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A feasibility study using interactive commercial off-the-shelf computer gaming in upper limb rehabilitation in patients after stroke.	Joo et al.; 2010	The Nintendo Wii™ (NW) gaming system, was used for this study, as it detects the user's movement and acceleration in 3 dimensions using a wireless handheld pointing device (Wiimote) housing a gyroscope and an accelerometer. Using various commercially available games (including sports themed games).	2 weeks per patient	The Wii detects specific movements and acceleration in 3 dimensions, via a wireless handheld pointing device. It is held by the user, and a sensor bar connected to the console. Different games are designed to test the skills of the user in executing and acceleration of the upper limbs as specified by the games. The NW was set up and calibrated before each training session. The sensor was positioned either above the television or at the base of television. The subject was asked to hold the	Patients of the study after stroke with upper limb weakness. The patients were recruited from the inpatient rehabilitation unit of a Singapore Rehabilitation Centre. Patients were included if they were less than 3 months post-stroke, had Medical Research Council motor power of at least grade 2 in the hemiplegic upper extremity. They were excluded if they had a history of epilepsy, arthritis or pain in the affected upper limb restricting repetitive exercises, severe aphasia or cognitive impairment, or other psychiatric illnesses	The player uses part or whole of the upper limb to perform tasks (e.g. swinging a virtual tennis racket or throwing a virtual bowling ball). The games are designed to be fun and interactive, with scores and various motivational features (e.g. in-game medals, encouraging commentaries, video playbacks, bonuses, music, etc.) to encourage the user	6 sessions per day for 30 minutes	Outcome measures include a questionnaire, Fugl-Meyer Assessment of Upper Limb Motor Function and visual analogue scale of upper limb pain.
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				Wiimote. The Wiimote was strapped to their hand by either a customized fabric grasp assist. These adaptations were made after the therapist had assessed the subject's hand function at the beginning of the first session.	that limited their ability to participate or give consent.	repetitively to improve his or her performance.		
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A gaming adventure.	Ward et al.; 2005	For this study participants are required to play the game called "Adventures in Generose" in which individuals roll the die and move the "nurse" playing pieces to the space on the board that corresponds with the number on the die. Pick up a	N/a	Asking participants to learn through auditory, visual, and kinesthetic approaches and each person has a preferred learning style. Playing the colourful interactive, action-oriented game stimulants. And had them create their own characters.	Students were used to test the game.	The creation of these games were for educational purposes to address concepts: 1) need for knowledge or new skills 2) integrate new knowledge with current 3) active participation	N/a	What measured outcomes is: discerning therapeutic boundaries, medication management, teamwork, commutation and management of aggression.
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		scenario card that matches the coloured square landed on. Several obstacles are put in place.				and 4) ability to share life experiences.		
A gaming strategy for teaching the use of critical cardiovascular drugs	Saethang et al.; 1998	In the game developed for this study to test medical-surgical units for patients who will be receiving IV vasoactive drugs, listing cardiovascular agents. Etc. to test staff	N/a	Learners were divided into competing teams used to encourage consultation. A game board made of board with a wheel divided into six different coloured wedged in 6 different categories: drug dosage, action of drug, nursing implications, drug side effects, generic names.	Participants were nursing staff at hospitals.	Participants got individual cards with questions corresponding to categories	N/a	The outcome measurements: learning, knowledge, memory and education.
A randomized controlled trial to test the effectiveness of an immersive 3D	Scholten et al.; 2016	Dojo is an emotion management video game and incorporates two evidence-based	Screening data were collected between Novemb	The Dojo game focuses on HRV enhancement by training adolescence to gain awareness of	This study is for adolescence both male and female and there is a large variety of students mainly from higher	Dojo trains emotional strategies with instructional videos and then engaging	Participants played the game six times over three weeks, with two one-	It measures: muscle relaxation, bodily arousal and psychological arousal, deep-breathing, positive

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video game for anxiety in adolescents		strategies for reducing anxiety symptoms, emotion regulation training and heart rate variability. This is an electrocardiographic index of automatic control of the heart reflects change in consecutive heart beat intervals.	er 2013 and May 2014. The pre and post-test data were collected between January – July 2014.	their bodily arousal, to reduce psychological arousal, to become more flexible in physiological responses. The video game provides a self-regulated opportunity to practice the skills.	education.	players in immersive and emotion evoking puzzles that challenge players to acquire strategies.	hour sessions per week. These gaming sessions were held in a computer room with individual laptops.	thinking, and guided imagery.
*A serious games framework for health and rehabilitation	Rego et al.; 2010	The serious game tool includes three games that are controlled by using center-of-pressure (COP) signal biofeedback as the input device, and flexible pressure mat containing piezoelectricity resistive sensors that is placed		The patients interact with the virtual environment of the game using wireless magnetic sensors that track movements from upper body, affected arm and hand and two data gloves that capture hand postures and finger flex.		These serious games maintain the patient's interest, motivation, competitiveness and allowing customized treatment programs for individual patients. It includes virtual		

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		between the patients and the surface. The patient sits on the pressure mat, which is connected to the computer. There is a range of difficulty that could be adjusted.				reality (VR) used for therapy programs for stroke patients with upper limb disorders to motivate them to practice physical exercise. Improving social skills.		
A task-specific interactive game-based virtual reality rehabilitation system for patients with stroke: a usability test and two clinical experiments	Shin et al.; 2014	Using a task-specific game-based VR rehabilitation system called RehabMaster that provides an interactive rehabilitation setting. The patients sit in front of the monitor, facing an OpneNI-compliant depth sensor. The	Patients complete a 2-week intervention and a follow-up evaluation during the fourth week.	Providing the RehabMaster that is interactive where patients sit in front of a monitor, facing an OpneNI – compliant depth sensor.	Patients with hemiparetic upper limb dysfunction secondary to first-ever stroke to the habitation and neurorehabilitation unit of the hospital. They exhibited mild-to-severe deficits of paretic upper extremity. The exclusion criteria were pre-existing arm impairment, any	The underwater fire game was designed to train patients forearm movement and eye-hand coordination (patient is asked to use two weapons to target fish by performing elbow	30 min sessions at regular intervals twice a week for two weeks.	This program has four elements to measure: a user management module that contains information about each participant (medical record, history etc.) an assessment module that tracks the patients to imitate some of 40 different motions from an avatar, and

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		<p>sensor is a universal serial Bus plug-and-play device that translates a scene geometry into depth, the point at which it is located with an angle of 70 degrees, 0.8-3.5 m, and a response of 10 ms and generates images of the participants with resolution of 640 x 480 at 30 frames. A computer operated by Window 7 with a 2.9-GHz quad-core CPU and 4 GB SDRAM renders the image to a 60-inch monitor. This is monitored by the occupational therapist,</p>			<p>painful condition affecting the upper limbs, difficulty sitting for at least 20 mins, severe cognitive impairment and severe aphasia. All patients were provided a written informed consent</p>	<p>flexion/extension and shoulder rotation). The Goalkeeper and Bug hunter games train UE control, endurance, speed, accuracy and range of motion. (Patients controlled a goalkeeper's hands on display to catch the football). And the Rollercoaster game was designed to increase the control, speed and accuracy of UE and trunk movements. (Patients</p>		<p>rehabilitation games that provides an engaging form to exercise the use of these concepts.</p>
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		providing control of the patients training module and difficulty.				position their arms and trunk as shown by avatar).		
Activity-promoting gaming systems in exercise and rehabilitation.	Taylor et al.; 2011	Activity-promoting gaming systems such as the Nintendo Wii, Dance, Dance Revolution, Sony EyeToy and Xbox Kinect require player motion and weight bearing to control gameplay. For this study, the Wii was chosen. Movement is controlled by the Wii remote, nunchuck, or balance board. The Wii remote uses a three-axis accelerometer to translate body movement into onscreen movement.	N/a	These were asked to participate in 30 minutes of Wii activities per day plus additional exercise for the study to measure an increase in things such as coordination.	Patients were university students aiming to find a way to use these systems for those in need on rehabilitation.	Wii boxing and Wii tennis were involved.	30 minutes 5 days a week	For Wii Tennis, Baseball, and Boxing. These values were lower than self-paced brisk walking, respectively. For health gains, a combined session of playing the three games would not meet these guidelines. Wii Boxing appears to be the most beneficial game for EE because of the vigorous nature of the game and the need to use both arms for gameplay. Playing Wii Boxing and Tennis resulted in METs. Wii Boxing “provided marginal physiological

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		Controllers can be connected wirelessly to the console, allowing group play and social interaction. The Wii remote also provides basic audio and vibration feedback.						stimulus” compared with a fitness boxing video, with mean heart rate (HR) and rating of perceived exertion (RPE) greater for the latter.
Active video games as a form of exercise and the effect of gaming experience: a preliminary study in healthy young adults.	O'Donovan et al.; 2012	A Wii system was used in the study to measure the health in young adults.	N/a	Participants were divided into the Wii sports group and the Wii fit group.	Young non-smoking university students were participants of the study. Those with a history of cardiac or respiratory disease, musculoskeletal injury, lower back pain. Pregnant women were excluded.	Wii sports included: Boxing, baseball, tennis. Wii fit included: jogging.	30 minute sessions per sport/ activity.	The outcome measurements are: heartrate, and metabolic equivalents, energy.
Active video gaming improves body coordination in survivors of childhood brain tumours	Sabel et al.; 2016	An off-the-shelf motion-controlled video console, Nintendo Wii was used in the study aiming for a minimum of	12 weeks	Each child received two pairs of controls, which enabled them to play with friends, and a balance board, the Wii Fit.	Children 7–17 years old who completed treatment including RT, for a brain tumour between 1 and 5 years earlier, were eligible to	The following games were used: Wii Sports, Wii Sports Resort, Wii Fit and Wii Fit plus. Also,	30 minute sessions 5 days a week	This study measured motor coordination.



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		30min AVG per day, at least 5 days a week, for 10 weeks, but allowing to extend the period to 12 weeks to compensate for weeks being away or ill. The Nintendo Wii is controlled by one or two hand-held remote controls, and requires movement to play the games.		During the first home visit, the children created their own unique avatar and were instructed not to let anyone else use it. The video games used were pre-tested by the investigators and chosen according to the level of physical activity, balance and gross body movements required. Participants were instructed to start every session with a physically more demanding game for at least 10 min, before considering switching to a slower paced game, such as a balance game.	participate in the study. All were patients as the Children's Cancer Centre at Queen Silvia Children's Hospital. The inclusion criteria, were identified through the Swedish childhood cancer registry and hospital records. Patients were excluded if they had a medical condition making them unable to follow the study protocol, e.g. uncontrolled seizures, severe motor or visual impairment or autism or were not speaking Swedish.	several dance games were used: Just Dance 1–3 and Michael Jackson – the Experience.		
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Assessment of Voluntary Exercise Behavior and Active Video Gaming Among Adolescent and Young Adult Patients during Hematopoietic Stem Cell Transplantation	Rosipal et al.; 2013	Nintendo Wii, stationary bicycle with video games, and DDR dance pad were used in the study.	May-November 2010	All participants were asked to exercise for a minimum of 60 minutes per week and to distribute their weekly exercise time over at least 3 exercise sessions. Duration for individual exercise sessions were not defined, and participants were allowed to exercise more than 60 minutes per week, if they so desired. This flexibility in exercise prescription was designed to empower these patients by allowing them to manage their exercise behavior within the	Cancer Hospital, a component of The University of Texas M. D. Anderson Cancer Center. Eligibility criteria included patients aged 13 to 25 years, undergoing their first stem cell transplant, able to read and speak English, and medically cleared by their primary transplant physician.	Each participant was asked to select at least 1 piece of AVG equipment, which remained in the participant's room. The participant was instructed in the proper use of the equipment, also instructed in how to safely engage in standard exercise activities including walking, strength training, and playing basketball within the	60 minute sessions per week	These tests physically evaluated the strength, range of motion, gait, balance, and peripheral neural function of each participant using standard evaluation techniques prior to a participant's first exercise session. Physical performance status was assessed by having the patient perform both the 6-Minute Walk Test (6-MWT) and the Timed-Up-and-Go test (TUG). Both tests are reliable and valid tools in both healthy children and adolescents and in those with a chronic disease and/or disability. This also increased
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				<p>constraints imposed by their complex medical schedules and the daily variability in their overall medical status.</p>		<p>environmental constraints of the transplant facility. Each participant was asked to record in an activity log the type and duration of each exercise session. The principal investigator and research assistant visited the participants twice weekly to assist with completeness of the self-report activity logs and to answer questions as needed. Logs were collected on a weekly basis.</p>		<p>socialization in patients. Patients had access to standard exercise activities (walking, resistance training, and basketball) and active video gaming equipment. Physical function (6-Minute Walk Test and Timed-Up-and-Go test) and quality of life (Behavioral, Affective, and Somatic Experiences Scale) were assessed at different time points during admissions.</p>
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						Adherence, exercise frequency, exercise duration, and exercise preference (AVG vs standard exercise activities) were determined from the self-report activity logs.		
Blood clot: Gaming to reinforce learning about disseminated intravascular coagulation	Wargo et al. 2000	This study uses a gaming system called Blood Clot. That evaluates one's knowledge of DIC, and pathophysiology experienced with DIC, it includes a lecture outline and gaming answers.	1 day piolet game	The goal of the game is to cover a 3-inch circle in the middle of the game board with chips forming a blood clot. And each group must answer questions that are worth 3-5 chips. Making groups of 2-10 players	This was tested on young students.	The aim is to provide reinforced learning and collaboration between people.	40 minutes per game	This game demonstrates: positive reinforcement, group involvement, communication and creativity, memory, retention of material etc.
Brain Health and Online	Baxter; 2011	This study uses a "serious game" to	N/a	One area of lifestyle gaming	A range of different individuals and can	Brain fitness games	N/a	Online games can also offer a variety of

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Gaming		aid in rehabilitation in their study, that are a subset of the emerging genre of lifestyle games, which, in contrast, are generally less academic and more focused on experiences that can improve a person's life. Wii Fit is an example of a successful lifestyle game that has resonated strongly with broad audiences.		that has grown quickly is brain fitness. These games aim to increase brain reserve, the density of Wii Fit has gained widespread adoption in healthcare facilities. Neuroscience of the connections within the brain, which is widely believed to delay the onset of mental deterioration.	be used for those who are not avid gamers; It has also gained widespread adoption in hospitals, nursing homes, and physiotherapy rehabilitation centers.	generally divide the brain into major areas, such as memory and executive functions, and stimulate each of these areas using techniques derived from the related fields of cognitive science and neuropsychology. By offering stimulation across a spectrum of the brain, and ramping the difficulty in a way that increases task complexity, brain games can potentially		ways to connect with other people, including competitive and cooperative experiences, as well as integration with broad social networks such as Facebook. Socialization with friends and family can increase engagement and strengthen motivation—and it is also good for the brain.
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						offer people an effective way of increasing brain reserve.		
Breast Cancer Detective: a computer game to teach breast cancer screening to Native American patients.	Roubidoux et al.; 2005	A game titled "Breast Cancer Detective Game" was developed, to be an interactive Web-based teaching tool about breast cancer screening and imaging for senior medical students. A computer game loosely based on the game Jeopardy. It was designed to be played by 2 students or 1 student with a cyber player.	N/a	Rules were developed for playing the game. Students would play for points, which were acquired by answering the case-based questions correctly. Two choices of cyber players were made. One was programmed to choose mostly incorrect answers (Cyber Doug), and the other was programmed to choose mostly correct answers. Permission was obtained to use the likenesses of physicians.	The participants were students and health providers	Promoting awareness to students and providers	N/a	The interactive nature of computer games results in experiential learning, which is advantageous to conventional methods of health education in several ways. Games have demonstrated significant impact including improved knowledge about risk factors and prevention; increased confidence to apply learned behaviors; promotion of better health behaviors; more discussions about health conditions with friends, family, and

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								clinicians—a factor associated with improved health; and increased patient responsibility for their own health.
Cardiovascular Effects and Enjoyment of Exercise Gaming in Older Adults	Fachko et al.; 2013	To quantify the cardiovascular responses and enjoyment of one trial of electronic exercise gaming (EG) (Nintendo® Wii™ Tennis) in healthy, older adults. Nintendo Wii Tennis (Nintendo, 2011) was used as the exercise modality. The software game, Wii Tennis, comes bundled with the computer console. The system uses embedded sensors to measure changes	N/A	The 48-hour post-Wii Tennis follow-up questionnaire was developed to subjectively quantify potential post-Wii tennis hazards that might arise after the experiment, as well as participants' reflections of study participation. A 48-hour post-physical activity timeframe was chosen due to its association with delayed onset muscle soreness, which peaks between 24 and 48 hours after physical activity ceases.	Participants were selected if (a) 60 or older, living independently, cognitively intact, able to stand and ambulate without aid for 30 minutes, able to read, write, and communicate in English, capable of adequate functional visual acuity and hearing acuity levels and having a resting heart rate <120 beats per minute with no serious illness. Exclusion Criteria: patients were excluded if they had an implanted cardiac pacemaker or	Wii Tennis, comes bundled with the computer console. The system uses embedded sensors to measure changes in participant direction, speed, and acceleration enabling interaction with the game.	N/a	The purpose of this study was to quantify the cardiovascular responses and enjoyment of one trial of electronic exercise gaming. Outcome Measures. Rate pressure product (RPP) is an indirect marker of myocardial oxygen demand and was calculated by multiplying the heart rate by the systolic blood pressure.

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		in participant direction, speed, and acceleration enabling interaction with the game.			Defibrillator, were unable to stand unsupported for 30 minutes, were taking any anti-angina medication with an acute or chronic illness or had uncontrolled hypertension.			
Cognitive training on stroke patients via virtual reality-based serious games	Gamito et al.; 2015	One technology used for this study was virtual reality (VR) games. The use of VR applications in health care has been progressing. Research on VR-based interventions on patients with mental or physical dysfunctions date from the late 90s, and its overall results suggest that this technology	One year	Patients were trained to use the computer during a 1 hour session, in which they were able to acquire interaction skills with the VR setup. The VR intervention program was run after this training session. Each of the patients was randomly assigned to either the intervention group or the control group based on	Twenty-nine stroke patients were recruited from a specific hospital. The exclusion criteria for this study were: a previous history of neurological or psychiatric disorders, substance or alcohol abuse, scores below the cut off values in the Mini-Mental Examination, or uncorrected visual deficiencies.	The cognitive training in the VR scenario included several daily life activities that were devised to train cognitive functions such as: working memory tasks (i.e. buying several items), visuospatial orientation tasks (i.e. finding the way to the	1 hour sessions in 4-6 week trials	The Wechsler Memory Scale is an assessment tool that allows evaluation of the different components of working memory. The WMS-III consists of seven sub-tests, namely, personal and general information, orientation, mental control, logical memory, digit span, visual reproduction and associative learning. The Rey Complex Figure



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		improves the quality of physical and mental health care.		simple randomization using a random number generator. The patients were subjected to cognitive stimulation during their inpatient stay at the hospital by the same therapists involved in recruitment, who provided the mobile devices on which the application was run, and fired-up the exercises.		minimarket), selective attention tasks (i.e. finding a virtual character dressed in yellow), recognition memory tasks (i.e. recognition of outdoor advertisements ) and calculation (i.e. digit retention). These training tasks set gradually increasing demands on memory and attention abilities.		(ROCF) is a standardized approach to assess visual memory based on drawings of visual elements. The ROCF has three drawing trials: Copy trial and Delayed Recall trial. In this study, authors focused on immediate memory The Toulouse–Pieron Test (TPT) consists of a standard cancellation test involving symbols. The TPT is a test to assess sustained attention. Its main outcome measures are based on 2 indexes: (1) work-efficiency, speed; and (2) the dispersion index, resistance to distraction.
Clinical	Bower et al.;	The games used a	Four	Four games, which	This study is for	These game	26 minute	The four games

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feasibility of interactive motion-controlled games for stroke rehabilitation	2015	Prime Sense "Carmin" depth camera connected via USB to a laptop with graphics displayed on a television screen, uses a three-dimensional depth sensor used in Microsoft Kinect for Xbox 360 and Kinect for Windows VI enabling users to interact with gaming environment without the need for controllers or body-worn sensors. The camera is able to detect a range of 0.8 – 3.5 m with a distance of 2.5 m, to identify human shapes.	weeks	used a depth-sensing camera (Prime Sense). Three games were controlled by movement of the torso and one was used for upper limb movement.	participants with haemorrhagic or ischaemic strokes who were able to sit unsupported for greater than 10 sec. individuals excluded from this study had dysphasia, significant cognitive defects, or visual impairments. Participants were randomly assigned to an intervention or control group.	activities were designed to minimise inaccuracies with skeleton tracking and to simultaneously trigger the desired movements of rehabilitation exercises. Participants were able to interact with the games whilst having physical assistance from therapists or using a wheel chair. This is to encourage dynamic balance and upper limb activities and be adaptable to different	sessions	measure: 1. Ball Maze, 2. Fridge frenzy 3. Tentacle Dash-measures motion of shoulders and hips, and torso. 4. Bubble Fish-measures the wrist joint relative to shoulder.
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						levels of balance, motor control and perceptual problems after stroke.		
Development and usability evaluation of the mHealth Tool for Lung Cancer (mHealth TLC): a virtual world health game for lung cancer patients.	Brown-Johnson et al.; 2015	mHealth is a technology used for lung cancer patients is based on a stigma-reduction intervention.	N/a	The lung cancer patient “players”, arrive at a bus stop outside the hospital and is greeted by a coach that is knowledgeable. This provides a narrative to increase motivation.	Lung cancer patients	The goal is for patients to choose a more assertive response to help elicit the most information in order to manage their lung cancer and advance through the clinic landscape. Patients experience role play and answer questions.	N/a	Players are able to engage, learn and benefit from role-play. It measures patient-clinic and promotion of self-esteem.
Does the inclusion of virtual reality	Rajaratnam et al.; 2013	Nintendo Wii-Fit or Microsoft Kinect game	N/a	TUG assesses functional mobility and claims to	Subjects of the study were those who with a recent episode of	The study evaluated if interactive	40 minutes of conventional rehabilitation	Virtual reality explores sensory, motor, and visual

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games within conventional rehabilitation enhance balance retraining after a recent episode of stroke?		console system was used during rehabilitation. The Nintendo Wii-Fit programme required subjects to shift their weight during standing in response to the game. The Microsoft Kinect game system required them to constantly change their centre of mass in both sitting and standing. The Nintendo Wii-Fit programme required subjects to shift their weight during standing in response to the game. The Microsoft Kinect game system		predict those at risk of falls if their timing is greater than 14.7 sec. BBS evaluates subjects' ability to maintain balance while performing 14 everyday functional tasks. It has a good internal consistency, test-retest and interrater reliability. Center of Pressure (CoP) sway was measured using the Nintendo Wii-Fit Board. This device evaluated balance and was reported to be comparable with force platforms with a high test-retest reliability. The Modified Barthel Index (MBI)	stroke were recruited from a local rehabilitation hospital and randomly assigned to either a control or an experimental group.	virtual reality balance related games integrated within conventional rehabilitation sessions resulted in more superior retraining of dynamic balance compared to CR after stroke.	with 20 minutes of interactive virtual reality balance related games 15 times a day.	strategies that are important for movement, it may actually slow down recovery as performance gains are seldom transferred to performance of real-world tasks. Evaluated for both groups were the Functional Reach Test (FRT), Timed Up and Go (TUG), Berg Balance Scale (BBS), Centre of Pressure (CoP), and Modified Barthel Index (MBI) before and after the intervention period. FRT is a quick and easy dynamic test of anterior-posterior stability evaluated when subjects perform one arm forward reach task.
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		required them to constantly change their centre of mass in both sitting and standing.		assessed the level of one's functional independence and reported to have a high interrater reliability and internal consistency.				
Effectiveness of Conventional Versus Virtual Reality–Based Balance Exercises in Vestibular Rehabilitation for Unilateral Peripheral Vestibular Loss: Results of a Randomized Controlled Trial.	Meldrum et al.; 2015	Virtual reality (VR) games were used such as: The Wii Fit plus and Wii balancing board.	6 weeks	The glaze stabilization exercises and the walking program was similar for both groups. Balancing training in the conventional group was based on the progressions of exercise, and provided a foam balance board to use at home. Participants in the VR group was given a Wii Fit plus to use at home.	Patients of the study were those who had dizziness/vertigo, gait and balance impairment. Also patients diagnosed with unilateral peripheral vestibular hypofunction.	N/a	4 sessions a week, 1 hour a session.	Outcome measurement were the increase of gait and speed as well as hospital anxiety and depression.
Effects of a repetitive	Combs et al.; 2012	The Hand Dance Pro™ gaming	6 weeks	For the kinematic analysis,	Inclusion criteria: patients were 6	Each training session	18 weeks	Gaming systems that incorporate multiple

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gaming intervention on upper extremity impairments and function in persons with chronic stroke: a preliminary study		system was created for the study that included trunk restraint. Measures collected at pretest and post-test included three-dimensional motion analysis of paretic upper extremity reaching: Wolf Motor Function Test (WMFT) and Stroke Impact Scale (SIS). Data were analyzed across time, with effect sizes (Cohen's d), and by categorizing participants with Fugl-Meyer Upper Extremity Motor Assessment scores. The Hand Dance Pro™ upper		participants were seated with their back directly in front of the electromagnetic transmitter that was placed at the height of the spine of the scapula on the tested side. Three-dimensional kinematics of the scapula, forearm and trunk were collected for the upper extremities (at 100 Hz) with the Motion Monitor™ short-range transmitter system with use of "mini-bird" sensors. This system has a reported root mean square position accuracy of 0.07 inches/0.5° at a 36-inch range	months after stroke, not receiving physical therapy during the study, medically stable with a signed physician's release stating approval, correctable auditory and visual capability, able to actively raise involved arm from their side at least 45° in any plane, able to follow verbal instructions, available for the entire period of the study; and able to access transportation. Individuals excluded had: more than one stroke, a pacemaker, were pregnant, had a pre-existing cardiovascular, neurological or musculoskeletal condition or	consisted of the participant striking the targets on the game board as directed by a combination of auditory cues via music, and visual cues via arrows on a screen in front of the participant. Fifteen 2-minute songs were performed during each session, totaling approximately 30 minutes on task in playing the game. One-minute rest periods were given between each song. If a		repetitions of reaching for targets with trunk restraint can improve movement patterns in the paretic upper extremity of persons with chronic stroke.
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		extremity platform has a total of six targets. Four of the targets were actively used by participants during the intervention and coordinated with the arrows projected on the video gaming screen. The other two targets were device controllers and were not used by the participants during the intervention.		with a resolution of 0.03 inches/0.1° [20].	complications from other health conditions that would influence upper extremity movement.	participant requested a longer rest period or if the researchers determined that additional rest was necessary based on a change in vitals, additional rest time was provided before starting another song.		
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Effectiveness of an upper extremity exercise device integrated with computer gaming for aerobic training in	Widman et al.; 2006	The game cycle was a game created for the use of the same crank mechanism on many 3-wheeled exercise bikes as controllers. They			Participants of this study were adolescence with spina bifida. All patients had some level of mobility impairment.			Measures outcomes of: peak oxygen uptake, minimum work output, aerobic endurance, peak heart rate, rating of perceived exertion, and user satisfaction.
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adolescents with spinal cord dysfunction.		can sit in a wheelchair and adjust the crank handles up and down.						
Effect of a Virtual Reality–Enhanced Exercise Protocol after Coronary Artery Bypass Grafting	Chuang et al.; 2006	The Veterans Affairs Medical Center Taipei operates the Telepresence Cardiac Rehabilitation Program, in which users are physically active in and interactive with an imaginary 3D setting, as though they were physically in a real-life scenario. The system’s graphic user interface permits speed alteration and treadmill incline adjustments in conjunction with	3 months	Two balls, designated A and B, were placed in a box. If the A ball was drawn, then the subject was assigned to group 1; that is, no VR would be used. If the B ball was drawn, the subject was assigned to group 2, and a VR experience would be provided during the rehabilitation sessions.	Each subject who participated in this study had received CABG between January and June 2004. Subjects were recruited from the cardiovascular surgery department at the Veterans Affairs Medical and were included if they qualified for the supervised outpatient cardiac rehabilitation programs (phase II).	These study outcomes clearly support the notion that incorporating a VR environment into cardiac rehabilitation programs will accelerate maximum recovery of patients’ cardiovascular function.	30 minute sessions twice a week	The primary outcome measures were maximum load during the work sessions, target oxygen consumption, and target heart rate.



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		scenery changes. The system also includes a visual screen with a wide field of view, 3D auditory outputs, and 3D accelerator cards. The Microsoft Windows series operating systems form the principal operating environment for this model and include Windows 2000 Professional and XP.						
Effectiveness of virtual reality using Wii gaming technology in stroke rehabilitation: a pilot randomized clinical trial and proof of	Saposnik et al.; 2010	Nintendo introduced a new style of VR using a wireless controller that interacts with the player through a motion detection system and avatar. The controllers use embedded	14-day period	Patients received an intensive program consisting of 8 interventional sessions. Patients were instructed to remain in a sitting position and primarily use their more affected arm/hand in these	Participants 18-85 years of age who had a first-time ischemic or hemorrhagic stroke were eligible for the study, although the protocol allowed the inclusion of patients up to 6 months after stroke. All	RT sessions included leisure activities such as playing cards, stamping a seal while playing bingo, or playing Jenga. Adherence to	8 1-hour sessions of physiotherapy and another hour of occupational therapy per day depending on tolerance.	The arm movements involved in the use of the Wii included shoulder flexion and extension (bowling and tennis), shoulder rotation (tennis), elbow extension and flexion (Cooking Mama), wrist supination and

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principle.		acceleration sensors responsive to changes in direction, speed, and acceleration that enable participants to interact with the games while performing wrist, arm, and hand movements. Because Wii is computer assisted, big sweeping movements in the games are not necessary. The feedback provided by the TV screen as well as the opportunity to observe their own movements in real time, generates positive reinforcement,		activities. Participants randomized to one arm were not exposed to the other intervention. Video games may be associated with a risk of photo sensitive induced seizures and repetitive motion injuries. To reduce the likelihood of seizures, the lights were kept on during the VR Wii gaming sessions, and patients were sitting 6 feet away from the television screen. The study coordinator remained in the room during the sessions and monitored the patient for symptoms	participants had a clinically defined acute stroke confirmed by neuroimaging (CT or MRI) and neurological assessment and met a level of function of the upper extremity derived from the McMaster scale either in the arm or hand (i.e., shrug their shoulders, touch chin with the affected arm) at time of enrollment. Participants were excluded if they were unable to follow instructions, had a pre-stroke modified Rankin score of 2, were medically unstable or had uncontrolled hypertension, had a severe illness with a	standard rehabilitation and to the study tasks were monitored with a timer. RT was used as a control group to allow a fair comparison between the time spent in rehabilitation activities between groups and a lack of evidence that Wii gaming system is standard rehabilitation therapy.		pronation (tennis and Cooking Mama), and different degrees of wrist flexion and extension as well as thumb flexion involved in all activities. The recreational activities engaged similar movements.
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		thus facilitating training and task improvement		suggestive of seizures or shoulder, arm, or hand pain.	short life expectancy, angina, or had recent myocardial infarction, or a history of seizures.			
Electronic gaming as pain distraction	Jameson et al.; 2011	This study used a "Wii play Bubble" game.	N/A	Participants were seated 1 metre away from two identical flat screen TVs, one displayed a TV show and the other displayed a Wii Bubble game. Then they were questioned from a questionnaire after the test.	Participants were university students recruited from online social media. If patients indicated they had any heart problems they were asked not to participate.	Participants played the Wii game and when they reached level 3 they had to put one hand in a water bath while continuing to play.	N/A	The outcome measured: pain tolerance, perceived pain absorption, task enjoyment, anxiety, passive distraction and happiness.
Gaming: A teaching strategy to enhance adult learning	Henry ; 1997	No intervention implemented in article. This is a literature review article focused on the history of gaming, current use, and successes in nursing education. Gaming in this context is defined	No discussion	Gaming involves processes that allows for learning in the cognitive, psychomotor, and affective domains.	No discussion	No discussion	No discussion	No discussion

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		as Game playing that use games and simulations involving cognitive, psychomotor, and affective processes.						
Gaming console exercise and cycle or treadmill exercise provide similar cardiovascular demand in adults with cystic fibrosis: a randomised cross-over trial.	Kuys et al.; 2011	The gaming console used for the experimental intervention was the Nintendo-Wii. The intervention incorporated interval training using the EA Sports Wii Active program and involved an individualised program comprised of games and activities such as boxing, running/ track exercises, and dancing tailored to each	N/a	A randomised cross-over trial with concealed allocation, intention-to-treat analysis, and assessor blinding for two outcomes. Participants underwent two exercise interventions in a randomised order within a 48-hour period. One intervention involved exercise using a gaming console and the other involved exercise on a	Patients with cystic fibrosis were eligible to participate in this study once they were considered clinically stable, i.e., had a temperature within normal limits, were not excessively breathless, and had no respiratory issues. Also, they were required to be able to communicate in English and were receiving a daily physiotherapy exercise program as part of routine management. Patients were	Gaming console exercise provides a similar cardiovascular demand as traditional exercise modalities. It is feasible that adults with cystic fibrosis could include gaming console exercise in their exercise program.	N/a	Energy expenditure during the exercise was measured using a Sense Wear Pro activity monitored. The Sense Wear Pro activity monitor, worn on the right upper arm, measured skin temperature, galvanic skin response, heat flux, and motion via a 2-axis accelerometer, calculating energy expenditure in metabolic equivalents during the recorded movement with the

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		participant's preferences, impairments, and activity limitations.		treadmill or cycle ergometer. Participants were randomly allocated to the order of exercise interventions by an investigator independent of the recruitment of participants using a computer-generated random number program.	excluded if they had a cardiovascular condition prohibiting exercise, a systemic disease, recent surgery, or acute musculoskeletal pain requiring physiotherapy intervention.			activity monitor energy expenditure during low to moderate intensity activities and underestimating energy expenditure at high exercise intensities compared to indirect calorimetry.
Games for Health: The Latest Tool in the Medical Care Arsenal	Hawn; 2009	This article provided a general discussion on Exer-Games (i.e. Dancetown (modelled after Dance Revolution) to "encourage exercise or other healthy behaviour, improve coordination, and enhance cognition"	No discussion (estimated \$50 million in venture capital investment 2004-2009 into developing health games	No discussion	No discussion	Patients participated in interactive dance game that encourages movement – Dancetown	No discussion	No discussion (article indicates the need for outcomes data on games and health)

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		amongst patients (p. 842). Humana (US' 4 <sup>th</sup> largest health insurer), is piloting a program on the clinical outcomes of Dancetown.						
Game-informed learning and teaching in healthcare education.	Begg; 2008	The Labyrinth is a web based approach to learning. The article briefly describes this technology as a "web based authoring and delivery platform" to assess student skills (p. 9, col. 2, para. 4). The article only mentions the Labyrinth, and does not utilize any gaming intervention. Informative paper outlines the	No discussion	This informative paper (not a research or intervention study) includes some mention of Labyrinth used in education to assess student skills, uses a case study approach (i.e. Clinical investigation as a detective story approach)	No discussion	No discussion	No discussion	No discussion

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		difference between Game-informed learning”; “Game-informed teaching”; Game-informed assessment”						
Health and digital gaming: The benefits of a community of practice.	Schott et al.; 2006	This article outlines ways that digital games can enhance health: surgical training, therapeutic interventions, physical exercise, health education, and community participation.	No discussion	No discussion	No discussion	No discussion	No discussion	No discussion
Home-based stroke rehabilitation using computer gaming	King et al.; 2012	Various computer games using The CyWee Z controller (a motion sensor based game controller from Taiwan, similar to the Nintendo Wii). Games include	61 days at the participant’s home.	Each participant was oriented, taught, and observed in hardware set up, software use, and game practice before the systems were left with them.	3 volunteer participants with chronic, post-stroke upper limb hemiplegia, and who had previously participated in a trial of 10 sessions of bilateral therapy using VR. Inclusion	The participant was required to have low cognition as the games were developed with clear graphics and achievable motor	90 minutes per day for 61 days	Primary outcomes: 1) participant diaries were used to record occurrence and duration of intervention; 2) Intrinsic Motivation Intervention: 32 question IMI was used to measure

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		stationary target hitting games (Whack a mole), strategic target hitting games (Bejewelled and Balloon Popping), moving target hitting games (Mosquito Swat, Music Catch, and ReBounce), faster sports games (Air hockey), and puzzle games (Mah-Jong and solitaire).		If the participant was able to use the trigger button of the CyWee Z with their affected hand, the CyWee Z was used in that hand. If not, the CyWee Z was held in the unaffected hand. If grip strength in the affected hand was insufficient to hold the handlebar, a soft Velcro binder was used to hold the device in their affected hand. Participants chose when and for how long they played in each session; however, they were instructed to play for no longer than 90 minutes on any given day.	criteria: over 18 years of age; confirmed stroke diagnosis more than 6 months prior; limited voluntary movement in arm affected by stroke; no other conditions preventing them from using the bilateral exercise device comfortably; and informed consent. Exclusion criteria: fixed contractures in affected upper limb preventing use of the device; inability to comprehend requirements (i.e. dementia).	demands allowing the participant to understand and use the games quickly. All games required large horizontal and vertical cursor movements.		post-intervention motivation; 3) Disabilities of Arm, Shoulder, and Hand (DASH) questionnaire used to assess participant perceived change in upper limb physical functioning (pre and post)  Secondary outcomes of body function: 1) Fugl-Meyer-Upper Extremity (FMA) to evaluate motor function; 2) Motor Assessment Scale (MAS) to measure stroke motor function
Increasing	Jaarsma et	The Nintendo Wii	12	Patients received	Participants of the	The aim of this	30 min	This measured: 1)



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exercise capacity and quality of life of patients with heart failure through Wii gaming: the rationale, design and methodology of the HF-Wii study; a multicentre randomized controlled trial.	al.; 2015	games were used by the patients to evaluate their success, such as Wii sports.	months	regular treatment and information about rehabilitation and daily physical activity. After instructed on how to use the Wii, it was installed in the patient's homes and played as if in real life such as, using the remote control to swing a bowling ball.	study had cardiovascular problems: both with preserved and reduced ejection fraction, were older than 18, and could speak the same language as the testers. Those not able to join: were people not able to use Nintendo Wii due to visual difficulty, hearing, motor or cognitive impairment, unable to fill out data sheet, or had a life expectancy of 6 months.	study was to use the Wii game computer in patients with heart failure to improve exercise capacity level of daily physical activity to decrease healthcare resources, and to improve self-care and health-related quality of life.	sessions per day for 12 months.	Muscle function, through unilateral isotonic heel-lift, bilateral isometric shoulder abduction, and unilateral isotonic flexion. 2) Exercise motivation 3) Self-efficiency beliefs, through self-reports, and 4) Perceived physical efforts.
Integrative gaming: a framework for sustainable game-based diabetes management.	Kahol et al.; 2011	Integrative gaming unit – a central unit linked a variety of exercise equipment together into a single unit. This	No specific discussion (there is some mention of stages through	The utility of a story based game motivated the patient to engage in physical and cognitive skills. The game used various stages to engage	No discussion of inclusion criteria. However, there was mention of diabetes management.	Patient used entire body as indicated by each stage of the game. For instance, patient would walk or run on	No discussion	No discussion.

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		prototype combined multiple activities involving physical exercise and cognitive skills through a game-based storyline.	the game that require physiological achievements)	the patient through challenges. The patient wore sensors to measure movement (accelerometers, gyrometers, magnetometers) and sensed physiological measures (heart rate, pulse oximeter, oxygen saturation) to drive the game.		a treadmill to power an airplane – head movement either left/right steered the plane.		
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Interactive gaming consoles reduced pain during acute minor burn rehabilitation: A randomized, pilot trial	Parker et al.; 2015	Patients had access to a Nintendo Wii and an additional Nunchuck configuration was used during upper limb prescriptions. All intervention participants were requested to play a minimum of 2 min/game and then repeat the	7 days of twice daily 20-30 mins of exercise using the Nintendo Wii IGC.	These sessions were self-directed and in addition to their individualized exercise therapy program, which was standardized for this study, the patients were provided with unhindered access to Nintendo Wii machines set up by mobile telephone	Participants that had sustained both upper and lower limb burns were selected. Participants were excluded if: there was limb amputation, TBSA, electrical injury, or neurological conditions affecting participation, were Non-English speaking, had poor	The upper limb subjects were alternating between tennis and boxing from Wii Sports. Lower limb subjects utilized multiple yoga, and step up exercises from Wii Fit.	20-30 minutes of use twice a day.	The Measurement outcome of this study was to measure by asking before and after to record: Pain score, in a visual analogue scale from 0-10. Analgesia prescribed was individualized based on body weight, burn size etc. Fear avoidance was measured using the
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		schedule prescribed, exercises from Wii Fit and Wii Sports for upper limb and lower limb subjects.		unit.	English or were intellectually challenged, had superficial burns, or at risk for infections.			Pain anxiety symptoms scale. A 40 item self-rated scale 0-5. Assessing the influence of fear using categories like escape or avoidance, fearful reappraisal and psychological anxiety. Also, this study measured range of motion using a goniometer utilizing data in the mobility of the upper and lower limbs while taking into consideration the environmental factors.
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Interactive video gaming compared with health education in older adults with mild cognitive impairment: a	Hughes et al.; 2014	The Nintendo Wii gaming console using the remote device with sensor motion capacity to participate in virtual bowling, golf, tennis, and baseball (The Wii	36 hours total,. 24 sessions of 3-4 members per group (20 participa	Participants played Wii sports games including bowling, golf, tennis, and baseball which comprised the core games of each of the 24 sessions. Participants were	Participants were recruited from population-based study of Mild Cognitive Impairment (MCI) along with additional exclusion criteria of severe vision, hearing, and	The players used arms and other body parts to simulate actions required for each game (i.e. swinging a golf	24 sessions at 90 minutes every week for a total of 36 hours	Clinical outcomes measured: 1) primary = cognitive performance using Computerized Assessment of Mild Cognitive Impairment; 2) secondary outcomes
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feasibility study		Sports) for 24 sessions (weeks).	nts = 18 attended 80% of the sessions)	divided into groups of 3-4 members. Week 1-6 focused on training and competence with Wii system using Wii Sports only. Week 7 engaged in Wii sports as well as new games (i.e. Boom Blox, Wii play, and Sports resort) in the final 15-30 mins. Weeks 10 and 20, the participants competed in Wii tournament.	motor impairment; history of debilitating neurologic disorders (i.e. Parkinson's disease, stroke, multiple sclerosis, traumatic brain injury or seizure disorder); any use of psychotropic medications; or history of consuming 2-3 alcoholic drinks or more per occasion. Additional exclusion criteria included having played Nintendo Wii on 3 or more occasions in the past year or unable to commit to attending 20 out of 24 sessions.	club and throwing a bowling ball).		= subjective cognitive ability & mood/social functioning using The Cognitive Self-Report Questionnaire-25, performance-based instrumental activities of daily living used the Timed Instrumental Activities of Daily Living measurement, and gait speed used timed measurements in seconds to complete a 6 metre walk.
Increasing Patient Engagement during Virtual Reality-Based Motor	Zimmerli et al.; 2013	Virtual reality exercises were simulated with Unity3D game and projected onto a screen in front of	Approximately 40 minutes (6 different	The gait orthosis Lokomat comprised of 2 actuated leg orthoses strapped to the legs of the	10 control subjects (between 23-31 yrs) without any neurologic movement disorders, and 12 subjects with	Participants were exposed to 4 exercises: 1. Steady – subjects walking along a	No discussion (presumed to be 1 session of 40 minutes)	Measurements were focused on determining whether different VR exercises influenced the level of

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Rehabilitation		the participants in a 2-m diameter (resolution of 1280 x 800).	conditions at 4 minutes each with 3 minute relaxation between conditions)	patient used in conjunction with a body weight support system and a treadmill. Sensors measured each joint with respect to biofeedback performance of each activity. Participants' legs had surface electrodes (Electromyograms = EMG) placed on bilateral proximal and distal leg muscles to acquire locomotion data. Heart rates were measured using a chest strap.	spinal cord injury (SCI) (between 23-66 yrs). Inclusion criteria for SCI: able to stand upright for at least 30 seconds with or without support; chronic (>1 year) and acute (<1 year) SCI were considered. Exclusion criteria: depression, severe contractures or skin lesions in the lower limbs, osteoporosis, cardiovascular instability, uncontrolled spasticity that would interfere with lower extremity movement, acute medical illness, >190 cm height or >135 kg weight.	path with constant speed, no interaction with virtual environment; 2. Speed – modulated speed in the virtual reality environment; 3. Sprint – mapping of the activity to the virtual speed, with information provided regarding average speeds over the last and second last 100m; 4. Race – activity of subjects mapped onto the virtual speed, plus competition		engagement of participants measured through Heart Rate and EMG measurements.  EMG measurements included Biceps femoris, Gastrocnemius medialis, Rectus femoris, Tibialis anterior.
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						with a virtual opponent.		
Interactive videogames as rehabilitation tool of patients with chronic respiratory diseases: Preliminary results of feasibility study	Mazzoleni et al.; 2014	The Nintendo Wii system uses haptic sensor-based controllers and a balance board as interfaces to the games. The physiotherapist created patient "avatars" that personified the patients in the game. The "Avatar" movements received visual and auditory feedback in order to perform the activity.	Both groups participated in a 3 week therapy session of PRP but one group had an additional 7 1-hour daily session of Wii Fit exercises	A random controlled trial (20 patients using PRP) and an experimental group (20 patients using PRP + sessions of interactive videogames).	Patients recovering from chronic Respiratory Disease requiring acute care hospital admission to the Pulmonary Rehabilitation unit including: a stable condition. People with a co-existing motor condition, other associated severe clinical conditions or lack of uptake of procedure or adherence were excluded.	Patients participated in multidisciplinary in-hospital PRP that included drug therapy and sessions of: exercise on treadmill, 30 mins of continuous exercise, abdominal upper and lower limb muscle activities, education and nutrition & psychological counselling programs. The experiment group had additional interactive	1 hour daily sessions.	Measured Lung and respiratory muscle function, arterial blood gases, exercise capacity, dyspnoea, health status and emotional responses including a questionnaire to measure acceptability of PRP.

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						exercises on Wii Fit including “yoga”, “jogging plus” and “twist and squat”		
Interactive virtual reality Wii in geriatric day hospital: A study to assess its feasibility, acceptability and efficacy	Chan et al.; 2010	In this study, a Wii-IVR was used in participants by playing “Wii Fit”. Participants used a Wii controller to carry out movements involved in an arm ergometer.	Each patient received 8 sessions with 10 minutes each of rehabilitation in GDH.	The eight sessions were scheduled in a flexible manner as long as all eight sessions were completed within the 10–16 sessions of rehabilitation in The GDH.	Patients of a GDH were recruited to participate. The GDH provided Multi-disciplinary rehabilitation for older patients with different referred diagnosis. All patients referred for rehabilitation in GDH were assessed by the principal investigator. Those who could understand the procedure of using Wii-IVR and were suitable to carry out the movements involved in the study were recruited as participants. Patients	The game chosen was one of the games in “With Fit”, the “2-P Run”. Participants sat on a sofa 180 cm away from the television screen, held the Wii controller on their hand (left or right hand), and moved their wrist, elbow and shoulder. The movements	All patients had 1.5 hours of physiotherapy in the morning, 1.5 hours of occupational therapy in the afternoon and a 2-hour of resting session in Between, at a frequency of twice per week.	The movements simulated those involved in an arm ergometer, which was associated with improved motor recovery after a stroke, Improved health status and aerobic fitness of older adults.

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					were excluded if they had poor vision, were unable to follow verbal commands or had global aphasia, unstable angina or recent myocardial infarction, severe heart failure, a history of symptomatic Ventricular tachyarrhythmia's, a history of seizure, a severe chronic obstructive pulmonary disease, uncontrolled hypertension or the patient was unwilling or unable to comply with the protocol.	were reproduced on the television screen as if the participant was running in a virtual countryside. It allowed two participants to play together each time. Participants were asked to take a rest whenever they felt fatigue or had shortness of breath.		
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Neurorehabilitation using the virtual reality based rehabilitation gaming system:	Cameirão et al.; 2010	The Rehabilitating gaming system uses a PC with graphics accelerator, a 17-inch LCD display, a	20 minute sessions with an average number	Spheroids had a green landscape with trees and mountains in the background, with a model of a human	Control subjects were students with no history of neurological disorder. All patients receiving	This task evaluated ecological validity of the RGS task designed for	A 20-minute session.	This task extracted info on: the speed of movement, range of movement (combined shoulder and elbow
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Methodology, design, psychometrics, usability and validation		colour CCD camera positioned on top of the display, four colour patches and two 5DT data gloves. The virtual tasks were implemented with a Torque Game Engine. The movements of the upper extremities of patients were tracked using the custom developed vision based motion capture system. A subject sat on a chair with their arms facing the screen and arm movements were tracked by a camera. A) The tracking system determined in real-time the position of colour	of combinations of 82 spheres	torso with arms that mimiced the arms of the user. Spheres moved toward the user and were to be intercepted through the movement of virtual arms. The level of difficulty changed with each individual.	rehabilitation were required to pass a mini-mental state examination. People excluded were people with emotional or cognitive deficits that interfered with the execution of the task i.e. dementia etc.	directed pointing calibration. This task evaluated specific properties of arm movements and analysed their transfer between physical and virtual worlds.		movement for arm extension), and latency (time to initiate a movement from a start cue).
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		patches. B) Data gloves detected figure movements. And C) on the display two virtual arms mimiced the subjects.						
The use of gaming technology for rehabilitati in people with multiple sclerosis	Taylor et al.; 2015	This study used “exergaming” systems that are off-the-shelf platforms such as, Nintendo Wii and Xbox Kinect. Both used body motion to control game play. Wii used handheld controllers and a balance board that translated the movement of the players on the screen. The Wii Fit plus comes as a standard with the Wii. The Kinect uses cameras and	12 weeks	Functional near-infrared spectroscopy and magnetic resonance imaging have been used to record the brain activity while playing exergaming.	Those who could access included those with: relapsing MS, owned a television, had the ability to walk without resting for 100 m, had a present balance disturbance, in a stable phase, impaired balance, cognitive impairment, no visual deficits, home risk assessment, and “inactive”. The exclusion criteria was: more than 150 mins of physical activity a week, pregnancy, metabolic	Playing exergaming to record changes in the cerebellar connections, and identify a robust hyperemic response in superior temporal gyrus and super marginal gyrus. Suggested an adaption of the vestibular network in response to balance task.	Depending on the patient, from 20 minute to 1 hour sessions.	This study measured: balance, gait, mobility, physical activity, hand dexterity/coordination, self-efficiency, and psychological wellbeing.

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		depth sensors to translate body movement onto the game and does not require hand held controllers or a balance board, allowing users with impaired dexterity to have access and benefit from exergames.			or cardiopulmonary disease, lower-extremity amputation, low vision, severe fatigue, epilepsy, or major depression.			
Understanding upper extremity home programs and the use of gaming technology for persons after stroke	Brown et al.; 2015	Neuro Game Therapy (NGT) "Peggle" is a game-based system that utilizes surface electromyography biofeedback to control a commercially available computer game for use as a home exercise program. It was designed to collect	4 weeks	Participants aimed a ball to eliminate colored pegs with increasing complexity as the game proceeded. Levels of difficulty were advanced in two ways: 1) passing into higher game levels required increased motor control, or 2) adjustments to the amount of muscle activation	Participants of the study were post-stroke patients with unilateral hemiparesis and motor impairments ranging from difficulty with handling objects to no active hand movements and had vision and hearing sufficient to complete the outcome measures and NGT.	The aim of the study 1) functional use of the affected upper extremity in daily life 2) experience with previous home exercise or activity programs. Codes were organized into themes of affected upper	45 minutes for five days a week for 4 weeks.	This study focused on motor control of the muscle activity in affected limb and on the motor control of the wrist flexors and extensors of hemiparetic limbs.

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		quantitative and qualitative data on the effectiveness and acceptability for adults, post-stroke.		required to control the cursor for muscles.		extremity, perceptions and experiences.		
Using a virtual game system to innovate pulmonary rehabilitation: Safety, adherence and enjoyment in severe chronic obstructive pulmonary disease	Wardini et al.; 2013	VGS (Wii Nintendo) games were pre-screened and categorized into lower- and upper-body workouts. The games presented were from Wii Sport, Participants played two different games per session the first type consisted of an aerobic/ lower body workout and the second involved an upper body workout.	A 3 to 4 week program at Mount Santi Hospital centre.	First there was a PR exercise session at MSH that involved exercise sessions 5 times weekly. These sessions included resistance and endurance training from physiotherapists. Then there was the game description: training occurred on an individual basis and in a dedicated room on the repertory ward at MSH.	Patients were admitted through referrals from physicians, they acquired moderate to severe COPD assessed by a health care team. Individuals with severe cardiovascular disease, unstable angina, acute myocardial infarctions, physical or mental impairments and inability to speak English or French were unable to participate in the study.	“Basic run”, “Basic step”, “obstacle course” and “Island cycling” were all games that targeted the lower body where patients walked on the Wii Balancing Board. “Boxing”, “Canoeing”, and “Rhythm parade” focused on upper body exercise. The level of difficulty was able to be	Patients admitted for a three- to four-week inpatient PR program where they exercised daily.	Dyspnea, oxygen saturation and heart rate were measured before, during and after the game sessions.

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						adjusted.		
Validity and reliability of balance assessment software using the Nintendo Wii balance board: usability and validation.	Parks et al.; 2014	The balance of participants was measured using the WBB-based system and laboratory grade force platform. The WBB-based system included the WBB, a laptop equipped with Bluetooth, and software for signal acquisition and analysis, respectively. The size of the WBB equipped with four load cells was 45 × 26.5 cm. Data was exchanged between the WBB and the laptop using the built-in Bluetooth and Balancia software. Balancia software	N/a	The first assessor measured the balance of the participants using the WBB based system, and the second assessor measured the balance of the same participants using WBB based system after providing them with sufficient rest. On the next day, the balance of the same participants was also measured by the first assessor using the WBB based system. Finally, on the last day, the balance of the same participants was measured by the first assessor using	None of the participants had injuries or diseases of the musculoskeletal or nervous system or had been taking medications that would affect standing balance six months prior to participation. Participants provided informed consent, and all procedures were approved by National Rehabilitation Center Institutional Review Board.	The Wii Balance Board (WBB) is designed to test balance. Thus, the development of a balance assessment software using the Nintendo Wii Balance Board, investigated its reliability and validity, and compared it with a laboratory-grade force platform.	N/a	This study measured balance in individuals.

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		was developed using C++ and LabVIEW.		the laboratory based force platform after 1 day of sufficient rest time. All measurements were performed according to four tasks that involved (1) standing on two legs with open eyes (STOE), (2) standing on two legs with closed eyes (STCE), (3) standing on one leg with open eyes (SOOE), and (4) standing on one leg with closed eyes.				
Virtual reality-based paediatric interactive therapy system (PITS) for improvement of arm and hand function in children with	Wille et al.; 2009	This study developed a virtual-reality based, paediatric interactive therapy system (PITS) that allowed children to practice specific movements of the	N/a	The patient received direct on-screen feedback about the arm movements either via virtual arms or by other objects controlled by the movements. Rewards in each	Participants were children with congenital or motor deficits, caused by e.g. cerebral palsy, stroke, traumatic brain injury, brain tumour or other disorders of the central or peripheral	Three different gaming scenarios were developed to motivate the patient to train specific arm and hand movements as intensively as	45 minute sessions	The Melbourne Assessment measured quality of unilateral upper limb movement in children aged 5–15 years with neurological conditions. The assessment was

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motor impairment		upper limbs with immediate feedback about their motor performance. The PITS consisted of a custom-made table on wheels which was optionally height adjustable, with data gloves in different sizes, a monitor with speakers and a personal computer. The custom designed gloves allowed measurement of both finger flexion/extension using bend sensors and 3D orientation of the forearm using accelerometers and magnetometers.		gaming scenario were provided in the form of a cumulative score, visible at all times on the screen, which increased depending on the number of tasks and sub-tasks completed. Therapists could, in consultation with the patient, decide independently at all times which game was played and which difficulty was applied in each setting. This freedom was designed to maximize patient participation and motivation.	nervous system, intense motor activity can re-establish and reinforce neuronal pathways and enhance neuronal plasticity. All were inpatients at the Rehabilitation Centre Affoltern am Albis, Children's University Hospital Zurich.	possible, including the Melbourne assessment measures, The Box and Block Test (BBT), and The Nine Hole Peg Test. The trained movements included hand grasping and releasing, wrist pronation and supination and arm reaching.		designed to be a simple, easy to administer test that provides general information about levels of ability/disability rather than specific diagnostic information. It consists of 16 items that involve reach, grasp, release and manipulation. The Box and Block Test (BBT) is a staff-assessed, patient-completed gross manual dexterity test involving the transfer of individual blocks within a partitioned box using the dominant and then non-dominant hand for a timed 60-second period. Number of blocks successfully
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								<p>transferred becomes the final score. The Nine Hole Peg Test is a simple timed test of fine motor coordination, involving placing dowels in nine holes. Subjects are scored on the amount of time it takes to place and remove all nine pegs. Two scores (time in seconds) are collected, one for each hand.</p>
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