REVIEW ARTICLE

Use of interactive video game for stroke rehabilitation

Lucas Barbosa de Souza[1], Chennyfer da Rosa Paino Paim[2], Marta Imamura[2], Fabio Marcon Alfieri[3]

ABSTRACT

Stroke is an ischemic or hemorrhagic clinical condition that affects the central nervous system and engenders cognitive and motor deficits. Many studies are made each year to find better ways to alleviate the symptoms and recover as many of the functions lost as possible. Nowadays, the latest trends in rehabilitation are exploiting advances in technology and virtual reality devices, such as the Nintendo Wii®. **Objective:** To identify the functional results obtained in the rehabilitation of individuals with stroke using the interface of the Nintendo Wii games. **Method:** For this systematic review, articles were selected from MEDLINE, PubMed and the Cochrane Library through the PICO strategy. The keywords used were: User-Computer Interface; Stroke; and Rehabilitation. **Results:** We found 229 articles, of which only 3 were used in this review, because they showed a direct relationship between Wii and stroke. All studies showed benefits such as improved motor coordination and agility of upper limbs using the Wii associated with conventional therapies such as physiotherapy and occupational therapy. **Conclusion:** Further studies should be performed with Nintendo Wii® and the new Virtual Reality Technologies that appear every day in order to improve the level of scientific evidence regarding the use of these resources in the rehabilitation of stroke patients.

Keywords: rehabilitation, stroke, user-computer interface

[1] Student in the Physical Therapy Course at the Centro UniversitárioAdventista de São Paulo (Adventist University Center of São Paulo).
[2] Physical Medicine and Rehabilitation Institute at the Clinical Hospital, Medical School of the University of São Paulo/HC-FMUSP.
[3] Professor, Physical Therapy Course at the Adventist University Center of São Paulo, Researcher at the Physical Medicine and Rehabilitation Institute at HC-FMUSP.

Mailing address:
Rua Carlos Blum, 339- Parque Fernanda
São Paulo - SP
CEP 05889-260
E-mail: luccas.fisioterapia@gmail.com

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INTRODUCTION

The cerebral vascular accident (CVA) is an ischemic or hemorrhagic clinical condition that impairs the central nervous system and can trigger motor and cognitive deficiencies. These losses are permanent or recoverable such as hemiplegia, and generate dysfunctions in gait, changes in the strength of upper limbs, changes in balance, increased risk of falling, and increased production of reactive types of oxygen.[1,2] Currently, CVAs affect 15 million people per year, with 5 million dying and another 5 million becoming unable to perform their daily leisure or work activities.[1]

Individuals affected by a CVA are predisposed to develop sedentarism, for their level of physical energy is reduced. They can spend at least half the day resting in bed, which causes prolonged immobility and gradual loss of muscle and bone mass, thus increasing the risks of osteoporosis and falls.[3,4]

The regular practice of physical activity and the absence of previous encephalic lesions are important factors for a good recovery. The type of CVA (ischemic or hemorrhagic) also determines part of the patient's prognosis.[5,6] Many studies are made nowadays to find new ways to mollify the symptoms and recover the maximum of functions in patients with CVA sequelae.

Due to rapid technological advances, the techniques used in rehabilitation are being developed exponentially, making the use of more and more sophisticated devices a common event.

One of the most recent approaches is Virtual Rehabilitation, which seeks to encourage the use of gross and fine motor functions through the interaction of the individual with a virtual mean, the so-called "Immersive Virtual Environment Technology" or virtual reality. It can provide benefits due to its capacity to maintain simultaneous control over reality and over the abstract, providing situations in which the user can learn things that he or she would not learn by traditional methods.[7-10]

Virtual Reality is, according to Lucca[11] similar to the stimulation of a real environment, but is generated by software that interacts the real with the virtual by an interface, either a control or a helmet. The explanation for the efficacy of this form of rehabilitation is supported on the theory of reorganization mediated by mirror neurons, responsible for motor imagery, that is, imagination or visualization of movements that facilitate learning.[11-15]

The Nintendo Wii® is a non-immersive virtual reality device, which is to say it does not involve the whole body inside a virtual system. It is a videogame that is being introduced as a therapeutic tool in motor and cognitive treatments. Its interface includes various games that provide motor benefits and entertainment, encouraging patients to continue therapy for long periods of time.[16] It detects movements as much as acceleration in three dimensions using a manual remote control (Wii Remote) and a receiver positioned above or below the television set.[17,18]

The first study made with Nintendo Wii® was a case report made by Deutsch et al.,[19] who evaluated the motor benefits that a child with cerebral palsy obtained after 11 supervised sessions of Wii Sports. After that work, more studies started to be published like the case study developed by Clark et al.[20] that involved an older individual with high risk of falling and showed results such as functional gains referring to improved balance.

However, despite the recent success in rehabilitation, there are some limitations to using Nintendo Wii® (Wii Rehabilitation) in all types of therapies. Regular games have a very high level of difficulty for individuals with important motor limitations.[21] For this reason its use may be restricted.

As the use of therapeutic resources must be based on scientific evidence, it is important to know the real effects of each game in order to recommend them. In this way, the objective of this literature review is to identify the functional results obtained in the rehabilitation of individuals with EVA using the Nintendo Wii games interface.

METHOD

Articles from the Pubmed, Medline, and Cochrane library data banks were selected by the PICO[22] search strategy with P - Patient; I - Intervention, or new alternative. As the Nintendo Wii® is not a MeSH descriptor we selected the User-Computer Interface descriptor. In that way, the search strategy used was: User-Computer Interface AND Stroke AND Rehabilitation. The search was limited to publications in English.

We found 229 articles, from which the titles and abstracts published since 2005 were read, excluding the articles that did not discuss motor rehabilitation. Articles with these descriptors were only found in the Pubmed data banks. In the study, articles were included that used Nintendo Wii® to treat individuals with CVA sequelae. Only 3 studies had any direct relation between Wii and CVA. The JADAD scale was applies to the random studies.

The following data from studies was obtained: year of publication, size of sample, clinical tests made before and after therapy, duration of intervention, objectives of the work, technique used, and conclusions from authors.

RESULTS

The three articles selected were pilot studies and only one was a randomized blind simple clinical test study, which exemplifies the lack of studies with this theme. For this randomized study the JADAD scale was applied with the value of 1.

The sample of patients was varied. The total number of patients who used Nintendo Wii® as treatment was 32: 16 in the first study, 9 in the second, and 7 in the third study. From these 32 individuals, 43% were males and the average age of all the patients was 63.5 years.

The main analyses made in the studies were: function of upper limbs and the patients' acceptance to use Nintendo Wii® for therapy. Clinical tests such as the Wolf test, the Berg scale, and the Fugl-Meyer test were used for the motor evaluation of the individuals with CVA.

The patients suffered a CVA and remained in an acute state, varying from 26 days to 15 months in the three studies. The duration of treatment and number of interventions were different, varying from 6 to 14 sessions. The trainings consisted basically of one hour playing Wii and all the authors worked with Wii Sports games, including boxing, tennis, bowling, golf, and baseball.

The objectives were similar, focusing on the verification of viability, safety, and efficacy of treatment with Nintendo Wii® as supporting therapy to the conventional therapy. Only one of the authors had the objective of comparing the efficacy of Nintendo Wii® therapy with a conventional therapy.

The items evaluated from the three articles selected by the inclusion and exclusion criteria are shown on Table 1.

Table 1. Sample characteristics of the articles according to study, population, intervention technique, objectives, and results

Study	Population	Intervention	Objectives	Results
Author/Year: Joo LY, Yin TS, Xu D, Thia E, Chia PF, et al. 2010. Recruited: 20 patients. Lost samples: 4 of these patients did not participate: 20%. Analysis: Upper limbs function, motricity index, muscle tone of shoulder, elbow, and wrist, and pain in the upper limbs, acceptance of Nintendo Wii as therapy. Clinical tests: Fugl-Meyer evaluation of upper limbs motor function (FMA), motricity index, modified Ashworth scale, visual analogue scale (VAS).	Average age: 64.5 years Females: 65% Males: 35% Period of intervention: 6 sessions every two weeks, with 30 minutes each session; plus 1 hour of occupational therapy and physiotherapy daily. Diagnosis: Patients post CVA (average of 26.3 + 13.2 days) or patient with sub-acute CVA and upper limb weakness	Technique: Nintendo Wii Sports games. The games were boxing, bowling, tennis, golf, and baseball. Group: 16 patients	Objectives: To verify the viability of using Nintendo Wii as support therapy to conventional rehabilitation therapy after a CVA with weakness of upper limbs. Measured before and after therapy: a) Pain: CVA b) Function: FMA c) Motricity Index d) Modified Ashworth scale e) Patients' satisfaction	a) Pain: CVA Diminished $p = 0.33$ b) Function: FMA Improved $p = 0.007$ c) Motricity Index: Improved $p = 0.031$ d) Modified Ashworth scale: No change $p = 0.32$ e) Patients' satisfaction: 6 - pleasant 7 - very pleasant 3 -slightly pleasant Conclusion:. Nintendo Wii seems to be a viable device as support to conventional therapy of patients with sub-acute CVA with moderate deficiencies of strength and upper limb functions.
Author/Year: Saposnk G, Teasell R, Mamdami M, Hall J, McIlroy W, et al. 2010. Recruited: 110 patients who had their first hemorrhagic or ischemic CVA episode. Randomized: Participants were distributed randomly in a proportion of 1:1 into two groups of study. Lost samples:93 of these patients did not participate: 84%. Analysis: Safety, viability, and results with clinical relevance. Clinical tests: Wolf Motor Balance Test (WMBT), Berg scale, Boxes and Blocks Test (BBT), Stroke Impact Scale (SIS).	Average age: 61 years Females: 64% Males: 36% Period of intervention: 8 sessions of 60 minutes each for 14 days, followed by evaluations 4 weeks after intervention. Diagnoses: Patients who had a clinically confirmed acute CVA event.	Technique: (1) Software EVERST, Wii Sports and Packages of Cooking Mamma (2) Recreational therapy including leisure activities such as playing cards, stamp a stamp while playing bingo or playing Jenga. Groups: Group 1 n = 9 and 4 weeks giving continuity n = 9. Group 2 n = 8 and 4 weeks giving continuity n = 7	Objectives: To examine the viability and safety of the Nintendo Wii (VRWii) Non-immersive Virtual Reality game system compared to recreational therapy (RT), to facilitate the upper limb motor function required for daily life activities among patients with sub-acute CVA still receiving conventional rehabilitation. Measured before and after therapy: a) WMBT b) BBT c) SIS Hand function d) SIS Composed function e) SIS Perception of recovery f) Manual grip strength	a) WMBT (95% CI) Group 1: -10.5 (-19.3, -1.8) Group 2: -14 (-32.1, 4.1) b) BBT (95% CI) Group 1: 8.6 (0.9, 16.2) Group 2: 12 (3.8, 20.2) c) SIS Manual function (95% CI) Group 1: 15.3 (-1.2, 31.8) Group 2: 11.2 (-21.3, 43.8) d) SIS Composite function (95% CI) Group 1: 8.3 (-3.3, 19.9) Group 2: 13.3 (0.9, 25.8) e) SIS Perception of recovery (95% CI) Group 1: 14 (-2.7, 12.6) Group 2: 15.7 (-9.1, 40.5) f) SIS Manual grip strength (95% CI) Group 1: 6.4 (3.8, 9.0) Group 2: 2.8 (-1.6, 7.1) Conclusion: VRWii game technology represents a safe, viable, and also a potentially effective alternative to ease rehabilitation, therapy, and to promote motor recovery after a CVA.
Author/Year: Mouawad MR, Doust CG, Max MD, McNutly PA. 2010 Recruited: 7 patients post-CVA and 5 healthy controls. Lost sample: No patients ceased participation or were excluded. Analysis: Functional ability on the side affected by CVA and control of the dominant hand. Clinical Tests: Wolf Motor Balance Test (WMBT), Fugl-Meyer evaluation for upper limbs motor function, Boxes and Blocks Test (BBT), Movement Activity Log - Quality of Movement (MAL-QOM), Wii Age, Satisfaction Visual Analogue Scale (VAS), Ashworth scale, Balance Berg Scale (BBS)	Average age: 65.3 years Females: 28.6% Males: 71.4% Period of intervention: Total of 14 days. 10 days supervised training in laboratory, 1 hour duration, plus home training, which varied from 30 to 180 minutes per day. Diagnosis:. Patients after CVA event, average of 15.3 months.	Technique: To play Wii Sports for tennis, golf, boxing, bowling, and baseball. Groups: Group1 n = 7 Group 2 n = 5	Objectives: To investigate the efficacy of therapy based on the Wii for individuals in the CVA rehabilitation process. Measured before and after therapy: a) WMBT b) Fugl-meyer c) MAL-QOM d) BBS e) Ashworth scale f) Performance (Wii Age) and satisfaction (Visual Analogue Scale - VAS) in the Wii	a) WMBT - average time diminished $p = < 0.001$ - timed tasks < 120 seconds diminished $p = 0.027$ - manual strength unchanged - weight lifting (weight lifted) increased $p = 0.018$ b) FMA - increased $p = 0.013$ c) MAL-QOM - score increased $p = 0.008$ - scores added for all 30 items increased $p = 0.009$ - tasks that could not be done pre and post-therapy decreased $p = 0.022$ - passive range of motion of shoulder and elbow joints increased $p = < 0.001$ d) BBS - not changed e) Ashworth scale - not changed f) Wii performance and satisfaction: - Wii age * Control group: improved $p = 0.022$ Test group: improved $p = 0.005$ - VAS general satisfaction average: 9.4 + 0.4 Conclusion: An intense protocol of two weeks resulted in significant and clinically relevant improvements in the functional motor ability post CVA. These gains can trigger positive improvements in the quality of daily life activities.

* Wii Age: Calculation made by the game after a session of tests. The greater the age, the less the performance of the individual

DISCUSSION

The results of the studies show that the use of Nintendo Wii® was efficient in the treatment of patients with CVA sequelae, providing gains in functionality such as velocity of movement, agility, and improvement of the muscular strength of upper limbs. In spite of that, a large portion of the patients still remains in conventional treatment, for this equipment can be more efficient as a supplement to CVA rehabilitation than as a therapy in itself.[16-18]

We noticed that, despite the total sample of patients from the articles reviewed being relatively small (40 patients treated with Nintendo Wii®) and the time of intervention being varied, there are no conflicting results in the works. It is noteworthy that these articles were selected with the PICO strategy, in order to standardize the process of collecting articles.[22]

It is not prudent to forget that all forms of exercise present risks and with Nintendo Wiii® is no different. There are reports that the use of the Wii can cause some problems such as injuries to shoulder and elbow joints, tendons, and even fractures.[23-27] However, in one of the three studies analyzed some patients were submitted to the visual analogue scale test for pain before and after the treatment and none of them presented any increase of the pain sensation, nor even reported the occurrence of injuries associated with the use of Wii, showing the safety of this type of instrument for CVA rehabilitation.

A fact to be considered in the studies is that merely playing Wii is not the primordial cause of the patient's rehabilitation, for the studies include the use of physical therapy or occupational therapy in addition to this resource, which also help in the motor improvement quantified by tests like Fugl-Meyer or Wolf, which are reliable to monitor the motor evolution of CVA patients.[28,29] Although they maintain the conventional treatment, all the authors who worked with these tests obtained statistically significant gains when they used the Nintendo Wii® to supplement the conventional treatment. Consequently, it is possible to observe that the Nintendo Wii® can promote a relative increase in the motor capacity of an individual during treatment.

Other tests such as the Berg scale, the boxes and blocks test (BBT), and the stroke impact scale (SIS) were used, but their results were not statistically significant. However, the literature shows that light increases in the result of these tests still provide benefits to the patients,[30-33] which does not eliminate the inclusion of Nintendo Wii® in treatments that aim to improve balance and manual agility.

Fung et al.[33] developed research among physical and occupational therapists that used Nintendo Wii® and other video games with control centered on the body motor function. They discovered that among the 63 individuals who answered the research, the reports were of improvement of global function, recovery of motor deficits, distraction from the pain (especially burn victims), and increase in motivation during the sessions, which corroborates the results of good acceptance from the patients of this new form of therapy.[16-18, 33]

There is evidence in literature pointing to patients' interest in the treatment with Nintendo Wii® for it is an interactive, efficient, and fun way to treat motor sequelae stemming from injuries.[33] Two of the authors of the reviewed articles made tests that analyzed the interest of patients for this type of therapy and in both the studies the results were satisfactory.[16,17] It is probable that patients who were not willing to adhere to treatment would become more inclined to cooperate with rehabilitation if they are pleased with the instrument used for that end.

By the results surveyed among the articles selected by this strategy, these three studies also present methodological differences, such as patients' groups with diagnosed time of CVA and different evaluation forms, however, their results converge into the same purpose.[16-18]

It is noteworthy that probably other more recent technologies like Kinect Xbox 360® that also involves virtual reality, can present results similar to Nintendo Wii®, however, as affirmed by Laver et al.,[34] there is still a paucity of studies evaluating the use of these commercial videogames in rehabilitation.

CONCLUSION

The literature is still too scarce to define the efficacy of Nintendo Wii® concerning its use in the neurological rehabilitation of individuals with CVA sequelae. Nevertheless, considering these studies' findings, we can see that the employment of this tool is capable of promoting well-being and working the movements that stimulate basic body functions, such as using silverware, taking a shower, or combing the hair. As a therapeutic instrument it can be a valuable ally for health professionals. Still, new studies must be made with the Wii and other new virtual reality technologies that appear every day, so that the level of scientific evidence on the use of these resources in the rehabilitation of individuals suffering CVA sequelae may be raised.

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