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**Literature search results**

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**Search details**

Patients with stroke/CVA and the intervention of Nintendo Wii

**Resources searched**

NHS Evidence; TRIP Database; Cochrane Library; AMED; CINAHL; MEDLINE; Google Scholar

**Database search terms:** "nintendo wii", "virtual reality", wii, stroke*, exp STROKE, ("cerebrovascular accident** OR CVA OR "transient ischemic attack** OR TIA), exergam*, kinect

**Evidence search string(s):** (wii OR kinect OR "virtual reality") AND stroke

**Google search string(s):** wii OR kinect OR "virtual reality" AND stroke

**Summary**

This is a new area for research and as such more evidence is needed. It appears that using virtual reality gaming such as the Nintendo Wii has had some positive results for upper limb rehabilitation but these need to the weighed against the limits of each study (such as small sample sizes).

**Guidelines**

**Royal College of Physicians**

National Clinical Guidelines for Stroke, 2012

(from p. 83) The evidence base for virtual reality based interventions for the upper limb after stroke is growing, and further research is needed (Laver et al 2011).
### Evidence-based reviews

**Australia and New Zealand Horizon Scanning Network**  
Rehabilitation of stroke patients using virtual reality games, 2010  
There is limited published information on trials and studies which examined the use of virtual reality for the rehabilitation of stroke patients. Those included in this summary are of a high level of evidence but involved small numbers of patients who underwent rehabilitation with virtual reality for only a short period of time. Some patient benefits were observed especially in motor functioning rather than motor recovery. Larger, well-designed randomised trials to investigate the benefits and the potential risks of introducing virtual reality therapy into patient rehabilitation are required, especially to identify those patients who would benefit most from this therapy. The benefits of virtual reality therapy is that it can be delivered at home or in a therapeutic environment and can be delivered at low cost, however caution should be used in the introduction of this therapy in an ad-hoc manner without evidence to support its beneficial effects.

**Cochrane Database of Systematic Reviews**  
Virtual reality for stroke rehabilitation, 2011  
We found limited evidence that the use of virtual reality and interactive video gaming may be beneficial in improving arm function and ADL function when compared with the same dose of conventional therapy. There was insufficient evidence to reach conclusions about the effect of virtual reality and interactive video gaming on grip strength or gait speed. It is unclear at present which characteristics of virtual reality are most important and it is unknown whether effects are sustained in the longer term. Furthermore, there are currently very few studies evaluating the use of commercial gaming consoles (such as the Nintendo Wii).

**Database of Abstracts of Reviews of Effects**  
Virtual reality in stroke rehabilitation: still more virtual than reality, 2008  
The findings of the review were generally positive, but the evidence base was too limited by design and power to allow a definitive evaluation of its value.

**Virtual reality in stroke rehabilitation: a systematic review of its effectiveness for upper limb motor recovery, 2008**  
There was limited but encouraging evidence that VR is effective in post-stroke rehabilitation of the upper limb.

**Health Technology Assessment**  
Rehabilitation of stroke patients using virtual reality games, 2010  
There is limited published information on trials and studies which examined the use of virtual reality for the rehabilitation of stroke patients. Those included in this summary are of a high level of evidence but involved small numbers of patients who underwent rehabilitation with virtual reality for only a short period of time. Some patient benefits were observed especially in motor functioning rather than motor recovery. Larger, well-designed randomised trials to investigate the benefits and the potential risks of introducing virtual reality therapy into patient rehabilitation are required, especially to identify those patients who would benefit most from this therapy. The benefits of virtual reality therapy is that it can be delivered at home or
in a therapeutic environment and can be delivered at low cost, however caution should be used in the introduction of this therapy in an ad-hoc manner without evidence to support its beneficial effects. The evidence assessed is high-level but limited in amount. However, further studies reporting long-term outcomes are required to ascertain the potential for clinical benefit and to assess whether these benefits are maintained over time. Therefore HealthPACT does not intend to further review this technology.

Liverpool John Moores University
The Feasibility and Appropriateness of Utilising the Nintendo Wii during Stroke Rehabilitation to Promote Physical Activity, 2011
(from p. 33) The stroke care practitioners cited a large number of benefits of employing the Wii during rehabilitation
- Physical (balance, co-ordination, endurance and motor re-learning),
- Cognitive (concentration, attention, and ability to problem solve),
- Psychological (mood, motivation, enjoyment, confidence),
- Social (interaction, engagement),
- Therapy (adjunct, different, tool to belt),
- Participation (stimulation, independent exercise, self-management).
Furthermore, they suggested the Wii may be more appropriate for higher level/community patients who have good activity, younger patients, and those who have had prior experience of the Wii or gaming.
Major challenges of employing the Wii with stroke patients were highlighted by the practitioners
- Physical (neglect, high tone, inattention, poor muscle patterning),
- Psychological (mood, frustration).

NHS Lanarkshire
Does stroke wiihab work?
We have ascertained that the Nintendo Wii console is a safe and acceptable therapy tool for use in patients with upper limb weakness following stroke. Further larger scale studies with randomisation are required to further investigate the efficacy of this therapy tool.

Stroke
Virtual reality in stroke rehabilitation: A meta-analysis and implications for clinicians, Saposnik, 2010
VR and video game applications are novel and potentially useful technologies that can be combined with conventional rehabilitation for upper arm improvement after stroke.

Published research
Title: Sony PlayStation EyeToy elicits higher levels of movement than the Nintendo Wii: implications for stroke rehabilitation.
Citation: European journal of physical & rehabilitation medicine., February 2013, vol./is. 49/1(13-21), 1973-9087;1973-9095 (2013 Feb)
Author(s): Neil A, Ens S, Pelletier R, Jarus T, Rand D
Language: English
Abstract: Background: Virtual reality (VR) is an emerging trend in stroke rehabilitation. VR gaming consoles in stroke intervention have been shown to increase motivation and enjoyment during exercise. The amount and intensity of movements elicited using these consoles are unknown. Aims. The aims of this study were: 1) to quantify the amount and intensity of movement elicited from both hands of two groups of individuals (chronic stroke and without a disability [healthy]); 2) to determine the effect of console (Wii/EyeToy) and group (stroke/healthy) on the amount and intensity of upper extremity movement; 3) to
determine the effect of console (Wii/EyeToy) and group (stroke/healthy) on the usability and VR experience. Design: A cross-sectional design was taken. Setting: Outpatient rehabilitation setting and healthy participant's homes. Population: Participants included ten adults with stroke and ten adults without a disability. Methods. Participants experienced two games from each console. Amount and intensity of movement was measured using accelerometers on both wrists, while the virtual experience and usability was determined with questionnaires.

Results: No significant differences were found between the consoles usability and experience. EyeToy elicited significantly greater activity count than Wii among the healthy participants (P=0.028) and significantly greater movement intensity in both the stroke (P=0.005) and healthy (P=0.005) groups. Conclusion: Both consoles rated high for usability, enjoyment and satisfaction highlighting their suitability for a range of individuals in stroke rehabilitation. EyeToy provides increased movement and movement intensity. Clinical Rehabilitation Impact: Both consoles are suitable for use in stroke rehabilitation however this information can be helpful to clinicians while selecting a gaming console according to the type and intensity of movements that he/she aims to encourage during therapy.

Publication Type: Journal Article
Source: MEDLINE

Virtual-reality balance training with a video-game system improves dynamic balance in chronic stroke patients.

Author(s) Cho KH, Lee KJ, Song CH
Citation: Tohoku Journal of Experimental Medicine, 2012, vol./is. 228/1(69-74), 0040-8727;1349-3329 (2012)
Publication Date: 2012
Abstract: Stroke is one of the most serious healthcare problems and a major cause of impairment of cognition and physical functions. Virtual rehabilitation approaches to postural control have been used for enhancing functional recovery that may lead to a decrease in the risk of falling. In the present study, we investigated the effects of virtual reality balance training (VRBT) with a balance board game system on balance of chronic stroke patients. Participants were randomly assigned to 2 groups: VRBT group (11 subjects including 3 women, 65.26 years old) and control group (11 subjects including 5 women, 63.13 years old). Both groups participated in a standard rehabilitation program (physical and occupational therapy) for 60 min a day, 5 times a week for 6 weeks. In addition, the VRBT group participated in VRBT for 30 min a day, 3 times a week for 6 weeks. Static balance (postural sway velocity with eyes open or closed) was evaluated with the posturography. Dynamic balance was evaluated with the Berg Balance Scale (BBS) and Timed Up and Go test (TUG) that measures balance and mobility in dynamic balance. There was greater improvement on BBS (4.00 vs. 2.81 scores) and TUG (-1.33 vs. -0.52 sec) in the VRBT group compared with the control group (P < 0.05), but not on static balance in both groups. In conclusion, we demonstrate a significant improvement in dynamic balance in chronic stroke patients with VRBT. VRBT is feasible and suitable for chronic stroke patients with balance deficit in clinical settings.

Source: Medline
Available in fulltext from Tohoku Journal of Experimental Medicine at EBSCOhost

Title: Suitability of Nintendo Wii Balance Board for rehabilitation of standing after stroke.
Citation: Physical Therapy Reviews, 01 October 2012, vol./is. 17/5(311-321), 10833196
Author(s): Harvey, Nathan, Ada, Louise
Language: English
Abstract: Background: Normal standing requires ongoing postural adjustments while performing a variety of everyday tasks. Reduced muscle strength and
dexterity affect the ability to stand after stroke. Biofeedback has been shown to be effective in training lower limb activities in people with stroke. Nintendo Wii, Nintendo Wii Balance Board, and Nintendo Wii Fit Plus are potentially useful devices for providing feedback to train standing after stroke. Objectives: What specific Nintendo Wii Fit Plus games are suitable for rehabilitation of standing in patients with stroke? Method: A criteria-based review of the Nintendo Wii Fit Plus was carried out to determine the movements required, feedback provided, demands upon the patient, difficulty of and instruction provided by the Nintendo Wii Fit Plus games in the context of stroke rehabilitation. Seventy-five Nintendo Wii Fit Plus games were reviewed and 20 were included for in-depth review. Major findings: The games require movements of the centre of mass in different directions, provide feedback in different ways and place additional physical and cognitive demands upon the patient. Only five games are suitable for people who have severely impaired ability to stand. Six games are suitable for people with moderately impaired standing and nine games are suitable only for people with mildly impaired standing ability. Game goals and the position of the patient can be modified to make the games target physiotherapy goals. Conclusions: Enough suitable games exist to make the Nintendo Wii and Nintendo Wii Fit Plus an appropriate biofeedback device for rehabilitation of standing after stroke. 

**Publication Type:** journal article  
**Source:** CINAHL

**Title:** Stroke patients' experiences with Wii Sports during inpatient rehabilitation.  
**Citation:** Scandinavian Journal of Occupational Therapy, September 2012, vol./is. 19/5(457-63), 1103-8128;1651-2014 (2012 Sep)  
**Author(s):** Celinder D, Peoples H  
**Language:** English  
**Abstract:** INTRODUCTION: Commercial virtual reality games have been used as adjunct therapy for stroke rehabilitation, mainly after patients have been discharged. The aim of this study was to explore stroke patients' experiences with Wii Sports as a supplement to conventional occupational therapy in a controlled hospital setting. MATERIALS AND METHODS: The study had a qualitative triangulation design that included semi-structured interviews and field notes. Nine Danish stroke patients participated, receiving between one and nine interventions with Wii Sports during a three-week period. Responses were coded by qualitative content analysis. RESULTS: Analysis revealed one overarching category, "Connecting to past, present, and future occupations", and three categories that encompassed patients' experiences with Wii: (i) variety, (ii) engagement, and (iii) obstacles and challenges. Interview findings were confirmed by field notes that included observations of engagement and challenges. DISCUSSION: Stroke patients in hospital settings may experience Wii Sports as a beneficial and challenging occupation for both rehabilitation and leisure. Incorporation of Wii Sports into conventional occupational therapy services may benefit patient rehabilitation directly or provide motivation for alternative leisure activities.  
**Publication Type:** Journal Article, Research Support, Non-U.S. Gov't  
**Source:** MEDLINE  
**Full Text:** Available from the ULHT Library and Knowledge Services' eJournal collection in Scandinavian Journal of Occupational Therapy  
**Available from** the ULHT Library and Knowledge Services' eJournal collection in Scandinavian Journal of Occupational Therapy

**Title:** Seven capital devices for the future of stroke rehabilitation.  
**Citation:** Stroke Research and Treatment, 2012, vol./is. 2012/(187965), 2042-0056 (2012)  
**Author(s):** Iosa M, Morone G, Fusco A, Bragoni M, Coiro P, Multari M, Venturiero V, De Angelis D, Pratesi L, Paolucci S
Abstract: Stroke is the leading cause of long-term disability for adults in industrialized societies. Rehabilitation's efforts are tended to avoid long-term impairments, but, actually, the rehabilitative outcomes are still poor. Novel tools based on new technologies have been developed to improve the motor recovery. In this paper, we have taken into account seven promising technologies that can improve rehabilitation of patients with stroke in the early future: (1) robotic devices for lower and upper limb recovery, (2) brain computer interfaces, (3) noninvasive brain stimulators, (4) neuroprostheses, (5) wearable devices for quantitative human movement analysis, (6) virtual reality, and (7) tablet-pc used for neurorehabilitation.

Title: Effects of virtual reality on upper extremity function and activities of daily living performance in acute stroke: a double-blind randomized clinical trial.

Citation: Neurorehabilitation, 2012, vol./is. 31/4(379-85), 1053-8135;1878-6448 (2012)

Author(s): Kwon JS, Park MJ, Yoon IJ, Park SH

Abstract: AIM: To examine the effects of conventional therapy (CT) combined with intensive virtual reality (VR) program on upper extremity function and activities of daily living (ADL) in individuals in the acute stage of stroke. METHOD: Twenty-six individuals were randomly assigned to the control or experimental group. The control group received CT, while the experimental group received VR training in addition to CT on same day. The Fugl-Meyer Assessment (FMA) and the Manual Function Test (MFT) were used to measure improvement of functioning in the affected limb and the Korean version of the Modified Barthel Index (K-MBI) was conducted to evaluate ADL. RESULT: In tests of upper extremity functioning, VR group showed significant improvement on FMA and MFT (p< 0.05). In the CT group, only FMA score showed significant change (p< 0.05). ADL performance improved significantly in both groups (p< 0.05). However, there were no significant differences between the two groups in upper extremity function and ADL performance (p> 0.05). CONCLUSION: This study observed that VR training has the advantage of improving intended arm function during intensive training for individuals in the acute stage of stroke.

Title: Cochrane review: virtual reality for stroke rehabilitation.

Citation: European journal of physical & rehabilitation medicine., September 2012, vol./is. 48/3(523-30), 1973-9087;1973-9095 (2012 Sep)

Author(s): Laver K, George S, Thomas S, Deutsch JE, Crotty M

Abstract: AIM: Virtual reality and interactive video gaming are innovative therapy approaches in the field of stroke rehabilitation. The primary objective of this review was to determine the effectiveness of virtual reality on motor function after stroke. The impact on secondary outcomes including activities of daily living was also assessed. METHODS: Randomised and quasi-randomised controlled trials that compared virtual reality with an alternative or no intervention were included in the review. The authors searched the Cochrane Stroke Group Trials Register, the Cochrane Central Register of Controlled Trials, electronic databases, trial registers, reference lists, Dissertation Abstracts, conference proceedings and contacted key...
researchers and virtual reality manufacturers. Search results were independently examined by two review authors to identify studies meeting the inclusion criteria.

**RESULTS:** Nineteen studies with a total of 565 participants were included in the review. Variation in intervention approaches and outcome data collected limited the extent to which studies could be compared. Virtual reality was found to be significantly more effective than conventional therapy in improving upper limb function (standardised mean difference, SMD) 0.53, 95% confidence intervals [CI] 0.25 to 0.81) based on seven studies, and activities of daily living (ADL) function (SMD 0.81, 95% CI 0.39 to 1.22) based on three studies. No statistically significant effects were found for grip strength (based on two studies) or gait speed (based on three studies).

**CONCLUSION:** Virtual reality appears to be a promising approach however, further studies are required to confirm these findings.

**Publication Type:** Journal Article

**Source:** MEDLINE

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**A feasibility study of an upper limb rehabilitation system using Kinect and computer games.**

**Author(s)** Pastor I, Hayes HA, Bamberg SJ

**Citation:** Conference Proceedings: ... Annual International Conference of the IEEE Engineering in Medicine & Biology Society, 2012, vol./is. 2012/(1286-9), 1557-170X;1557-170X (2012)

**Publication Date:** 2012

**Abstract:** A new low-cost system for rehabilitation of the impaired upper limb for stroke survivors is presented. A computer game was developed specifically for this purpose and the user's impaired upper extremity is tracked using a downward-pointed Kinect, an inexpensive motion capture system commercially available from Microsoft. A Kalman filter was implemented to reduce data jittering. Patients are required to move their impaired arm, sliding it on top of a transparent support, in order to play the game. The game is personalized to the patient through specific settings that adapt to the patient's range of motion and motor control at the start of the game as well as performance during the game. The final score is proportional to the arm's movement speed. A feasibility study was carried out with one stroke survivor. The game was played for ten days and usability surveys were answered before and after the study. The patient was engaged with the game, found it easy to understand and reported willingness to use it in the home environment and enjoyment of the use in the clinic.

**Source:** Medline

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**Balance recovery through virtual stepping exercises using Kinect skeleton tracking: a follow-up study with chronic stroke patients.**

**Author(s)** Llorens R, Alcaniz M, Colomer C, Navarro MD

**Citation:** Studies in Health Technology & Informatics, 2012, vol./is. 181/(108-12), 0926-9630;0926-9630 (2012)

**Publication Date:** 2012

**Abstract:** Stroke patients often suffer from hemiparesis, which affects their balance condition and consequently their self-dependency and quality of life. Balance rehabilitation can be a long and tedious process. Virtual rehabilitation systems have been reported to provide therapeutic benefits to the balance recovery of stroke patients while increasing their motivation. This paper presents a follow-up study involving chronic stroke patients to evaluate the clinical effectiveness of a virtual stepping exercise using skeleton tracking through a low-cost Kinect depth sensor.

**Source:** Medline

**Available in fulltext from Studies in Health Technology and Informatics at EBSCOhost**

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**Development and evaluation of low cost game-based balance rehabilitation tool**
The use of the commercial video games as rehabilitation tools, such as the Nintendo WiiFit, has recently gained much interest in the physical therapy arena. Motion tracking controllers such as the Nintendo Wiimote are not sensitive enough to accurately measure performance in all components of balance. Additionally, users can figure out how to "cheat" inaccurate trackers by performing minimal movement (e.g. wrist twisting a Wiimote instead of a full arm swing). Physical rehabilitation requires accurate and appropriate tracking and feedback of performance. To this end, we are developing applications that leverage recent advances in commercial video game technology to provide full-body control of animated virtual characters. A key component of our approach is the use of newly available low cost depth sensing camera technology that provides markerless full-body tracking on a conventional PC. The aim of this research was to develop and assess an interactive game-based rehabilitation tool for balance training of adults with neurological injury.

Title: Activity-promoting gaming systems in exercise and rehabilitation.
Citation: Journal of Rehabilitation Research & Development, 15 December 2011, vol./is. 48/10(1171-1186), 07487711
Author(s): Taylor, Matthew J. D., McCormick, Darren, Shawis, Teshk, Impson, Rebecca, Griffin, Murray
Language: English
Abstract: Commercial activity-promoting gaming systems provide a potentially attractive means to facilitate exercise and rehabilitation. The Nintendo Wii, Sony EyeToy, Dance Dance Revolution, and Xbox Kinect are examples of gaming systems that use the movement of the player to control gameplay. Activity-promoting gaming systems can be used as a tool to increase activity levels in otherwise sedentary gamers and also be an effective tool to aid rehabilitation in clinical settings. Therefore, the aim of this current work is to review the growing area of activity-promoting gaming in the context of exercise, injury, and rehabilitation.
Publication Type: journal article
Source: CINAHL
Full Text: Available from EBSCOhost in Journal of Rehabilitation Research and Development

Title: Nintendo wii sports and wii fit game analysis, validation, and application to stroke rehabilitation.
Citation: Topics in Stroke Rehabilitation, November 2011, vol./is. 18/6(701-19), 1074-9357;1074-9357 (2011 Nov-Dec)
Language: English
Abstract: BACKGROUND: Interactive video gaming has become ubiquitous in the practice of rehabilitation. The Nintendo Wii is one such system. Interactive gaming can promote intensive task-based therapy in a manner that is motivating for the user. Widespread enthusiasm for consoles and their games prompted us to analyze the games for their rehabilitation elements related to improving balance and mobility for individuals poststroke.PURPOSE: The purpose of this article is to provide a game analysis for clinical application and evaluation of the game elements for research on interactive video gaming. Methods: Using a team of
game players and raters, 5 tables (1 for the Wii Sports and 4 for the Wii Fit) were
developed and validated. The tables consist of 3 categories: game description,
impairments targeted (strength, endurance, balance, and coordination), and
feedback provided (knowledge of performance [KP] and knowledge of results
[KR]). Two domain content experts established face validity. Construct validity was
performed by 2 therapist-raters who had more than 15 years’ clinical experience
and postgraduate training in motor learning. Observations about the games
including the fidelity of the interfaces, the nature of the feedback, and some of the
challenges to adapting the games for rehabilitation are presented.RESULTS: An
80% agreement between raters set as the criterion for establishing the construct
validity was met for feedback evaluation. There was 100% agreement on
impairment ratings. Games provide a greater amount of KR compared with
KP.CONCLUSION: Given the preponderance of KR, therapists will need to monitor
motor performance. Adaptation of interactive video consoles for rehabilitation
requires careful evaluation of the games' attributes using relevant rehabilitation
construits.

Publication Type: Journal Article
Source: MEDLINE

Title: Wii-rehabilitation for stroke -- gimmick or goal achieving? A pilot study
evaluating the use of a commercially available games console in improving upper
limb function as part of stroke rehabilitation... Occupational Therapy Australia, 24th
National Conference and Exhibition, 29 June - 1 July 2011.

Citation: Australian Occupational Therapy Journal, 02 June 2011, vol./is. 58/(82-
82), 00450766

Author(s): Hawkes A
Language: English

Publication Type: journal article
Source: CINAHL

Full Text: Available from the ULHT Library and Knowledge Services’ eJournal collection in
Australian Occupational Therapy Journal

Available from EBSCOhost in Australian Occupational Therapy Journal

Title: Wii-based movement therapy to promote improved upper extremity function

Citation: Journal of Rehabilitation Medicine, May 2011, vol./is. 43/6(527-33), 1650-
1977;1651-2081 (2011 May)

Author(s): Mouawad MR, Doust CG, Max MD, McNulty PA
Language: English

Abstract: BACKGROUND: Virtual-reality is increasingly used to improve
rehabilitation outcomes. The Nintendo Wii offers an in-expensive alternative to
more complex systems.OBJECTIVE: To investigate the efficacy of Wii-based
therapy for post-stroke rehabilitation.METHODS: Seven patients (5 men, 2 women,
age 42-83 years; 1-38 months post-stroke, mean 15.3 months) and 5 healthy
controls (3 men, 2 women, aged 41-71 years) undertook 1 h of therapy on 10
consecutive weekdays. Patients progressively increased home practice to 3 h per
day.RESULTS: Functional ability improved for every patient. The mean
performance time significantly decreased per Wolf Motor Function Test task, from
3.2 to 2.8 s, and Fugl-Meyer Assessment scores increased from 42.3 to 47.3.
Upper extremity range-of-motion increased by 20.1o and 14.33o for passive and
active movements, respectively. Mean Motor Activity Log (Quality of Movement
scale) scores increased from 63.2 to 87.5, reflecting a transfer of functional
recovery to everyday activities. Balance and dexterity did not improve significantly.
No significant change was seen in any of these measures for healthy controls,
despite improved skill levels for Wii games.CONCLUSION: An intensive 2-week
protocol resulted in significant and clinically relevant improvements in functional
motor ability post-stroke. These gains translated to improvement in activities of daily living.

**Publication Type:** Journal Article, Research Support, Non-U.S. Gov't

**Source:** MEDLINE

**Title:** Bilateral upper-limb rehabilitation after stroke using a movement-based game controller.

**Citation:** Journal of Rehabilitation Research & Development, 2011, vol./is. 48/8(1005-13), 0748-7711;1938-1352 (2011)

**Author(s):** Hijmans JM, Hale LA, Satherley JA, McMillan NJ, King MJ

**Language:** English

**Abstract:** This study aimed to determine the effectiveness of a bilateral, self-supported, upper-limb rehabilitation intervention using a movement-based game controller for people with chronic stroke. Fourteen participants received a control treatment, followed by a washout period, and then the intervention. The intervention comprised playing computer games with the CyWee Z (CyWee Group Ltd; Taipei, Taiwan), a movement-based game controller similar to the Nintendo Wii remote. The CyWee Z was incorporated into a handlebar, making bilateral exercises possible by allowing the unaffected side to support and assist the affected side. The intervention lasted for 8 to 10 sessions of 45 to 60 minutes over a period of 2.5 weeks. The Fugl-Meyer Assessment upper-limb section (FMA-UL) was used as the primary outcome. The Wolf Motor Function Test and the Disabilities of Arm, Shoulder, and Hand outcome measure were used as secondary outcomes. Postintervention, motor performance as measured by the FMA-UL was significantly improved compared with all preintervention assessments (p < 0.001), whereas no changes were found on both secondary outcomes. It can be concluded from this pilot study that upper-limb motor performance of adults with chronic stroke improves with repetitive, game-assisted, self-supported bilateral exercises.

**Publication Type:** Journal Article, Research Support, Non-U.S. Gov't

**Source:** MEDLINE

**Full Text:** Available from EBSCOhost in Journal of Rehabilitation Research and Development

**Title:** Energy expenditure in chronic stroke patients playing Wii Sports: a pilot study.

**Citation:** Journal of Neuroengineering & Rehabilitation, 2011, vol./is. 8/(38), 1743-0003;1743-0003 (2011)

**Author(s):** Hurkmans HL, Ribbers GM, Streur-Kranenburg MF, Stam HJ, van den Berg-Emons RJ

**Language:** English

**Abstract:** BACKGROUND: Stroke is one of the leading causes of long-term disability in modern western countries. Stroke survivors often have functional limitations which might lead to a vicious circle of reduced physical activity, deconditioning and further physical deterioration. Current evidence suggests that routine moderate- or vigorous-intensity physical activity is essential for maintenance and improvement of health among stroke survivors. Nevertheless, long-term participation in physical activities is low among people with disabilities. Active video games, such as Nintendo Wii Sports, might maintain interest and improve long-term participation in physical activities; however, the intensity of physical activity among chronic stroke patients while playing Wii Sports is unknown. We investigated the energy expenditure of chronic stroke patients while playing Wii Sports tennis and boxing.METHODS: Ten chronic (>=6 months) stroke patients comprising a convenience sample, who were able to walk independently on level ground, were recruited from a rehabilitation centre. They were instructed to play Wii Sports tennis and boxing in random order for 15 minutes each, with a 10-minute break between games. A portable gas analyzer was used to measure
Oxygen uptake (VO2) during sitting and during Wii Sports game play. Energy expenditure was expressed in metabolic equivalents (METs), calculated as VO2 during Wii Sports divided by VO2 during sitting. We classified physical activity as moderate (3-6 METs) or vigorous (>6 METs) according to the American College of Sports Medicine and the American Heart Association Guidelines.

RESULTS: Among the 10 chronic stroke patients, 3 were unable to play tennis because they had problems with timing of hitting the ball, and 2 were excluded from the boxing group because of a technical problem with the portable gas analyzer. The mean (±SD) energy expenditure during Wii Sports game play was 3.7 (±0.6) METs for tennis and 4.1 (±0.7) METs for boxing. All 8 participants who played boxing and 6 of the 7 who played tennis attained energy expenditures >3 METs.

CONCLUSIONS: With the exception of one patient in the tennis group, chronic stroke patients played Wii Sports tennis and boxing at moderate-intensity, sufficient for maintaining and improving health in this population.

Publication Type: Journal Article
Source: MEDLINE
Full Text: Available from BioMedCentral in Journal of NeuroEngineering and Rehabilitation
Available from National Library of Medicine in Journal of NeuroEngineering and Rehabilitation

Title: Effectiveness of virtual reality using Wii gaming technology in stroke rehabilitation: a pilot randomized clinical trial and proof of principle.
Citation: Stroke, July 2010, vol./is. 41/7(1477-84), 0039-2499;1524-4628 (2010 Jul)
Language: English
Abstract: BACKGROUND AND PURPOSE: Hemiparesis resulting in functional limitation of an upper extremity is common among stroke survivors. Although existing evidence suggests that increasing intensity of stroke rehabilitation therapy results in better motor recovery, limited evidence is available on the efficacy of virtual reality for stroke rehabilitation.

METHODS: In this pilot, randomized, single-blinded clinical trial with 2 parallel groups involving stroke patients within 2 months, we compared the feasibility, safety, and efficacy of virtual reality using the Nintendo Wii gaming system (VRWii) versus recreational therapy (playing cards, bingo, or "Jenga") among those receiving standard rehabilitation to evaluate arm motor improvement. The primary feasibility outcome was the total time receiving the intervention. The primary safety outcome was the proportion of patients experiencing intervention-related adverse events during the study period. Efficacy, a secondary outcome measure, was evaluated with the Wolf Motor Function Test, Box and Block Test, and Stroke Impact Scale at 4 weeks after intervention.

RESULTS: Overall, 22 of 110 (20%) of screened patients were randomized. The mean age (range) was 61.3 (41 to 83) years. Two participants dropped out after a training session. The interventions were successfully delivered in 9 of 10 participants in the VRWii and 8 of 10 in the recreational therapy arm. The mean total session time was 388 minutes in the recreational therapy group compared with 364 minutes in the VRWii group (P=0.75). There were no serious adverse events in any group. Relative to the recreational therapy group, participants in the VRWii arm had a significant improvement in mean motor function of 7 seconds (Wolf Motor Function Test, 7.4 seconds; 95% CI, -14.5, -0.2) after adjustment for age, baseline functional status (Wolf Motor Function Test), and stroke severity.

CONCLUSIONS: VRWii gaming technology represents a safe, feasible, and potentially effective alternative to facilitate rehabilitation therapy and promote motor recovery after stroke.

Publication Type: Clinical Trial, Comparative Study, Journal Article, Randomized
A feasibility study using interactive commercial off-the-shelf computer gaming in upper limb rehabilitation in patients after stroke.

**Citation:** Journal of Rehabilitation Medicine, May 2010, vol./is. 42/5(437-41), 1650-1977;1651-2081 (2010 May)

**Author(s):** Yong Joo L, Soon Yin T, Xu D, Thia E, Pei Fen C, Kuah CW, Kong KH

**Language:** English

**Abstract:** BACKGROUND: Commercial off-the-shelf computer gaming devices have been making inroads into the rehabilitation arena, with the objective of making therapeutic exercise fun and contextual. One such device is the Nintendo Wii. Published clinical studies evaluating its acceptance, potential benefits and side-effects in the rehabilitation of patients with post-stroke weakness are few in number.

OBJECTIVE: The aim of this study is to assess the feasibility of using the Nintendo Wii as an adjunct to conventional rehabilitation of patients with post-stroke upper limb weakness.

METHODS: Twenty rehabilitation inpatients within 3 months after a stroke with upper limb weakness received 6 sessions of upper limb exercises via a Nintendo Wii over 2 weeks in addition to conventional rehabilitation. Outcome measures include a questionnaire, Fugl-Meyer Assessment of Upper Limb Motor Function and visual analogue scale of upper limb pain.

RESULTS: A total of 16 subjects completed the study. All 16 found Nintendo Wii gaming enjoyable and comparable to, if not better than, conventional therapy. There were small but statistically significant improvements in the Fugl-Meyer Assessment and Motricity Index scores.

CONCLUSION: Nintendo Wii appears to be a feasible adjunctive device to augment conventional therapy in a cohort of subacute stroke patients with moderate impairments of upper limb strength and function.

**Publication Type:** Comparative Study, Journal Article

**Source:** MEDLINE

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**Title:** Effectiveness of Virtual Reality Exercises in STroke Rehabilitation (EVREST): rationale, design, and protocol of a pilot randomized clinical trial assessing the Wii gaming system.

**Citation:** International Journal of Stroke, February 2010, vol./is. 5/1(47-51), 1747-4930;1747-4949 (2010 Feb)

**Author(s):** Saposnik G, Mamdani M, Bayley M, Thorpe KE, Hall J, Cohen LG, Teasell R, EVREST Steering Committee, EVREST Study Group for the Stroke Outcome Research Canada Working Group

**Language:** English

**Abstract:** BACKGROUND: Evidence suggests that increasing intensity of rehabilitation results in better motor recovery. Limited evidence is available on the effectiveness of an interactive virtual reality gaming system for stroke rehabilitation. EVREST was designed to evaluate feasibility, safety and efficacy of using the Nintendo Wii gaming virtual reality (VRWii) technology to improve arm recovery in stroke patients.

METHODS: Pilot randomized study comparing, VRWii versus recreational therapy (RT) in patients receiving standard rehabilitation within six months of stroke with a motor deficit of > or =3 on the Chedoke-McMaster Scale (arm). In this study we expect to randomize 20 patients. All participants (age 18-85) will receive customary rehabilitative treatment consistent of a standardized protocol (eight sessions, 60 min each, over a two-week period).

OUTCOME MEASURES: The primary feasibility outcome is the total time receiving the intervention. The primary safety outcome is the proportion of patients experiencing intervention-related adverse events during the study period. Efficacy, a secondary outcome
measure, will be measured by the Wolf Motor Function Test, Box and Block Test, and Stroke Impact Scale at the four-week follow-up visit. From November, 2008 to September, 2009 21 patients were randomized to VRWii or RT. Mean age, 61 (range 41-83) years. Mean time from stroke onset 25 (range 10-56) days.

CONCLUSIONS: EVREST is the first randomized parallel controlled trial assessing the feasibility, safety, and efficacy of virtual reality using Wii gaming technology in stroke rehabilitation. The results of this study will serve as the basis for a larger multicentre trial. ClinicalTrials.gov registration# NCT692523.

**Publication Type:** Journal Article, Randomized Controlled Trial, Research Support, Non-U.S. Gov’t

**Source:** MEDLINE

Effectiveness of Virtual Reality Using Wii Gaming Technology in Stroke Rehabilitation. (2010), Stroke 41, pages 1477-1484. Saposnik

Background and Purpose—Hemiparesis resulting in functional limitation of an upper extremity is common among stroke survivors. Although existing evidence suggests that increasing intensity of stroke rehabilitation therapy results in better motor recovery, limited evidence is available on the efficacy of virtual reality for stroke rehabilitation.

Methods—In this pilot, randomized, single-blinded clinical trial with 2 parallel groups involving stroke patients within 2 months, we compared the feasibility, safety, and efficacy of virtual reality using the Nintendo Wii gaming system (VRWii) versus recreational therapy (playing cards, bingo, or “Jenga”) among those receiving standard rehabilitation to evaluate arm motor improvement. The primary feasibility outcome was the total time receiving the intervention. The primary safety outcome was the proportion of patients experiencing intervention-related adverse events during the study period. Efficacy, a secondary outcome measure, was evaluated with the Wolf Motor Function Test, Box and Block Test, and Stroke Impact Scale at 4 weeks after intervention.

Results—Overall, 22 of 110 (20%) of screened patients were randomized. The mean age (range) was 61.3 (41 to 83) years. Two participants dropped out after a training session. The interventions were successfully delivered in 9 of 10 participants in the VRWii and 8 of 10 in the recreational therapy arm. The mean total session time was 388 minutes in the recreational therapy group compared with 364 minutes in the VRWii group (P=0.75). There were no serious adverse events in any group. Relative to the recreational therapy group, participants in the VRWii arm had a significant improvement in mean motor function of 7 seconds (Wolf Motor Function Test, 7.4 seconds; 95% CI, −14.5, −0.2) after adjustment for age, baseline functional status (Wolf Motor Function Test), and stroke severity.

Conclusions—VRWii gaming technology represents a safe, feasible, and potentially effective alternative to facilitate rehabilitation therapy and promote motor recovery after stroke.
Abstract: Aims/background: Off-the-shelf games for consoles such as the Nintendo Wii, Nintendo WiiFit and Sony PlayStation 2 EyeToy have been developed and tested for the purpose of entertainment. Many clinics are adopting the use of these off-the-shelf devices for exercise, social interaction and rehabilitation because they are affordable, accessible and can be used within the clinic and home. Our group carried out initial usability evaluations for these off-the-shelf games and a prototype game (using an off-the-shelf device) specifically developed for people with disabilities. Methods: A series of studies have been undertaken through formative and summative evaluation and focus group research with a sample of people recovering from spinal cord injury, traumatic brain injury and stroke. Findings from two studies are presented. Following a demonstration and trial of the devices, observational and questionnaire data were collected to determine participants' perception of each system's usability, appeal and enjoyment. Results: The first study involved evaluation and focus group discussions of seven participants (two females, five males) with SCI (n=4) and CVA (n=3). Findings indicated that interaction with the EyeToy interface appeared to be more intuitive than the use of the Wii-mote interaction device, although some participants had difficulty navigating the menu of the PlayStation EyeToy. The second study involved evaluation of six participants (SCI=4 males, TBI=1 male, CVA=1 female), aged between 25 and 58 years. The investigator was able to increase or decrease the difficulty of a game (developed specifically for bimanual rehabilitation task), using an off-the-shelf haptic feedback device, for each participant, depending on their skill level so that each participant was able to work at a level that was challenging to them. In both studies, participants reported that they would be more motivated to exercise if playing these types of games in both the clinic and home setting. Conclusion: This series of usability tests is the first phase within a program of work using gaming for a range of physical disabilities. The use of virtual reality and video games for rehabilitation offers potential for motivating patients to perform specific therapy tasks.

Source: AMED
Available in fulltext from Physical Therapy Reviews at EBSCOhost


Citation: International Journal of Rehabilitation Research, 01 August 2009, vol./is. 32/(0-), 03425282
Author(s): Brown R, Sugarman H, Burstin A
Language: English
Publication Type: journal article
Source: CINAHL

Title: Case history: use of the Nintendo Wii to increase fine motor dexterity post cerebral vascular accident.

Citation: American Journal of Recreation Therapy, 01 July 2009, vol./is. 8/3(41-46), 15394131
Author(s): Drexler K
Language: English
Abstract: Use of the low cost commercially available gaming console (Nintendo Wii) is a current trend in the rehabilitation environment. Released in 2006 by Nintendo, Veterans Affairs Medical Centers across the country are just setting one, Wii is being used as a physical, social, and cognitive tool. This case report seeks to provide evidence of its use as a rehabilitation tool for individuals who have
experienced a recent stroke. By using whole body movements, the Wii sports games help in both gross motor and fine motor skills as well as in hand-eye coordination. This case study involves an older adult who is recovering from a cerebral vascular accident (CVA) and how using the Wii bowling game assisted to increase his fine motor strength and dexterity. CVA or stroke also called a "brain attack" can affect various parts of the brain. There are various signs and symptoms of CVA and these vary in each individual. Some of the signs that an individual having CVA shows are: sudden numbness or weakness of the face, arm or leg (especially on one side of the body), sudden confusion, trouble speaking, or understanding speech, sudden trouble seeing in one or both eyes, sudden trouble walking, dizziness, loss of balance or coordination, sudden severe headache with no known cause. This case study involved an older adult who experienced a CVA involving hemorrhage in the right cerebellum as revealed in a CT scan. This CVA affected the right hand of this individual. Hemorrhagic stroke occurs when a blood vessel in the brain ruptures. This lets blood to spill into nearby brain tissue, which damages the cells. Some brain cells die because their normal blood supply is cut off. Certified Therapeutic Recreation Specialist and Author of this case article utilized the Salisbury Veterans Affairs Medical Center Recreational Therapy initial intake assessment and discovered per patient's report that he had decreased strength and fine motor dexterity in the fingers of his right hand status post CVA. This patient reported that after his stroke, he was not able to hold a utensil in his right hand. This case study speaks the use of the Nintendo Wii in assisting patient to regain use of the fingers of the hand that was affected by the CVA. This article can provide information for other Certified Therapeutic Recreation Specialists as to the use of the Nintendo WiiTM as a treatment modality. This device can demonstrate outcomes of improving fine motor dexterity for those who are recovering from a CVA.

**Publication Type:** journal article  
**Source:** CINAHL

**Title:** The potential of Wii-rehabilitation for persons recovering from acute stroke.  
**Citation:** Physical Disabilities Special Interest Section Quarterly, 01 March 2009, vol./is. 32/1(1-3), 10937234  
**Author(s):** Brosnan S  
**Language:** English  
**Publication Type:** journal article  
**Source:** CINAHL

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T Exell, C Freeman, K Meadmore, M Kutlu, E Hallewell... - 2013 - eprints.soton.ac.uk

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R Brown, H Sugarman, A Burstin - International Journal of ..., 2009 - journals.lww.com

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JE Deutsch, D Robbins, J Morrison... - Virtual Rehabilitation ..., 2009 - ieeexplore.ieee.org

... Enthusiasm for new therapies needs to be tempered with evidence of efficacy with particular attention to retention of gains. Keywords: Interactive Computer Gaming, Nintendo Wii, Wii- Sports, Wii-fit, balance, gait, gaming, virtual reality, stroke. Interactive computer gaming ... Cited by 29 Related articles All 2 versions Cite

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JW Burke, MDJ McNeill, DK Charles... - Games and Virtual ..., 2009 - ieeexplore.ieee.org ... 11]. Recently our research group organised an informal two-day evaluation of commercial games (including the Sony EyeToy and Nintendo Wii) with a group of health professionals working in stroke rehabilitation. Feedback ... Cited by 47 Related articles All 7 versions Cite

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JE Deutsch, A Brettler, C Smith, J Welsh... - Topics in stroke ..., 2011 - Thomas Land

Background: Interactive video gaming has become ubiquitous in the practice of rehabilitation. The Nintendo Wii is one such system. Interactive gaming can promote intensive task-based therapy in a manner that is motivating for the user. Widespread ... Cited by 5 Related articles All 3 versions Cite

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G Alankus, A Lazar, M May, C Kelleher - Proceedings of the 28th ..., 2010 - dl.acm.org

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Abstract The Nintendo Wiimote sends 22 byte data packets to the Wii console over a Bluetooth wireless channel at a typical rate of 100 packets per second. The Wiimote wireless channel can be made to carry arbitrary digitized analog data via an I 2 C serial expansion ... Cited by 3 Related articles All 2 versions Cite