality, brain injuries or the correlation of the two will be included. Case studies and experiment trials including but not limited to randomized trials, cohort studies and case-control studies will be included.

Study Condition or Domain
Studies conducted on the rehabilitation of brain functions of individuals suffering from traumatic brain injury to single or multiple regions of the brain will be included. Any research prior to 2010 and of individuals with neurodegenerative conditions will be excluded. The primary focus is the rehabilitation of brain function through the use of virtual reality. Studies unrelated to virtual reality will be excluded.

Setting
Work conducted in clinical trials or rehabilitation centers will be included. Additionally, relevant studies will be validated for currency of findings to ensure findings have not since been disproven.

Time Frame
A date range for currency of research will be set from 2010 to 2024, as this outlines the point when virtual reality became a prevalent tool in industries like healthcare. [3]

Population
The population under study are individuals with damaged regions of the brain. The focus is the rehabilitation of brian functioning following such injuries through the use of VR.

Outcome
The primary outcome of the study will be determining the possibility for improvement of brain functioning following virtual reality rehabilitation characterized by cognitive recovery.

Data Extraction Process:

All five researchers will each independently extract and format data within the same Excel spreadsheet. Data extracted in this way will include citation details (author, country, year, URL), objectives, type of study, participant demographics, setting and context, measures in cognitive and motor functions (i.e. memory tests after injury), results reporting degree of improvement (i.e. test scores after VR intervention), and any major findings. Pertinent categories include but are not limited to: VR usage frequency, type of VR technology, number of additional therapies (other patient rehabilitations independent of VR).

Data Analysis and Synthesis:

The extracted data will primarily be analyzed qualitatively for common patterns and themes, synthesized in a narrative form. Quantitative data, though seldom the focus, will be analyzed separately and used as a supplement to aid when applicable.

Discussion

With the increasing number of traumatic brain injuries [1], and their lasting impacts on a patient's quality of life, an effective rehabilitation process is crucial in order to subside lasting symptoms. However, due to the plethora of unsatisfactory stimulation results of current rehabilitation methods, there is a need to innovate the current techniques. VR is one of the potential ways in which stimulation can be improved, as it enables the simulated activities to be flexible, and customizable [2]. The review conducted will synthesize the current research by exploring the current ways in which VR is being used in rehabilitation for brain injury patients, evaluating its effectiveness, and identifying future uses in clinical practices. Once the review is completed, it is expected that the need for VR in clinical settings will be highlighted further, and there will be more of an encouragement for its use in rehabilitation.

References

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