***C*entralized *O*pen *A*ccess *R*ehabilitation database for *S*troke (*SCOAR*) |Extraction of Text Data for the Descriptions of Experimental and Control Groups.**

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# A Authors

###

## Abdullah et al. Results of Clinicians Using a Therapeutic Robotic System in an Inpatient Stroke Rehabilitation Unit. J NeuroEng Rehabil 2011

TREATMENT GROUP 1: A. Experimental (Robotic Therapy) Group Individuals randomized to the experimental group received 45 minutes supervised training sessions three times a week using only the robot until discharge. No other arm therapy was provided to this group. Clients were seated in a chair or wheelchair in front of the computer screen at a height adjustable table. The trunk was not restrained, but the therapist ensured that the patient was sitting upright, using a pillow if necessary to ensure correct posture. Their affected arm was supported at the wrist by a comfortable forearm splint. The wrist was in a neutral position with the fingers unsupported. Facing the screen, clients began an exercise program starting with passive movements, progressing to active-assisted, and active as the treating therapist assessed their motor and cognitive ability to interact with the robotic system. There was a menu of assorted exercises. For example, for an individual with moderately severe cognitive difficulties, the therapist may select movements that use a series of nodes that progressively light up as the person approaches the target. Block practice of the exercise may be more appropriate for this particular individual. For the person whose upper limb is a CMSA Stage 1-2, the therapist may choose a set of active assisted exercises that occur in the typical synergistic flexion and extension patterns. For an individual with no discernible cognitive difficulties, feedback may be random and the practice schedule variable. For a person with a higher level of motor return, i.e., CMSA Stage 3-4, the therapist may choose active exercises occurring both within and outside the typical synergistic patterns (i.e., making a circle, abduction, external rotation). Each exercise was done 10 times for a total treatment time of 45 minutes. An automatic safety feature built into the robotic systems prevented the patient’s arm from moving outside the parameters established by the treating therapist. An external stop button was clearly displayed in front of the monitor, which could be manually activated at any time.

CONTROL GROUP 1: B. Conventional (Regular Therapy) Group Similarly, individuals randomized to the conventional group received 45-minutes supervised conventional therapy three times a week until discharge. Assorted techniques for upper extremity retraining were used by the treating therapists (task specific training, passive, active and resistive exercises). Programs progressed as indicated to meet the client’s goals. For both groups, hand exercises were permitted in class settings or with the treating therapist. The amount of occupational therapy where the client practices activities of daily living was recorded.

###

## Ada et al. A Treadmill and Overground Walking Program Improves Walking in Persons Residing in the Community After Stroke: A Placebo-Controlled, Randomized Trial. APMR 2003

TREATMENT GROUP 1: Training for the experimental group was carried out 3 times a week for 4 weeks. The training sessions were comprised of 30 minutes of walking, which actually took about 45 minutes to accomplish. Each session consisted of both treadmill and overground walking, with the proportion of treadmill walking decreasing by 10% each week from 80% in week 1 to 50% in week 4. Subjects received individual training from a physical therapist; however, there was some opportunity for social interaction because 2 subjects were trained concurrently. The program was carried out in a community setting and transport was provided if necessary. The treadmill walking component was structured to increase step length, speed, balance, fitness, and automaticity. To increase step length, the treadmill was run at a comfortable speed and subjects were instructed either to “walk as slowly as possible” or to “take as few steps as possible” or to “keep the stance foot on the treadmill for as long as possible” or to “keep the swinging foot in the air for as long as possible.” In addition, marching-type steps were included to encourage hip and knee flexion during swing phase to improve toe clearance. When a normal step length was observed, the speed of the treadmill was increased (until step length was compromised). When maximum speed was achieved, balance was challenged by reducing the degree of hand support and fitness encouraged by increasing the incline of the treadmill thereby increasing workload. Finally, automatically was promoted by presenting the subjects with a concurrent cognitive task. The cognitive task consisted of matching the word “red” with the response “yes” or the word “blue” with the response “no.”18 During treadmill walking, attention was also focused on alignment to help subjects to keep their trunk vertical. The overground walking component aimed to reinforce improvements in walking pattern and speed achieved on the treadmill. It was defined as whole-task practice involving propulsion forward, backward, or sideways, or up and down stairs; that is, there were no isolated exercises or part practice of walking. To reinforce the increased step length, visual cues were supplied in the form of nonslip footprints that were laid at intervals normal for that subject’s height. When step length approximated normal, subjects were encouraged to walk faster and were timed for feedback. Step width was reduced and balance challenged by forcing subjects to walk within 1 floor tile or walk along a line forward, sideways, and backward. Workload was increased by introducing stairs and slopes to overground walking practice and automaticity was promoted by the introduction of dual tasks. Subjects walked continuously around an outdoor circuit—which included curbs, slopes, stairs, and rough terrain—while conversing with the trainer. Overground walking also focused on walking alignment by encouraging an increase in hip extension and trunk verticality. Subjects walked sideways with their heels and shoulders in contact with a wall to encourage hip extension and trunk verticality.

CONTROL GROUP 1: The control group was given a home exercise program to carry out 3 times a week for 4 weeks. The program consisted of exercises to lengthen and strengthen lower-limb muscles as well as to train balance and coordination. However, although the exercises were individualized, they were not prescribed in sufficient number or intensity to achieve a training effect because the aim was to provide a credible sham program to control for the effect of placebo. Subjects were also encouraged to go for a walk every day. Subjects were telephoned once a week, and the exercises were progressed in number and/or type depending on progress during the previous week.

###

## Ada et al. Randomized trial of treadmill training to improve walking in community-dwelling people after stroke: the AMBULATE trial. Int. J. Stroke 2013

TREATMENT GROUP 1: Experimental groups 1 (four-month training group) and 2 (two month training group) received training based on a previous treadmill walking program (8). Thirty minutes of walking was carried out three times a week for 16 weeks for experimental group 1 and eight-weeks for experimental group 2. Given that participants could already walk, treadmill training was conducted without any body weight support. It was structured to increase step length, speed, workload, and automaticity. To increase step length, the treadmill was run at a comfortable speed and participants were instructed to ‘walk as slowly as possible’, and/or a

metronome was used to decrease cadence thereby encouraging larger steps.When necessary, marching-type steps were included to encourage hip and knee flexion during swing phase to improve toe clearance. When a normal step length was observed, the therapist increased the speed of the treadmill until step length was compromised. Workload was then progressed by increasing the incline of the treadmill. Finally, automaticity was promoted by presenting the participants with a concurrent cognitive task while maintaining speed and normal step length. For example, one task involved matching the word ‘red’ with the response ‘yes’ or the word ‘blue’ with the response ‘no’ (18). Overground walking was used each session to reinforce gains achieved during treadmill training. Overground walking comprised 20% of intervention time in week 1 and was progressively increased each week so that it comprised 50% of the 30 min intervention time in week 8 of training. In week 9, the four-month training group returned to 20% overground walking, which was again increased to 50% by week 16. Overground walking was defined as whole task practice involving propulsion forwards, backwards, sideways, or up and down stairs. To reinforce the increased step length achieved during treadmill walking, visual cues were used in the form of nonslip footprints scaled for the participant’s height and skill. As step length approached normal, participants were encouraged to walk faster and were timed for feedback. Direction of walking was varied to include sideways and backwards walking while maintaining vertical trunk alignment. Stairs and slopes were used to increase workload and automaticity was promoted through use of conversation while walking around an outdoor circuit of curbs, slopes, stairs, and rough terrain. Guidelines were used to outline the progression of training. Information describing the specific features of each training session (such as treadmill speed, distance walked, assistance required) was recorded to monitor adherence to the guidelines and to describe the intervention accurately.

TREATMENT GROUP 2: Experimental groups 1 (four-month training group) and 2 (two month training group) received training based on a previous treadmill walking program (8). Thirty minutes of walking was carried out three times a week for 16 weeks for experimental group 1 and eight-weeks for experimental group 2. Given that participants could already walk, treadmill training was conducted without any body weight support. It was structured to increase step length, speed, workload, and automaticity. To increase step length, the treadmill was run at a comfortable speed and participants were instructed to ‘walk as slowly as possible’, and/or a metronome was used to decrease cadence thereby encouraging larger steps.When necessary, marching-type steps were included to encourage hip and knee flexion during swing phase to improve toe clearance. When a normal step length was observed, the therapist increased the speed of the treadmill until step length was compromised. Workload was then progressed by increasing the incline of the treadmill. Finally, automaticity was promoted by presenting the participants with a concurrent cognitive task while maintaining speed and normal step length. For example, one task involved matching the word ‘red’ with the response ‘yes’ or the word ‘blue’ with the response ‘no’ (18). Overground walking was used each session to reinforce gains achieved during treadmill training. Overground walking comprised 20% of intervention time in week 1 and was progressively increased each week so that it comprised 50% of the 30 min

intervention time in week 8 of training. In week 9, the four-month training group returned to 20% overground walking, which was again increased to 50% by week 16. Overground walking was defined as whole task practice involving propulsion forwards, backwards, sideways, or up and down stairs. To reinforce the increased step length achieved during treadmill walking, visual cues were used in the form of nonslip footprints scaled for the participant’s height and skill. As step length approached normal, participants were encouraged to walk faster and were timed for feedback. Direction of walking was varied to include sideways and backwards walking while maintaining vertical trunk alignment.

Stairs and slopes were used to increase workload and automaticity was promoted through use of conversation while walking around an outdoor circuit of curbs, slopes, stairs, and rough terrain.

Guidelines were used to outline the progression of training. Information describing the specific features of each training session (such as treadmill speed, distance walked, assistance required) was recorded to monitor adherence to the guidelines and to describe the intervention accurately.

CONTROL GROUP 1: The control group received no intervention.

###

## Aisen et al. The Effect of Robot-Assisted Therapy and Rehabilitative Training on Motor Recovery Following Stroke. ARCH NEUROL. 1997.

TREATMENT GROUP 1: All patients received conventional therapy from the same team of therapists. The experimental group received an additional 4 to 5 hours per week of robot-aided therapy with MIT-Manus, a robot prototype designed and built at the Massachusetts Institute of Technology for clinical neurologic applications.14 This therapy consisted of goaldirected, robot-assisted arm movement; a customized, in¬teractive, computer-generated video program provided visual and auditory feedback to the patient. If the arm was para¬lyzed, limb movement was initially passive, and as motor function returned, the interactive robot required the ini¬tiation of motor activity by the patient. The patient's hand and wrisl were held in a rigid support affixed to the ro¬botic arm and therapy consisted of flexion, extension, and rotational movements across elbow and shoulder joints.

CONTROL GROUP 1: The control group had weekly to biweekly contact with the robotic device. During these sessions, the patients ac¬tively moved the robotic arm and were able to observe the response on the video monitor. The robotic device was also used to record strength and quality of movement. Patients and rehabiliLation therapists were blinded to the treat¬ment group.

###

## Arya et al. Meaningful task-specific training (MTST) for stroke rehabilitation: A randomized controlled trial. TOP STROKE REHABIL. 2012.

TREATMENT GROUP 1: MTST is a trhining program for upper extremity rehabilitation of poststroke clients. It is based on principles of motor learning, experience-dependent neuroplasticity, and shaping techniques. Motor learning refers to the permanent changes in behavior because of practice or experience.13 Experience dependent neuroplasticity is the abilit of the brain to recognize itself in response to practice of a task.18 Shaping is a training method in which a mtoor or behavioral objective is approached in small steps by successive approximations (ie, a task is progressively made more demanding with respect to a subject's motor abilities).25 MTST mainly comprises the specific number of meaningful tasks, which are common to all the patients. The tasks have to be practiced repetitively either with the unilateral (UL) (the most affected extremity) or bilateral (BL) upper limbs/s, depending on the task requirement. It also has a component of individualized meaningful tasks, which have to be selected from a task bank for repetitive practice. Similar to CIMT, MTST is based on task specificity. The aim of the program is to enhance motor recovery of the subject. The maximum total duration for hte experimental intervention is 1 hour (common task practice for 45 minutes and individualized task practice for 15 minutes). Duration for 1 to 5 sets or 2 to 5 minutes. The subject's goal of the practice is successful performance of a task, not the specific movement, with minimal compensatory movement deviation. However, the therapist's goal is the movement pattern that is expected in the usual task performance. As per the need, the task performance is guided, passively supported, actively assisted, or directed by the therapist. Variables such as speed, distance, time or repetition of a task performance are manipulated to make the task more challenging. Auditory, visual and proprioceptive feedback is also given to the patient to aid in the successful performance of a task without compensatory movements. Performance of a task can be demonstrated by the therapist or model to serve as a reference to provide various types of feedback. The tasks are practiced in components and in random order in each session. The appendix gives the detail of the experimental protocol.

CONTROL GROUP 1: The control group was given an intervention of the same duration based on the Brunnstrom movement therapy23 and Bobath neurodevelopmental technique26. Brunnstrom movement therapy uses reflexes to develop movement behavior through sensory stimulation to inhibit spasticity and movement retraining to enhance the recovery. The specific techniques are used to develop synergistic and voluntary control of movement as a per the Brunnstrom recovery stages. The Bobath neurodevelopmental technique is a concept of treatment based on the inhibition of abnormal reflex activity and the relearning of normal movement, through the facilitation and handling.

# B Authors

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## Bale et al. Does functional strength training of the leg in subacute stroke improve physical performance? A pilot randomized controlled trial. CLIN REHABIL 2008

TREATMENT GROUP 1: The aim for both training groups was to achieve

better performance of daily life activities. All participants trained with physiotherapists 50 minutes a day five days a week, for a time period of four weeks. Different physiotherapists trained patients in the two intervention groups. Functional strength training The patients in the functional strength training group had training to improve the muscle strength of the lower extremities three days a week, and trained arm functions and activities of daily living the remaining two days. The functional strength training programme was designed to facilitate appropriate power in the weak muscles of the affected leg in graded activities or sequences of activities. Most of the exercises were weight-bearing and also challenged standing balance (Appendix). Each strengthening exercise was performed according to the principle of 10–15 repetitions maximum to achieve moderate fatigue in one set.22

CONTROL GROUP 1: The aim for both training groups was to achieve

better performance of daily life activities. All participants trained with physiotherapists 50 minutes a day five days a week, for a time period of four weeks. Different physiotherapists trained patients in the two intervention groups. The patients in the training-as-usual group had traditional training influenced by the Bobath Concept, with a central focus on normalizing muscle tone and movements on the affected side, symmetrical use of the body and relearning activities of daily living, often using manual guiding and facilitation techniques. Use of excessive muscle power was avoided to prevent associated reactions during training. As part of their basic rehabilitation, all patients participated in multidisciplinary training programmes. Questionnaires were filled in by nurses and occupational therapists at week 3 of each patient’s training period to obtain information about attendance and quantity of training in the wards, and in sessions with occupational therapists.

###

## Barbeau et al. Optimal Outcomes Obtained With Body-Weight Support Combined With Treadmill Training in Stroke Subjects. APMR 2003

TREATMENT GROUP 1. The 100 subjects were randomized into the experimental

group (BWS, n50) and the control group (no-BWS, n50) by block randomization within strata identified according to the initial level of ambulatory status (low, high). Low ambulatory status was defined as being nonambulatory or requiring maximal assistance to walk. High ambulatory status was defined as needing moderate or minimal assistance or walking independently with or without supervision, but with residual gait deviations. The experimental group trained on a treadmill while a percentage of their body weight was supported by an overhead harness. The control group trained on a treadmill but without BWS. The BWS system and the overhead harness have been described in detail.14-16 Briefly, the harness consists of a pelvic belt that attaches around the hips and 2 thigh straps with anterior and posterior attachments to the pelvic band. The harness vertically supports the patient over the treadmill and is attached to a suspension system with a force transducer that signals the amount of body weight being supported. Individuals in the BWS group were provided up to 40% BWS at the beginning of training, and that percentage was progressively decreased as subject’s gait pattern and ability to walk improved. Subjects in the control group wore the harness for security and to ensure similar experimental conditions, but no BWS was provided. Both groups trained 4 times a week for 6 weeks under the supervision of a physical therapist. During each session, patients walked a maximum of 3 trials for no more than 20 minutes. Subjects’ pulse and heart rates were monitored before each session began and again after each trial to ensure that they did not exceed a baseline that was established by their physician. Walking on the treadmill (Burdick T500 modela) was initiated at 0.0km/h and increased by increments of .15km/h. Subjects could grip a horizontal bar attached to the front of the treadmill to provide stability. In addition to gait training, all subjects—regardless of their group allocation—received regular, weekday physical therapy.

CONTROL GROUP 1. The 100 subjects were randomized into the experimental

group (BWS, n50) and the control group (no-BWS, n50) by block randomization within strata identified according to the initial level of ambulatory status (low, high). Low ambulatory status was defined as being nonambulatory or requiring maximal assistance to walk. High ambulatory status was defined as needing moderate or minimal assistance or walking independently with or without supervision, but with residual gait deviations. The experimental group trained on a treadmill while a percentage of their body weight was supported by an overhead harness. The control group trained on a treadmill but without BWS. Both groups trained 4 times a week for 6 weeks under the supervision of a physical therapist. During each session, patients walked a maximum of 3 trials for no more than 20 minutes. Subjects’ pulse and heart rates were monitored before each session began and again after each trial to ensure that they did not exceed a baseline that was established by their physician. Walking on the treadmill (Burdick T500 modela) was initiated at 0.0km/h and increased by increments of .15km/h. Subjects could grip a horizontal bar attached to the front of the treadmill to provide stability. In addition to gait training, all subjects—regardless of their group allocation—received regular, weekday physical therapy.

###

## Blennerhassett et al. Additional task-related practice improves mobility and upper limb function early after stroke: A randomised controlled trial. AUS J PHYSIOTHERAPY. 2004.

TREATMENT GROUP 1: Both the Mobility and Upper Limb Groups received additional task-related practice for one hour a day, five days per week for four weeks. Each session consisted of a circuit of 10 five-minute workstations, with up to four subjects in each session. A physiotherapy department staff member supervised all sessions closely, and all activities were customised and progressed to suit individual subjects. Mobility circuit classes were conducted separately from the Upper Limb sessions. Mobility Group activities included warm-up and endurance tasks using stationary bikes and treadmills, followed by functional tasks such as sit to stand, step-ups, obstacle course walking, standing balance, stretching as required, and strengthening using traditional gymnasium equipment.

TREATMENT GROUP 2: Both the Mobility and Upper Limb Groups received additional task-related practice for one hour a day, five days per week for four weeks. Each session consisted of a circuit of 10 five-minute workstations, with up to four subjects in each session. A physiotherapy department staff member supervised all sessions closely, and all activities were customised and progressed to suit individual subjects.Upper Limb Group activities commenced with a warm-up (arm ergometer) followed by functional tasks to improve reach and grasp, hand-eye coordination activities, stretching as required, and strengthening using traditional gymnasium equipment. Therapist-assisted exercises were incorporated for subjects with limited control of arm or hand movement.

###

## Boake et al. Constraint-Induced Movement Therapy During Early Stroke Rehabilitation. NEUROREHABIL NEURAL REPAIR. 2007.

TREATMENT GROUP 1: Constraint-induced movement therapy. Therapy sessions consisted of performing tasks only with the affected UE. Task movements included reaching, grasping, lifting, and placing. Tasks were individually selected according to motor ability, to ensure successful experience and prevent frustration leading to learned nonuse.1,16 Task difficulty was progressively increased using behavioral techniques of shaping and successive approximation.17 In addition to individual therapy sessions, patients were asked to wear a mitten restraint (Sammons Preston #6727 “Padded Safety Mitt,” Sammons Preston, Inc., Bolingbrook, IL) on the unaffected hand during 90% of waking hours, excluding activities when risk of injury might increase. The mitten allowed the unaffected UE to assist in transfers and ambulation, but it prevented use of the unaffected fingers to manipulate objects and necessitated use of the affected hand to perform daily activities.

CONTROL GROUP 1: Intensive traditional therapy. Therapy sessions consisted of performing daily living tasks with either hand and therapeutic activities with the affected UE that were intended to improve strength,muscle tone, and range of

motion. This treatment condition differed from the standard therapy regimen provided to non-study patients in that the number of hours of therapy per day and the number of therapy days were increased to approximate the frequency and duration of CIMT. No restraint was used, and patients were free to use either hand for daily activities.

###

## Bolognini et al 2011. Neurophysiological and Behavioral Effects of tDCS Combined With Constraint-Induced Movement Therapy in Poststroke Patients. NEUROREHABILITATION NEURAL REPAIR 2011

TREATMENT GROUP 1. Constraint-induced movement therapy. Each subject underwent a 14-day CIMT, administered by a trained therapist, who was not involved in the pre–post evaluations. Participants had to wear, on the nonparetic hand, a resting splint secured in a sling, which hindered hand and finger activity (Skil-Care Rigid Palm Padded Mitt; AliMed, Inc, Dedham, Massachusetts; Figure 1). The splint had to be worn for at least 90% of waking hours. During the 10 weekdays of the treatment period, all patients received up to 4 hours per day of training of the affected arm, only in the laboratory.33 Training tasks were designed according to a behavioral “shaping” technique and were designed to force an intensive use of the paretic extremity, while requiring a progressive improvement of the quality of movement.34 Nine different shaping tasks were used during the 4-hour training period (the list of the tasks is available at ptjournal.apta.org; see Ref. 13). On D1, the majority of patients completed a minimum of 6 out of 9 tasks. On D10, all patients were able

to complete, on average, 1.5 repetitions of the 9 tasks, showing an improvement of their performance. Transcranial direct current stimulation. Direct current was transferred by a saline-soaked pair of surface sponge electrodes (7 × 5 cm, 35 cm2) and delivered by a battery-driven, constant current stimulator (Eldith Ltd, Illmenau, Germany).

The device can be set in advance to deliver either the active or the sham stimulation, thus keeping both the patient and the therapist masked.35 The 2 treatment modalities were the following:

1. Active tDCS (plus CIMT): The anode electrode was placed over the affected M1 (C3/C4, according to the 10/20 EEG system). The cathode electrode was placed over the contralateral (unaffected) M1 (Figure 1). At the beginning of each training session, a constant current of 2 mA intensity (current density of 0.57 A/m2) was applied for 40 minutes (total charge of 4.8 C; fade-in/fade-out phases = 10 seconds).36

CONTROL GROUP 1. Constraint-induced movement therapy. Each subject underwent a 14-day CIMT, administered by a trained therapist, who was not involved in the pre–post evaluations. Participants had to wear, on the nonparetic hand, a resting splint secured in a sling, which hindered hand and finger activity (Skil-Care Rigid Palm Padded Mitt; AliMed, Inc, Dedham, Massachusetts; Figure 1). The splint had to be worn for at least 90% of waking hours. During the 10 weekdays of the treatment period, all patients received up to 4 hours per day of training of the affected arm, only in the laboratory.33 Training tasks were designed according to a behavioral “shaping” technique and were designed to force an intensive use of the paretic extremity, while requiring a progressive improvement of the quality of movement.34 Nine different shaping tasks were used during the 4-hour training period (the list of the tasks is available at ptjournal.apta.org; see Ref. 13). On D1, the majority of patients completed a minimum of 6 out of 9 tasks. On D10, all patients were able

to complete, on average, 1.5 repetitions of the 9 tasks, showing an improvement of their performance. Transcranial direct current stimulation. Direct current was transferred by a saline-soaked pair of surface sponge electrodes (7 × 5 cm, 35 cm2) and delivered by a battery-driven, constant current stimulator (Eldith Ltd, Illmenau, Germany).

The device can be set in advance to deliver either the active or the sham stimulation, thus keeping both the patient and the therapist masked.35 The 2 treatment modalities were the following:

2. Sham tDCS (plus CIMT): The same site and parameters of stimulation were employed, but the stimulator was turned off after 30 seconds of stimulation. This ensured that patients could feel the initial itching sensation at the beginning of tDCS, a requisite for successful masking.35

Patients were randomly assigned to 1 of the 2 groups (7 patients in each group). With respect to the clinical and demographic data, no significant differences between the 2 groups were found, as assessed by unpaired t tests (see Table 1).

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## Brock et al. Does physiotherapy based on the Bobath concept, in conjunction with a task practice, achieve greater improvement in walking ability in people with stroke compared to physiotherapy focused on structured task practice alone? A pilot randomized controlled trial. CLIN REHABIL. 2011.

TREATMENT GROUP 1. Participants in both groups received six one hour physiotherapy sessions over a two-week period. During the intervention period, participants did not receive any other physiotherapy aimed at improving mobility, posture, balance or lower limb function. Instead, the intervention sessions replaced the usual physiotherapy treatment for mobility. Additional physiotherapy was provided in sitting or lying for other rehabilitation goals, such as independence in bed mobility and recovery of upper limb function. Intervention A was based on the Bobath concept.In this intervention, participants received individual treatment prescription based on the Bobath concept towards the goal of improving walking ability in different environmental contexts. This intervention included detailed assessment of the individual’s movement strategies and the neurological and neuromuscular deficits underlying motor dysfunction. Treatment strategies were individualized and aimed at both Brock et al. 905 reducing the severity of impairments where they impacted on function, and optimizing postural and movement strategies to improve efficiency and maximize function. Two detailed examples of interventions based on the Bobath concept for patients post-stroke who are able to walk independently but are limited in their ability to walk are described in Raine et al.11,14 These examples show assessment, clinical reasoning and intervention processes related to assessment findings. Interventions described include: . facilitated activation of postural activity and selective movement in the affected hip and knee in various postures including supine, standing and single leg stance; . enhancing foot contact and balance through improving alignment of the talocrural joint, activation of musculature of the foot and shank, and facilitation of ankle strategy;. facilitation of core stability during tasks of lying to sitting, and in standing;. facilitation through a wide variety of postures requiring complex rotation movements to improve midline orientation. These interventions are representative of the type of interventions utilized in this study with the aim of improving walking ability. The specific goal of therapy in this study was to improve the ability of the participant to walk safely in different environments, including components of endurance, walking on slopes, going up and down a single step and walking over rough ground. The session incorporated structured task practice (as described below) for 1/6 of the treatment time allocated. Both interventions were performed by physiotherapists with at least five years’ postgraduate experience and at least two years’ experience in the fields of rehabilitation or neurology. In addition, therapists providing Intervention A had to have also completed a Basic Bobath Course and at least two Advanced Bobath Courses (a minimum of 180 hours of formal training acquired over a minimum of three years).

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## Broeren et al. Virtual Rehabilitation in an Activity Centre for Community-Dwelling Persons with Stroke. CEREBROVASC DIS. 2008.

TREATMENT GROUP 1. The treatment group received additional VR therapy 3 times a week for 45 min for 4 weeks. The intervention consisted of playing 3D computer games with the UE unsupported during play. Both groups continued to participate in their usual activities at the activity centre which included different social activities, creative crafts and physical activities. The assessments were made by a person not responsible of the training, here the first author. The training was conducted by rehabilitation personnel at the activity centre, without prior experience of VR therapy. The VR environment consisted of a semi-immersive workbench ( fig. 1 ). Using stereographic shuttered glasses, a 3D image displayed above the tabletop was observed by the user. The participant was able to reach into a virtual space and interact with 3D objects, using a haptic device. This created the illusion of manipulating virtual objects. The Phantom Omni (www.sensable.com) with a maximum exertable force of 3.3 N is a desk-mounted robot that can sample movement data at 1 kHz with 6 degrees of freedom. This includes spatial coordinates for the stylus in metric units, as well as the roll, pitch and yaw of the stylus. A precise and detailed recording of hand movements was therefore possible. The haptic workspace was 160 ! 120 ! 120 mm (width/height/depth). Telemedicine based on Skype TM with a camera was used as a communication tool between the therapist and the personnel at the activity centre, offering clinical and technical support. A haptic game selection menu was designed; choosing various games with the haptic stylus from a game library was now possible ( fig. 2 ). The games were designed to activate the affected UE, focusing on engaging the whole arm. The subjects were introduced to the games with a 20-min demonstration prior to the start of the study.

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## Brokaw et al. Robotic Therapy Provides a Stimulus for Upper Limb Motor Recovery After Stroke That Is Complementary to and Distinct From Conventional Therapy. NNR 2014

CONTROL GROUP 1: Conventional Therapy Subjects received 12 hours of therapy from a neurologic clinical specialist physical therapist with 30+ years of experience. Therapy was consistent with the standard of care provided at NRH. Individualized programs were established based on assessment and patient goals. In weak muscles, manual therapy techniques were used to obtain isometric contractions in the shortened range. Subjects received mobilization to restricted joints as needed and stretching exercises to increase range of motion. Home stretching was

recommended to subjects who had less than full passive range of motion in the fingers. Treatments focused on practice of specific tasks. These included reach and grasp of various objects, isolated hand movements (typing, “playing the piano,” molding putty), and whole body activities

(swinging a tennis racquet, basketball handling skills, etc).

TREATMENT GROUP 1: Robotic Training Subjects received 12 hours of training with the ARMin III robot23 and the HandSOME24 device (Figure 1). The ARMin III provided active actuation of shoulder elevation, shoulder horizontal adduction/abduction, shoulder external/internal rotation, elbow flexion/extension, and forearm supination/ pronation. The ARMin was controlled with custom software (MATLAB xPC Target, MathWorks Inc, Natick, MA) that minimized the effects of gravity and friction at the robot joints.33 The HandSOME uses adjustable elastic elements to increase active range of motion, enabling coordinated finger and thumb movement in pinch-pad grasp (finger metacarpophalangeal joints and thumb carpometacarpal joint). The combination of the ARMin and HandSOME devices allowed for simultaneous reach and grasp of virtual and real-world objects. A technician received basic patient interaction training from the study therapists and oversaw the robotic therapy. The primary training tasks were the Shelf, Pouring, and Sorting tasks. Each task was practiced for 25 minutes in each session. In the Shelf task, subjects placed objects on a shelf using simultaneous shoulder elevation and elbow extension. This task practices movement out of the common flexor synergy. In the Pouring task, subjects grasped and poured from a pitcher using shoulder internal/external rotation and simultaneous wrist pronation/supination. In Sorting, subjects moved objects from one location to another using shoulder elevation and simultaneous shoulder

horizontal abduction. The robot was controlled using the Time Independent Functional Training (TIFT) method previously developed. 34,35 Joint space walls limited movement unless the arm joints are moved with a coordination that is appropriate for the task. The goal of TIFT is to retrain proper interjoint coordination within the context of functional multijoint reaching movements. Difficulty was graded through changes in range of motion and the amount of arm gravity compensation. Subjects practiced first with virtual objects and then physical objects were added to increase difficulty. Real object shape, fragility, and weight were varied. Coordinated reach and grasp was practiced; subjects planned their trajectory to the object, opening their hand as they reached for the object. At the beginning of each task, subjects attempted movements with zero gravity compensation to assess changing ability across training sessions. For 15 minutes each session, gamelike activities were played that focused on isolated joint movement. These included navigating mazes (L-Traj) and playing ping-pong against the computer.

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## Brunner et al. Is modified constraint-induced movement therapy more effective than bimanual training in improving arm motor function in the subacute phase post stroke? A randomized controlled trial. CLIN REHABIL 2012

TREATMENT GROUP 1: Participants in both intervention groups received the same time of task-related arm training with an experienced occupational and/or physical therapist, 4 hours a week for four weeks, both on an inpatient and outpatient basis. In addition, the patients received

written self-training exercises adjusted to their current motor capabilities at least three times during the intervention period. They were expected to use the affected arm actively at least 2–3 hours a day,

preferably in daily life activities. Both the training with a therapist and the self-training programme followed ‘shaping’ principles (i.e. the motor tasks were adapted to increasing motor function to maintain a challenging character). Therapists were encouraged to focus either on bilateral or unilateral activities where possible. The patients were asked to write a log about the time spent exercising. The proposed exercises were as close to daily life activities as possible, but included also strength training and mobility training when appropriate. Other necessary rehabilitation was provided according to individual needs. Patients in the modified constraint-induced movement therapy group were supposed to wear a mitt on the less affected arm for 4 hours a day and record the time of actually wearing the mitt in their logbook. Their self-training programme focused on unilateral activities. In ballgames the patients were prompted to use both hands when throwing and catching the ball, while patients in the modified constraint-induced movement therapy group were requested to use the affected arm only. Other specifically bilateral activities with need of both hands to perform the task were, for example, using cutlery, tying a knot and a ribbon, folding a towel, banging in a nail. Table 1 shows some examples of unilateral and bilateral activities. Activities were also tailored to the individual interests and needs of the patients. Patients in both groups were reminded to use the affected arm as often as possible and the logbooks

were checked regularly.

TREATMENT GROUP 2: Participants in both intervention groups received the same time of task-related arm training with an experienced occupational and/or physical therapist, 4 hours a week for four weeks, both on an inpatient and outpatient basis. In addition, the patients received

written self-training exercises adjusted to their current motor capabilities at least three times during the intervention period. They were expected to use the affected arm actively at least 2–3 hours a day,

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## Burgar et al. Robot-assisted upper-limb therapy in acute rehabilitation setting following stroke: Department of Veterans Affairs multisite clinical trial. J REHABIL RES DEV. 2011.

TREATMENT GROUP 1. All therapy was performed with the supervision of a physical or occupational therapist. The 5-minute preparatory and terminal segments of each session were identical in all three groups. The remainder of each CG session was aimed at improving the function of the paretic upper limb through a variety of therapeutic modalities. The therapy was progressive and tailored to the individual’s specific stroke diagnosis, level of impairment, and residual deficits. Treatment interventions addressed edema, loss of flexibility, loss of strength, decreased postural control, abnormal motor activation, and lack of coordination. Specific treatment techniques included soft tissue and joint

mobilization at the start of each session, neuromuscular reeducation strategies, isolated progressive resistive exercises, and a progression to functional activities of daily living (ADLs) retraining at the same workstation used for the RA sessions. About 5 minutes of each CG treatment session were devoted to exposure to MIME with the robot positioning targets for static and dynamic tracking, reaching, and self range-of-motion tasks. The robot did not apply any forces to the CG subjects during these tasks. This component of the protocol was included to control for potential novelty effects of the robotic intervention. Both RA groups performed the movements with continuous direct visualization of the limbs, using physical objects as targets to maintain a more functional (using physical instead of virtual targets) and goal-directed set of tasks. Movements progressed from passive, with paretic upper-limb motion controlled by the contralateral limb or by the robot in trajectories predetermined by the therapist, to practice of unilateral active-assisted movements followed by practice of actively resisted movements of the affected limb. As with the CG, subjects in the RA groups were advanced to the more challenging tasks consistent with their level of recovery and ability to complete those movements that required less volitional control and strength. Sessions began with practice of targeted, twodimensional reaching movements at table level and then progressed to more complex, three-dimensional, out-ofsynergy movements beginning at table level and ending at eye level. Movement patterns incorporated into the training sessions have been previously described [6]. Representative beginning and ending arm positions are shown in Figure 1. Subjects sat in a wheelchair at a height-adjustable table to which the robot and a digitizer were attached. The height was set to allow unrestricted movement within each subject’s functional range of motion during initial assessment and maintained at that height during subsequent sessions. Trunk movement was limited by a contoured seat back with solid shell (Jay Medical, Ltd, Model 182518TK; Longmont, Colorado) and customized cross-torso straps. The hemiparetic forearm was secured in a splint that stabilized the wrist and hand (Figure 2). A Puma 560 robot manipulator (Unimation, Inc, acquired by Staubli Corp; Duncan, South Carolina—no longer in production) was attached to the splint and applied forces to the limb during training movements. The forces and torques between the robot and the affected limb were measured by a 6-axis sensor (Delta SI 330-30, 0.25 N resolution, ATI Industrial Automation; Apex, North Carolina). Force and torque applied to the subject’s forearm were limited by a pneumatically controlled coupling (QuickSTOP, QS-200NP-T3, Applied Robotics Inc; Glenville, New York) that mechanically decoupled the subject and stopped the robot whenever interaction torques exceeded a preset level (~15 N·m typically). The MIME system was programmed to provide four modes of RA training. Forces applied to the subject’s forearm assisted or resisted elbow and shoulder movements in three-dimensional space. Three unilateral exercise modes facilitated practice of reaching movements to targets determined for each subject by the therapist, and a bimanual mode enabled subjects to practice mirror-image upper-limb exercises. The unilateral modes were (1) passive mode (the hemiparetic limb was moved to the target by the robot as the subject relaxed initially and then attempted to move with the robot), (2) active-assisted mode (the subject triggered robot movement by applying force in the intended direction of movement and then attempted to move with the robot as it moved the limb to the target), and (3) active-constrained mode (movement only occurred while the subject applied sufficient force to overcome a programmable, velocity-dependent resistance along the desired path, with any off-trajectory force opposed by a stiff springlike load). In the bimanual mode, the subject attempted bilateral mirror-image movements with assistance for the paretic limb provided by the robot as necessary. The contralateral (“normal”) limb was placed in a similar splint and its position and orientation were tracked by a low-inertia, 6 degrees-offreedom digitizer (MicroScribe 3DLX, Immersion, Corp; San Jose, California). This device was used instead of a second Puma robot to avoid inertial effects that could cause undesired sensory input to the less-affected side, simplify system design, increase reliability, and contain costs. The robot continuously moved the paretic limb to the mirror-image position of the opposite limb, as measured by the digitizer, with minimal delay. The robot was mounted to one side of the table and the digitizer to the other side. We accommodated subjects with right and left hemiparesis by positioning the subject appropriately in the workspace. The digitizer was also used for assessments of voluntary movement kinematics by attaching it to the paretic limb. During RA movements, interaction force and torque measurements from the transducer were recorded and archived by a personal computer. These data and the motions of the robot were monitored by the control program to prevent potentially hazardous situations from occurring. Strategically placed safety switches and mechanical stops were used to deactivate the robot, if necessary. Following initial evaluation, we coordinated studyrelated training sessions with those scheduled by the interdisciplinary clinical treatment team. Participation in this study did not affect other rehabilitation therapy or length of hospital stay. Study therapy was terminated when subjects reached the maximum number of sessions planned for their group or when they were discharged from acute inpatient rehabilitation, whichever came first. CG and Robot-Lo subjects were eligible to receive up to 15 one-hour therapy sessions over a 3-week period and Robot-Hi subjects were eligible to receive up to 30 onehour therapy sessions over the same period. Training under the study protocol was as tolerated and in addition to regular physical, occupational, and speech therapy. Subjects’ progression from easier to more challenging tasks during study-related therapy was contingent on their meeting performance criteria defined by consensus among therapists from all sites.

TREATMENT GROUP 2. All therapy was performed with the supervision of a physical or occupational therapist. The 5-minute preparatory and terminal segments of each session were identical in all three groups. The remainder of each CG session was aimed at improving the function of the paretic upper limb through a variety of therapeutic modalities. The therapy was progressive and tailored to the individual’s specific stroke diagnosis, level of impairment, and residual deficits. Treatment interventions addressed edema, loss of flexibility, loss of strength, decreased postural control, abnormal motor activation, and lack of coordination. Specific treatment techniques included soft tissue and joint mobilization at the start of each session, neuromuscular reeducation strategies, isolated progressive resistive exercises, and a progression to functional activities of daily living (ADLs) retraining at the same workstation used for the RA sessions. 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This device was used instead of a second Puma robot to avoid inertial effects that could cause undesired sensory input to the less-affected side, simplify system design, increase reliability, and contain costs. The robot continuously moved the paretic limb to the mirror-image position of the opposite limb, as measured by the digitizer, with minimal delay. The robot was mounted to one side of the table and the digitizer to the other side. We accommodated subjects with right and left hemiparesis by positioning the subject appropriately in the workspace. The digitizer was also used for assessments of voluntary movement kinematics by attaching it to the paretic limb. During RA movements, interaction force and torque measurements from the transducer were recorded and archived by a personal computer. These data and the motions of the robot were monitored by the control program to prevent potentially hazardous situations from occurring. Strategically placed safety switches and mechanical stops were used to deactivate the robot, if necessary. Following initial evaluation, we coordinated studyrelated training sessions with those scheduled by the interdisciplinary clinical treatment team. Participation in this study did not affect other rehabilitation therapy or length of hospital stay. Study therapy was terminated when subjects reached the maximum number of sessions planned for their group or when they were discharged from acute inpatient rehabilitation, whichever came first. CG and Robot-Lo subjects were eligible to receive up to 15 one-hour therapy sessions over a 3-week period and Robot-Hi subjects were eligible to receive up to 30 onehour therapy sessions over the same period. Training under the study protocol was as tolerated and in addition to regular physical, occupational, and speech therapy. 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# C Authors

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## Carmeli et al. HandTutorTM Enhanced Hand Rehabilitation after Stroke — A Pilot Study. PHYS REHAB INT 2011

CONTROL GROUP 1: Both experimental and control subjects continued to receive their usual rehabilitation treatment programme including occupational therapy (OT) and physiotherapy (PT) on the affected hand. Traditional hand therapy included passive and active therapeutic exercises focusing on range of motion, plus strength and endurance training of the wrist and fi ngers. In addition, the patients were trained to screw, twist, pull and stick certain objects using a ‘functional board’. The experimental group received a supplementary 20–30-minute hand rehabilitation programme using the Hand-TutorTM given by a physiotherapist research assistant. To avoid possible bias associated with the experimental group receiving an additional treatment session, subjects in the control group were given an additional traditional hand therapy session lasting 20–30 minutes. The traditional treatment included functional activities and exercises that facilitate arm movements and enhance strength. These exercises included active, assisted and passive arm movements.

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customize the task to allow the patient to perform active fl exion and extension exercises on the wrist and/ or fi nger/s. The exercises can be tailored to train all fi ngers or isolated fi nger movements. In this study, the task chosen was called ‘Track’. This task consisted of a ball that moves along a track that moves horizontally to track, the screen displaying the target also showed a prompt of either ‘rest’ or ‘track’. Each HandTutorTM training session lasted 20–30 minutes. The frequency of training was fi ve sessions per week.

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## Caurraugh et al. Chronic stroke motor recovery: duration of active neuromuscular stimulation. J NEUROL SCI 2003

TREATMENT GROUP 1. For the active stimulation, surface electrodes were attached to the muscles of the back of the impaired forearm. Muscle activity of the extensor communis digitorum and extensor carpi ulnaris was monitored by an Automove (AM 800) EMG Facilitation Stimulator microprocessor set on active, automatic mode. When subjects voluntarily generated a target threshold level of EMG activity, the microprocessor immediately provided a surface electrical stimulation that assisted the muscles through a full-range of extension motion for the wrist and fingers. The settings for the electrical stimulation were identical for each duration group except the time of activation: 1-s ramp up, 5 or 10 s of biphasic stimulation at 50 Hz, mA range of 17–28, pulse width of 200 As, and 1-s ramp down. Each session started with an initial threshold set at 50 AV, and as subjects voluntarily achieved the target threshold level, then the microprocessor unit automatically increased the target level higher for the next trial. If the target level was not met, then the microprocessor lowered the threshold level slightly for the next trial. All subjects were given 6 h of rehabilitation training across 4 days (90 min/day) over a 2-week period. For each training session, the treatment groups completed three sets of 30 successful active neuromuscular stimulation trials coupled with bilateral movement training according to the stimulation duration group assignments (5 or 10 s duration). The bilateral movement training involved mirror movements on the unimpaired wrist/ fingers simultaneously with the initiation of the impaired wrist/fingers extension movement attempts. The 0 s duration control group followed the same procedure during the training sessions as the treatment groups without receiving active neuromuscular stimulation. A rehabilitation trainer supervised the control subjects as they tried to

voluntarily move their impaired wrist/fingers 90 times in a session while simultaneously extending their unimpaired wrist/fingers.

TREATMENT GROUP 2. For the active stimulation, surface electrodes were attached to the muscles of the back of the impaired forearm. Muscle activity of the extensor communis digitorum and extensor carpi ulnaris was monitored by an Automove (AM 800) EMG Facilitation Stimulator microprocessor set on active, automatic mode. When subjects voluntarily generated a target threshold level of EMG activity, the microprocessor immediately provided a surface electrical stimulation that assisted the muscles through a full-range of extension motion for the wrist and fingers. The settings for the electrical stimulation were identical for each duration group except the time of activation: 1-s ramp up, 5 or 10 s of biphasic stimulation at 50 Hz, mA range of 17–28, pulse width of 200 As, and 1-s ramp down. Each session started with an initial threshold set at 50 AV, and as subjects voluntarily achieved the target threshold level, then the microprocessor unit automatically increased the target level higher for the next trial. If the target level was not met, then the microprocessor lowered the threshold level slightly for the next trial. All subjects were given 6 h of rehabilitation training across 4 days (90 min/day) over a 2-week period. For each training session, the treatment groups completed three sets of 30 successful active neuromuscular stimulation trials coupled with bilateral movement training according to the stimulation duration group assignments (5 or 10 s duration). The bilateral movement training involved mirror movements on the unimpaired wrist/ fingers simultaneously with the initiation of the impaired wrist/fingers extension movement attempts. The 0 s duration control group followed the same procedure during the training sessions as the treatment groups without receiving active neuromuscular stimulation. A rehabilitation trainer supervised the control subjects as they tried to

voluntarily move their impaired wrist/fingers 90 times in a session while simultaneously extending their unimpaired wrist/fingers.

CONTROL GROUP 1. All subjects were given 6 h of rehabilitation training across 4 days (90 min/day) over a 2-week period. For each training session, the treatment groups completed three sets of 30 successful active neuromuscular stimulation trials coupled with bilateral movement training according to the stimulation duration group assignments (5 or 10 s duration). The bilateral movement training involved mirror movements on the unimpaired wrist/ fingers simultaneously with the initiation of the impaired wrist/fingers extension movement attempts. The 0 s duration control group followed the same procedure during the training sessions as the treatment groups without receiving active neuromuscular stimulation. A rehabilitation trainer supervised the control subjects as they tried to

voluntarily move their impaired wrist/fingers 90 times in a session while simultaneously extending their unimpaired wrist/fingers.

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## Chan et al. Bilateral Upper Limb Training with Functional Electric Stimulation in Patients With Chronic Stroke. NNR 2009.

TREATMENT GROUP 1. One session of intervention lasted about 1.5 hours. For details of the training protocol, see the consort flow diagram in Figure 1. In the FES group, patients first performed stretching

or passive mobilization activities for 10 minutes to facilitate active movement. After passive-mobilization, 20 minutes of FES with bilateral upper limb training was started. The participants were then put on the FES device, which provided stimulation to the affected hand to facilitate them to perform hand opening. The stimulation unit was self-triggered by the subject’s unaffected hand with a motion detection system that was based on an accelerometer (model ADXL202; Analog Devices, Norwood, MA; Figure 2A and 2B). The subject could generate a motion of finger extension to trigger the stimulation. The accelerometer could detect the inclination of the sensor with gravitational force, which would generate a change in the acceleration signals for turning on the stimulation. Tong et al26

and Lau and Tong27 have shown that an accelerometer sensor was a reliable motion sensor for both upper limb FES control and gait pattern monitoring. The subject could properly position his or her limb for the preparation of the bilateral upper limb task and then self-trigger the stimulation in a 3-dimensional space. The stimulation could be synchronized with the motion, and the stimulation duration lasted for 8 seconds. Moreover, the subject could focus on the bilateral upper limb task rather than pressing a button, because the subjects could simply trigger the timing of the electric stimulation by extending their finger naturally at any time during the bilateral training tasks. For the FES, the stimulation frequency was 40 Hz, and the pulse width was 200 μs. Self-adhesive surface stimulation

electrodes (diameter = 3.8 cm) were used (PLAS Platinum NeuroStimulation Electrodes; Nidd Valley Medical, Harrogate, UK). The stimulation electrodes were placed on the motor point of the extensor digitorium superficialis (Figure 2C) and abductor pollicis longus muscles (Figure 2D). The stimulation

intensity was set at a sustainable level with functional movement, and the participants could open their hand with the electric stimulation. The motion sensor was placed in a plastic ring and worn on the index finger of the unaffected hand. The subjects extended the index finger of the unaffected hand to

trigger the stimulation and produced active hand opening of the affected side. A preprogrammed setting, which consisted of 3 seconds of ramp-up time, 3 seconds of electric stimulation time, and 2 seconds of ramp-down time, was provided to ensure that there was enough stimulation time for the subject to carry out the tasks and maintain a smooth motion. Moreover, no stretch reflex or increase in muscle tone was observed for all the subjects during the electric stimulation. Furthermore, a wrist extension splint was provided during the FES (Figure 2B). It was made of thermoplastic material to

support the affected arm in a functional position, with the wrist extension fixed at 15° to enhance the extension of the fingers for hand opening during stimulation. The splintage served the purpose of keeping the wrist in a fixed extended position that could minimize overextension of the wrist during stimulation, which might result in a tenodesis grip posture and affect the extension of the fingers for hand opening. Four bilateral upper limb training activities with FES were used for the FES group. These 4 activities were chosen as all of them involved hand manipulation and were functional tasks for daily activities. Each FES session lasted for 20 minutes, with 2 training activities out of the 4 tasks. Because the time limit of each trial was 30 seconds, the subjects could perform at least 20 repetitions in each activity. These training activities were run in a cycle so that each participant had a similar pattern of training. For details of the training activities cycle, see Table 1. The training activities were moving a bowl, pushing a basketball, and simulated feeding and drinking. The participants sat in front of a table. The start position was with the affected upper limb resting on the table such that the shoulder was in approximately 0° flexion/extension (Figure 3). In addition, theheight of the table could be adjusted to ensure the subjects’ elbow flexion angle was at 90° when resting on the table. The moving distance started from the resting position of the hand to the maximum extended arm length of the participants in a forward direction. Markers were placed at the start and the target distance during the training activities. If the participants could not reach the target, the reaching distance was shortened to ensure that the subjects could perform the tasks. Moving the bowl was an activity where the participants were instructed to lift up an aluminum bowl (diameter 27 cm, weight 300 g) from the start position, reach forward, and then place down at the full arm length position. The second task was horizontally pushing a basketball (circumference 76 cm, weight 624 g) onthe table surface and collecting it after it had bounced back. In addition, functional training such as simulated feeding and drinking was performed. The participants were asked to open their affected hand to hold a plastic bowl (diameter 11 cm, weight 80 g) and a plastic cup (diameter 6 cm, weight 30 g) for feeding and drinking, respectively. After the electric stimulation training, both the FES and control groups attended conventional occupational therapy training, including activities of daily living training and exercise training for 1 hour. These activities were mainly targeted at proximal upper limb control (eg, shoulder flexion activities for the patients with limited shoulder control).

CONTROL GROUP 1: Members of the control group participated in the same bilateral upper limb training tasks, but the intensity of the electric stimulation did not trigger any muscle movement (they only had a slight sensation of electric stimulation). The training activities were moving a bowl, pushing a basketball, and simulated feeding and drinking. The participants sat in front of a table. The start position was with the affected upper limb resting on the table such that the shoulder was in approximately 0° flexion/extension (Figure 3). In addition, the height of the table could be adjusted to ensure the subjects’ elbow flexion angle was at 90° when resting on the table. The moving distance started from the resting position of the hand to the maximum extended arm length of the participants in a forward direction. Markers were placed at the start and the target distance during the training activities. If the participants could not reach the target, the reaching distance was shortened to ensure that the subjects could perform the tasks. Moving the bowl was an activity where the participants were instructed to lift up an aluminum bowl (diameter 27 cm, weight 300 g) from the start position, reach forward, and then place down at the full arm length position. The second task was horizontally pushing a basketball (circumference 76 cm, weight 624 g) on the table surface and collecting it after it had bounced back. In addition, functional training such as simulated feeding and drinking was performed. The participants were asked to open their affected hand to hold a plastic bowl (diameter 11 cm, weight 80 g) and a plastic cup (diameter 6 cm, weight 30 g) for feeding and drinking, respectively. After the electric stimulation training, both the FES and control groups attended conventional occupational therapy training, including activities of daily living training and exercise training for 1 hour. These activities were mainly targeted at proximal upper limb control (eg, shoulder flexion activities for the patients with limited shoulder control).

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## Chen et al. Facilitation of motor and balance recovery by thermal intervention for the paretic lower limb of acute stroke: a single-blind randomized clinical trial. CLIN REHABIL. 2011.

TREATMENT GROUP 1. All participants received standard rehabilitation, including 40 minutes each of physiotherapy and occupational therapy, given once per day, five days per week for six weeks, by the rehabilitation team. The thermal group received one thermal stimulation intervention session of approximately 48 minute’s duration five times weekly, given by the same physical therapist. The control group had visits and discussions of 20 minutes at least three times per week instead. The principle of the thermal stimulation intervention has been described previously.13 To begin the therapy, a hot pack was placed once on the nonparetic leg; and the patient was asked to notice the change in skin temperature and move the nonparetic leg away from the hot pack when discomfort developed. Next, the hot pack was put on the paretic leg, and the patient was encouraged to actively move their paretic leg as much as possible away from the stimulus with a movement pattern guided by the therapist (e.g. hip flexion, abduction, adduction, knee flexion or ankle dorsiflexion) when discomfort developed. If a motor response was not generated after the development of discomfort or the patient accepted the maximum duration of stimulation, the leg was moved away guided and assisted by the therapist. Thus, the thermal agent produced thermal sensation followed by active/passive motion. During the session, eight repetitions of a maximum of 30 seconds of stimulation were performed followed by 30 seconds of rest. When the skin temperature of the paretic leg had dropped to baseline, an identical procedure was performed with the cold pack. A cycle of therapy comprised the eight applications of hot and eight applications of cold stimuli. Three such cycles were performed during each session. Therefore, approximately 48 minutes (8 x [30 sec+30 sec] x 2 x 3) were required to complete a session of thermal stimulation therapy. This duration was approximate because not all patients tolerated the full 30 seconds of stimulus. A session of thermal stimulation was performed once daily. The facilitative programme contained five sessions per week and lasted for six weeks. During treatment, the patients were lying comfortably on their backs or sides on a mat with one or two pillows under their heads so that they could observe their lower limbs. The temperatures of the room and the patients’ lower limbs were noted before therapy. The thermal agent consisted of an ordinary hot (75C) or cold (0C) pack wrapped with two towels, which buffered the thermal conduction. The thermal agent was placed over the region of the calf or foot, and the skin temperature was recorded by a thermal couple placed between the stimulation site and the thermal agent. The changes in skin temperature induced by the thermal agents were nonlinear. Before the study, 30 healthy age-matched individuals participated in a pilot safety study, and they showed signs of discomfort to the hot and cold agents after a mean (SD) of 23.9 (11.1) seconds at 45.0 (4.7)C and 32.4 (19.1) seconds at 17.9 (4.8)C. Therefore, to avoid tissue damage, maximum durations of hot and cold stimulation on the calf or foot were limited to 30 seconds at a mean temperature of 46.5 (4.1)C and 45 seconds at 15.5 (4.7)C. If patients were unable to move their paretic legs at the beginning (antigravity), they could turn to begin the therapy lying on their sides (gravity). Once the patient could control the Chen et al. 825 movements, they were encouraged to perform

them independently.

CONTROL GROUP 1. All participants received standard rehabilitation, including 40 minutes each of physiotherapy and occupational therapy, given once per day, five days per week for six weeks, by the rehabilitation team. The thermal group received one thermal stimulation intervention session of approximately 48 minute’s duration five times weekly, given by the same physical therapist. The control group had visits and discussions of 20 minutes at least three times per week instead.

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## Cho et al. Virtual Walking Training Program Using a Real-world Video Recording for Patients with Chronic Stroke: A Pilot Study. AM J PHYS MED REHABIL. 2013.

TREATMENT GROUP 1. All 14 subjects participated in the standard rehabilitation program, which included therapeutic exercise, occupational therapy, and functional electrical stimulation. Therapeutic exercise, which targeted lower extremity muscle strength and gait, was performed for 30 mins a day, five times a week, for 6 wks. For the 30-min session of therapeutic exercise, neurodevelopmental treatment and proprioceptive neuromuscular facilitation were performed.

Occupational therapy, an upper extremity training program for activities of daily living, was performed for 30 mins a day, five times a week, for 6 wks. Functional electrical stimulation was simultaneously applied to the lower extremity for 20 mins a day, five times a week, for 6 wks. In addition, the experimental group underwent VWTRW for 30 mins a day, three times a week, for 6 wks, and the control group participated in treadmill gait training for 30 mins a day, three times a week, for 6 wks (Fig. 1). In stroke rehabilitation, a sensory organ must receive realistic information to establish an effective VR system. In addition, symptoms of cybersickness, such as nausea, visual fatigue, and loss of direction, must be minimized.27 Thus, this study used a videocamera (Nex-5; Sony, Tokyo, Japan) to record real community videos and a steadicam camera-stabilizing system (Flycam nano; PIS, Seoul, South Korea) to minimize nausea or vomiting, which may be induced by shaky images. Steadicam is a brand of camera-stabilizing mount for motion picture cameras that mechanically isolates the camera from the operator’s movement, allowing for a smooth shot even when moving quickly over an uneven surface. The VR using a real-world video recording (VRRW) was composed of six screen shots: a sunny 400-m walking track, a rainy 400-m walking track, a 400-m walking track with obstacles, daytime walks in a community, nighttime walks in a community, and walking on trails (Fig. 2). Each screen shot was played for 10 mins, and each screen shot was repeated three times during the 30 mins of the VWTRW. The six screen shots were changed at intervals of 1 wk during the training period. Virtual Walking Training Program Using a Real-world Video Recording The VWTRW was performed using a treadmill (JT-4000; Saehan Medical, Gyeonggi-do, South Korea) and an overhead harness (TA-6000; Gyerim Medical, Gyeonggi-do, South Korea). The VRRW was projected onto a screen in front of the treadmill (2 m) using a projector and a laptop,12 and loudspeakers were connected to the laptop to provide auditory input (Fig. 3). Emergency stop devices were installed for the patients’ safety during the projection of the VRRW onto the screen. Moreover, each subject wore a harness that did not support any body weight.25 All subjects recorded self-selected comfortable walking speeds on the treadmill before the VWTRW was started. This speed was then halved and used for a 2-min warm-up on the treadmill.28 All subjects walked on a motorized treadmill, starting at a self-selected comfortable walking speed. The treadmill speed and the VRRW scene movement were not synchronized. The treadmill speed was increased by 5% during the subsequent training session if the subject could maintain the training speed while feeling safe18 for 20 secs. To prevent the subjects from experiencing a fall during training and to identify any other signs of excessive fatigue, a therapist stood within an arm’s reach of the subjects; the subjects were allowed to grab the handrails only if they feared falling.18 The patients were asked to release the handrails as soon as possible after they had grabbed the handrails. Both the experimental and control groups were similarly instructed on using the handrails. The experimental group received the VWTRW (30 mins per session, three times a week) during a 6-wk period. Similarly, the control group received treadmill training (30 mins per sessions, three times a week) during a 6-wk period. In the control group, the walking speed on the treadmill was controlled using a method similar to that used in the experimental group but with no VRRW projection. While walking on the treadmill, each subject in the control group was asked to lift his/her head and look through the window to achieve a head position similar to that of the experimental group while looking at the VRRW. In addition, each subject in the control group wore a harness without any body weight support.

CONTROL GROUP 1. All 14 subjects participated in the standard rehabilitation program, which included therapeutic exercise, occupational therapy, and functional electrical stimulation. Therapeutic exercise, which targeted lower extremity muscle strength and gait, was performed for 30 mins a day, five times a week, for 6 wks. For the 30-min session of therapeutic exercise, neurodevelopmental treatment and proprioceptive neuromuscular facilitation were performed. Occupational therapy, an upper extremity training program for activities of daily living, was performed for 30 mins a day, five times a week, for 6 wks. Functional electrical stimulation was simultaneously applied to the lower extremity for 20 mins a day, five times a week, for 6 wks. In addition, the experimental group underwent VWTRW for 30 mins a day, three times a week, for 6 wks, and the control group participated in treadmill gait training for 30 mins a day, three times a week, for 6 wks (Fig. 1). All subjects walked on a motorized treadmill, starting at a self-selected comfortable walking speed. The treadmill speed and the VRRW scene movement were not synchronized. The treadmill speed was increased by 5% during the subsequent training session if the subject could maintain the training speed while feeling safe18 for 20 secs. To prevent the subjects from experiencing a fall during training and to identify any other signs of excessive fatigue, a therapist stood within an arm’s reach of the subjects; the subjects were allowed to grab the handrails only if they feared falling.18 The patients were asked to release the handrails as soon as possible after they had grabbed the handrails. Both the experimental and control groups were similarly instructed on using the handrails. The experimental group received the VWTRW (30 mins per session, three times a week) during a 6-wk period. Similarly, the control group received treadmill training (30 mins per sessions, three times a week) during a 6-wk period. In the control group, the walking speed on the treadmill was controlled using a method similar to that used in the experimental group but with no VRRW projection. While walking on the treadmill, each subject in the control group was asked to lift his/her head and look through the window to achieve a head position similar to that of the experimental group while looking at the VRRW. In addition, each subject in the control group wore a harness without any body weight support.

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## Conroy et al. Effect of Gravity on Robot-Assisted Motor Training After Chronic Stroke: A Randomized Trial. APMR. 2011.

TREATMENT GROUP 1: All interventions were provided by the same therapist for 6 weeks: 1 hour 3 times a week for a total of 18 sessions. Robot therapy included the use of 2 different robots specifically designed for UE neurologic rehabilitation. Robot-assisted planar reaching was performed with a 2 degree of freedom shoulder-elbow robot (InMotion 2.0 Shoulder/Arm Robot).a The combined robot group (planar with vertical) used the planar shoulder-elbow robot for gravity-compensated horizontal reaching followed by the 1-degree of freedom linear robot (InMotion Linear Robot)a in its vertical position for reaching against gravity. The robots provided assistance with a performance-based algorithm, adapting forces as needed to challenge or assist movement. This algorithm, introduced in 2002,25 continuously challenges the patient by modifying (1) the time allotted for the patient to make the move and (2) the primary stiffness of the impedance controller that guides the movement. The better the patient performs, the more he or she is challenged to move quicker and receive less guidance. In addition, compliant and back-drivable programming allowed for expression of movement outside a rigid trajectory. The ICAE sessions were time matched with the robotic sessions. Rate of movement repetition was not precisely matched to the robot, but overall intensity was greater than that of a conventional exercise program.26 Robot-Assisted Planar Reaching: Participants performed reaching in the horizontal plane while seated wearing a torso harness to decrease compensatory trunk movement. Reaching focused on the completion of shoulder and elbow movements toward visual targets within this gravity compensated plane. The participant’s arm was supported throughout the movement in the robot arm, and straps were used as needed to maintain a cylindrical grasp. As many repetitions as possible were performed with the participant’s paretic arm reaching toward 8 targets in a point-to-point circular pattern. If a task could not be completed volitionally, the robot provided assistance in addition to continual visual feedback on target location and arm position. A summary graph of the individual’s performance appeared after every 80 movements. A typical session included 64 unassisted and 1280 assist-as-needed point-to-point movements for a total of 1344 movements.

TREATMENT GROUP 2: All interventions were provided by the same therapist for 6 weeks: 1 hour 3 times a week for a total of 18 sessions. Robot therapy included the use of 2 different robots specifically designed for UE neurologic rehabilitation. Robot-assisted planar reaching was performed with a 2 degree of freedom shoulder-elbow robot (InMotion 2.0 Shoulder/Arm Robot).a The combined robot group (planar with vertical) used the planar shoulder-elbow robot for gravity-compensated horizontal reaching followed by the 1-degree of freedom linear robot (InMotion Linear Robot)a in its vertical position for reaching against gravity. The robots provided assistance with a performance-based algorithm, adapting forces as needed to challenge or assist movement. This algorithm, introduced in 2002,25 continuously challenges the patient by modifying (1) the time allotted for the patient to make the move and (2) the primary stiffness of the impedance controller that guides the movement. The better the patient performs, the more he or she is challenged to move quicker and receive less guidance. In addition, compliant and back-drivable programming allowed for expression of movement outside a rigid trajectory. The ICAE sessions were time matched with the robotic sessions. Rate of movement repetition was not precisely matched to the robot, but overall intensity was greater than that of a conventional exercise program.26 Combined Planar and Vertical Robot-Assisted Reaching

Participants in this group performed 30 minutes of reaching with the planar robot described above, followed by 30 minutes of reaching against gravity with the vertical robot. The involved hand independently grasped the robot handle or was assisted with strapping. Arm positioning included 45° to 65° of shoulder abduction (in the scapular plane) for elevation in a diagonal pattern away from the body to shoulder height, followed by lowering toward the body. This positioning was chosen to promote elbow extension and encourage isolated shoulder movements outside the predominating flexor synergy pattern. Movements were directed toward 3 visually guided targets in a linear pattern. A typical combined robot session consisted of 32 unassisted and 640 assist-as-needed movements with the planar robot and 32 unassisted and 640 assist-as-needed movements with the vertical robot for a total of 1344 movements.

CONTROL GROUP 1: All interventions were provided by the same therapist for 6 weeks: 1 hour 3 times a week for a total of 18 sessions. Intensive Conventional Arm Exercise: Participants in this group performed exercises emphasizing active movement of the affected arm while in a seated position. The session included 40 minutes of active repetitive arm motions using an arm ergometer,b a timed target-specific skate-board activity reaching from a center point outward, and shoulder and elbow range of motion exercises. Task-specific and functional reaching activities for cone reaching and simulated drinking from a cup also focused on active shoulder and elbow movements. Assistance was provided by the subject’s less impaired arm or by the therapist as needed. In addition, passive and guided stretching activities were performed for 10 minutes with an additional 10 minutes for repositioning and rest between activities. Approximately 650 total arm motions were completed per session. Of notice, ICAE delivered a 15-times fold increase in intensity compared with usual conventional therapy for chronic patients, which in general includes 45 movements per session.26

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## Cooke et al. Efficacy of Functional Strength Training on Restoration of Lower-Limb Motor Function Early After Stroke: Phase I Randomized Controlled Trial. NEUROREHABILITATION AND NEURAL REPAIR. 2010.

CONTROL GROUP 1: Conventional Physical Therapy. All participants received routine CPT from their clinical physiotherapists using a treatment schedule.11 The content and duration of each session was recorded. Routine CPT included soft tissue mobilization, facilitation of muscle activity, facilitation of coordinated multijoint movement, tactile and proprioceptive input, resistive exercise, and functional retraining.11 All additional physical therapy, both CPT and FST, was delivered using standardized treatment schedules for up to 1 hour, 4 days a week for 6 weeks (24 hours) by research physio-therapists who were independent of the clinical team. Four research physiotherapists provided the experimental interventions over the course of the trial but for any clinical center at any time point the same research physiotherapist provided both forms of experimental intervention. To ensure adherence to experimental treatment

schedules, the research physiotherapists were supervised throughout the trial. The clinical team was given no information about participants’ group allocation and was not present when the additional intervention was provided. If

participants were discharged from inpatient care before the end of the 6-week intervention phase then a prepaid return taxi journey was arranged to enable attendance at therapy sessions. The control condition was CPT.11 Participants allocated to this condition did not receive any additional therapy.

TREATMENT GROUP 1: Additional Conventional Physical Therapy. All participants received routine CPT from their clinical physiotherapists using a treatment schedule.11 The content and duration of each session was recorded. Routine CPT included soft tissue mobilization, facilitation of muscle activity, facilitation of coordinated multijoint movement, tactile and proprioceptive input, resistive exercise, and functional retraining.11 All additional physical therapy, both CPT and FST, was delivered using standardized treatment schedules for up to 1 hour, 4 days a week for 6 weeks (24 hours) by research physio-therapists who were independent of the clinical team. Four research physiotherapists provided the experimental interventions over the course of the trial but for any clinical center at any time point the same research physiotherapist provided both forms of experimental intervention. To ensure adherence to experimental treatment schedules, the research physiotherapists were supervised throughout the trial. The clinical team was given no information about participants’ group allocation and was not present when the additional intervention was provided. If participants were discharged from inpatient care before the end of the 6-week intervention phase then a prepaid return taxi journey was arranged to enable attendance at therapy sessions. Experimental condition 1 was CPT11 plus CPT (CPT + CPT). To provide clear differentiation between the 2 CPT conditions, the experimental CPT focused on those interventions in the treatment schedule11 that emphasized control/quality of movement and gave prominence to sensory stimulation and preparation of joint and muscle alignment prior to activating muscle or a functional task. Additional CPT was therefore strongly therapist hands-on, with provision of passive movements, active assisted exercise, and/or hands-on intervention to facilitate muscle activity or functional ability. Some active exercise and repetitive practice of functional tasks was included but without systematic progression in resistance or repetition. The key differences between experimental CPT and experimental FST are outlined in Appendix 1.

TREATMENT GROUP 2: Additional Conventional Physical Therapy. All participants received routine CPT from their clinical physiotherapists using a treatment schedule.11 The content and duration of each session was recorded. Routine CPT included soft tissue mobilization, facilitation of muscle activity, facilitation of coordinated multijoint movement, tactile and proprioceptive input, resistive exercise, and functional retraining.11 All additional physical therapy, both CPT and FST, was delivered using standardized treatment schedules for up to 1 hour, 4 days a week for 6 weeks (24 hours) by research physio-therapists who were independent of the clinical team. Four research physiotherapists provided the experimental interventions over the course of the trial but for any clinical center at any time point the same research physiotherapist provided both forms of experimental intervention. To ensure adherence to experimental treatment schedules, the research physiotherapists were supervised throughout the trial. The clinical team was given no information about participants’ group allocation and was not present when the additional intervention was provided. If participants were discharged from inpatient care before the end of the 6-week intervention phase then a prepaid return taxi journey was arranged to enable attendance at therapy sessions. Experimental condition 2 was FST + CPT. Delivery of FST directed participants’ attention to the exercise/activity being performed, appropriate verbal feedback on performance, and repetition (therapist hands-off). Content of FST focused on repetitive, progressive resistive exercise during goal-directed functional activity. The emphasis was on producing appropriate muscle force for the functional activity being practiced. Treatment progressed systematically using repetition and increase in resistance by, for example, changing the limb’s relationship to gravity, increasing the range of movement or distance over which bodyweight was transported, and changing the weight of external objects used to provide resistance. Treatment activities progressed systematically from light to heavy loads and from few to many repetitions. Participants performed repetitive exercise of functional tasks such as sit-to-stand-to-sit, stair climbing/step ups, inside and outside walking, transfer training, bed mobility, and treadmill training with and without the use of a bodyweight support system. Further information is provided in Appendix 2.

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## Crosbie et al. Virtual reality in the rehabilitation of the arm after hemiplegic stroke: a randomized controlled pilot study. CLIN REHABIL. 2012.

TREATMENT GROUP 1. The length and timing of the virtual reality intervention was derived from a detailed review of existing evidence published in this area.8 The system comprised a desktop computer, a head-mounted display unit, a motion tracking system and sensors. The therapist could navigate through the data input and graphics by means of drop-down menus. The head mounted

display facilitated the participant’s immersion in the virtual environment. Three sensors were

applied to the shoulder, elbow and hand of the participant, who could then manipulate objects and

carry out upper limb tasks within a 3D environment. The virtual tasks were designed to simulate a range of upper limb tasks related to reach to target, reach and grasp and game tasks.19 As the participant’s performance progressed the tasks could be made easier or more difficult by means of changing the distance or height of objects or the speed of stimulus. The experimental group underwent a three-week training period using virtual reality-mediated upper limb therapy. This was delivered over three sessions per week of 30–45 minutes duration, which consisted of participant set-up and physical practice focusing on specific upper limb tasks. Each person in the virtual reality group received nine treatment sessions (three per week for three weeks).

CONTROL GROUP 1: The control group received therapy, focusing on the upper limb, to control for any dose effect in terms of the amount of intervention between groups. Conventional therapy followed an evidence-based approach. This was delivered by a physiotherapist, experienced in stroke rehabilitation, and followed a programme of techniques, which included muscle facilitation, stretching exercises, strengthening activities and the inclusion of the more affected upper limb in functional tasks.20 The content of therapy was recorded for each session, using a treatment checklist. A sample of these sessions was video-recorded to allow the content to be checked by an independent physiotherapist, also experienced in stroke rehabilitation.

# D Authors

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## da Silva Cameirao et al. Virtual reality based rehabilitation speeds up functional recovery of the upper extremities after stroke: A randomized controlled pilot study in the acute phase of stroke using the Rehabilitation Gaming System. RESTORATIVE NEUROLOGY AND NEUROSURGERY. 2011.

TREATMENT GROUP 1. The main elements of the Rehabilitation Gaming System (RGS) (Fig. 1) are: the vision based Analysis and Tracking System (AnTS) (Cameirao et al., 2010) that captures upper limb movements through color detection; two data gloves to capture finger flexure (5DT, Fifth Dimension Technologies, Johannesburg, South Africa); an intelligent controller, the Personalized Training Module (PTM) that adapts online the difficulty of the task to the performance of the user; and a virtual environment where an avatar mimics the movements of the user. In the scenario considered here, Spheroids, the user had to interact with approaching flying spheres controlled by parameters such as speed, range of movement and time interval between spheres. These parameters define the difficulty of the task. The training sessions were preceded by two versions of a calibration task, the same task being performed both in the physical and in the virtual environment (Cameirao et al., 2010). In this task patients were asked to move their arms in random sequences to specific positions on the tabletop. In the virtual version, the task was to be performed with the virtual arms moving on a virtual table. This task allowed measuring specific properties of movements such as speed and range of movement, and established the baseline of task difficulty level for every session. Following the baseline calibration, the PTM autonomously defined the baseline difficulty of the Spheroids task. During the training, each new difficulty setting was computed taking into account the previous responses of the user. The difficulty was increased when the user intercepted more than 70% of the spheres; and was decreased if the user intercepted less than 50% of the spheres (Fig. 1). This allowed a continuous adaptation of the game parameters to the user’s performance. Moreover, individualization was realized for each arm separately. The sessions followed a structured training protocol with tasks of increasing complexity (Hitting, Grasping, and Placing) that train speed and range of movement, grasp and release respectively.In addition to standard rehabilitation, patients had three weekly sessions of 20 minutes each of a given treatment condition (RGS or Control). Patients in the intervention group performed the Spheroids tasks (Hitting, Grasping, and Placing) introduced gradually during the treatment period.

CONTROL GROUP 2. The Control group was split in two subgroups to control different aspects of the intervention. The IOT subgroup carried out pure extended occupational therapy with emphasis on motor tasks similar to the ones promoted by the RGS, namely object displacement, and object grasp and release, but without the action observation component. To control for placebo effects such as computer use and game specific effects, and also for the effect of observing

the virtual arms during the task, patients allocated to the NSG subgroup performed games with theWii system (Nintendo,Tokyo, Japan) that requiredmovements with the paretic arm that did not show any virtual body in response to their actions. i.e., this control had in common with the RGS group the gaming features, but did not share the neuroscientific hypotheses on recovery based on an action observation paradigm. All patients in the Control group performed the RGS calibration task once per week for between-group comparisons.

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## Dahl et al. Short- and long-term outcome of constraint-induced movement therapy after stroke: a randomized controlled feasibility trial. CLIN REHABIL. 2008.

CONTROL GROUP 1. All the participants received standard stroke rehabilitation and physiotherapy during the initial hospital stay after onset of stroke. They also received further traditional rehabilitation recommended by the family physician before randomization into the trial. Traditional rehabilitation. Traditional rehabilitation was defined as further community-based follow-up treatment given according to each patient’s needs, involving both upper and lower extremity training. When long-term rehabilitation was necessary, inpatient rehabilitation was given, including both physiotherapy and occupational therapy. Patients were otherwise, or after inpatient rehabilitation, followed-up by the primary health care system including physiotherapy mainly given two sessions per week. The control group received traditional rehabilitation during the intervention period and during the further follow-up, but were offered the CIMT intervention after completing the six-month follow-up.

TREATMENT GROUP 1. All the participants received standard stroke rehabilitation and physiotherapy during the initial hospital stay after onset of stroke. They also received further traditional rehabilitation recommended by the family physician before randomization into the trial. Traditional rehabilitation. Constraint-induced movement therapy The CIMT was conducted at an inpatient rehabilitation clinic at Trondheim University Hospital and all the participants were inpatients during the intervention. The patients were intended to train 6 hours daily for 10 consecutive week days. The participants exercised in groups of four led by a physical and an occupational therapist, assisted by specially trained nurses. A mitten immobilized the non-paretic hand 90% of waking hours. It was removed for hygienic and safety reasons and its removal was registered in a log. In the afternoon the nursing staff supervised and motivated the participants to wear their mitten. Each participant formulated five realistic aims related to ADL or leisure time activities before starting the intervention. Daily activities were the basis for an individual activity form which was updated with daily progress. Exercises were chosen from a collection of approximately 150 activities to be carried out with one hand, divided into 10 fields: personal care, kitchen and household, games, handicrafts, gardening, office work, shopping, sports, strength and mobility. The activities ranged from complex to simple tasks and were individually adjusted with regard to number of repetitions, tempo, resistance, range of motion, texture, weight, size, and shape. The participants had mini-breaks when they shifted from one field of activity to another after half an hour.

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## Daly et al. Response to upperlimb robotics and functional neuromuscular stimulation following stroke. JRRD. 2005.

TREATMENT GROUP 1. Both groups received treatment 5 hours a day, 5 days a week for 12 weeks. For ROBML, during 1.5 h of the daily treatment session, subjects used the robot and practiced shoulder/elbow movements with the forearm and hand supported in a cradle and the wrist and

hand in fixed positions (wrist, 20° of extension, fingers resting around a cone) (Figure 1). Subjects practiced shoulder/elbow movement accuracy, trajectory maintenance, and movement smoothness. The practice movements were between a center target and targets located on the periphery of a circle 14 cm in diameter (Figure 2). The visual display provided online visual feedback of accuracy and coordination success. The remainder of each session (3.5 h) included practice of functional task components and whole task practice without technology assistance. This portion of the treatment protocol was identical for both groups. We used an array of everyday functional tasks that required

shoulder, elbow, forearm, wrist, and hand movements. For each task and task component, we

progressed a given subject through joint movements and combinations of joint movements of

progressively greater difficulty. Tasks were selected first according to the task's applicability in

addressing the coordination deficit of a given subject and then according to the subject's interests and functional goals.

TREATMENT GROUP 2. Functional Neuromuscular Stimulation and Motor Learning For FNSML,

during 1.5 h of the daily treatment session, subjects used FNS for wrist and finger muscle activation. They practiced single and multiple joint movements using FNS. FNSassisted coordination training included practice of movements that included wrist flexion/extension, finger and thumb flexion/extension, and simultaneous wrist extension and finger flexion. FNS was used along with task component movements. For example, subjects used FNS wrist and finger extension to assist during preparation before grasping an object. The stimulus parameters were 300 ms phase duration, 30 Hz, amplitude ranging from 1 mA to the highest comfortably produced stimulus, and 10 s on and 10 s off duty cycle. A typical stimulation pattern was 1 s rampup, 10 s on, 1 s rampdown, and 10 s off. The remainder of each session (3.5 h) was task components practice and whole task practice without

technology assistance, identical to that described in the previous section for the ROBML group.

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## Danzl et al. Brain Stimulation Paired with Novel Locomotor Training with Robotic Gait Orthosis in Chronic Stroke: a Feasibility Study. NEUROREHABILITATION. 2013.

TREATMENT GROUP 1. Transcranial direct current stimulation. For active tDCS, stimulation current was set to 2 mA and applied for 20 minutes. The intensity and duration were selected based on previous studies demonstrating these parameters to be safe (Boggio et al., 2007; Jo et al., 2009; Kim et al., 2010) and effective to induce persistent increases in cortical excitability as measured by transcranial magnetic stimulation motor evoked potentials in the tibialis anterior muscle (Jeffery, Norton, Roy, & Gorassini, 2007). For both groups, a 25 cm2 anode was positioned over the cortical motor area controlling the leg; and a 35 cm2 cathode was positioned supraorbitally. We used a larger cathode than anode in order to minimize potential unintended effects on cortical areas underlying the cathode. See Figure 1 for a depiction of the tDCS set-up. LT-RGO. The Lokomat is an RGO that has been used with neurologically compromised individuals, including those with stroke (Figure 2) (Hesse, Schmidt, Werner, & Bardeleben, 2003; Mayr et al., 2007; Westlake & Patten, 2009; Winchester et al., 2005). The Lokomat exoskeleton facilitates a bilaterally symmetrical gait pattern as the subject attempts to walk on a treadmill (Hesse, et al., 2003; Hidler et al., 2009; Neckel, Wisman, & Hidler, 2006). This robotic mechanism can elicit a comparable-to-normal walking pattern with respect to gait cycle timing. Locomotor training with the use of the Lokomat has shown promise in small studies as a form of intensive, task-oriented, repetitive training for gait restoration in neurological populations (Hesse, et al., 2003; Husemann, Muller, Krewer, Heller, & Koenig, 2007; Mayr, et al., 2007; Westlake & Patten, 2009). However, recent, randomized controlled studies in stroke have shown that this intervention in its conventional form has no greater benefit than either intensive home health or standard physical therapy (Carda et al., 2012; Hidler, et al., 2009; Swinnen, Duerinck, Baeyens, Meeusen, & Kerckhofs, 2010; Vaney et al., 2012). Therefore, we developed a novel protocol that imposes progressive decrease of speed in conjunction with progressive decrease of guidance force to increase physical and mental demand as recovery progresses (Table 1). Additionally, this novel protocol requires attempted initiation of movement by the subject. The theoretical basis for our novel LT-RGO protocol is presented in the discussion section.

TREATMENT GROUP 2. The control group received sham tDCS for 20 minutes with current set to ramp up and then down over the first 75 seconds of the session (Gandiga et al., 2006). This sham protocol produces the same sensation as active tDCS without having a measurable effect on cortical excitability; it is a widely used technique to preserve subject blinding in investigations using tDCS (Gandiga, et al., 2006). For both groups, a 25 cm2 anode was positioned over the cortical motor area controlling the leg; and a 35 cm2 cathode was positioned supraorbitally. We used a larger cathode than anode in order to minimize potential unintended effects on cortical areas underlying the cathode. See Figure 1 for a depiction of the tDCS set-up. LT-RGO. The Lokomat is an RGO that has been used with neurologically compromised individuals, including those with stroke (Figure 2) (Hesse, Schmidt, Werner, & Bardeleben, 2003; Mayr et al., 2007; Westlake & Patten, 2009; Winchester et al., 2005). The Lokomat exoskeleton facilitates a bilaterally symmetrical gait pattern as the subject attempts to walk on a treadmill (Hesse, et al., 2003; Hidler et al., 2009; Neckel, Wisman, & Hidler, 2006). This robotic mechanism can elicit a comparable-to-normal walking pattern with respect to gait cycle timing. Locomotor training with the use of the Lokomat has shown promise in small studies as a form of intensive, task-oriented, repetitive training for gait restoration in neurological populations (Hesse, et al., 2003; Husemann, Muller, Krewer, Heller, & Koenig, 2007; Mayr, et al., 2007; Westlake & Patten, 2009). However, recent, randomized controlled studies in stroke have shown that this intervention in its conventional form has no greater benefit than either intensive home health or standard physical therapy (Carda et al., 2012; Hidler, et al., 2009; Swinnen, Duerinck, Baeyens, Meeusen, & Kerckhofs, 2010; Vaney et al., 2012). Therefore, we developed a novel protocol that imposes progressive decrease of speed in conjunction with progressive decrease of guidance force to increase physical and mental demand as recovery progresses (Table 1). Additionally, this novel protocol requires attempted initiation of movement by the subject. The theoretical basis for our novel LT-RGO protocol is presented in the discussion section.

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## de Diego et al. A sensorimotor stimulation program for rehabilitation of chronic stroke patients. 2013.

TREATMENT GROUP 1. The intervention protocol is divided into the work that the patient does with the therapist during the rehabilitation sessions and the work that the patient does at home helped by the family. The EG received 16 sessions of the protocol of 1 hour at the center during 8 weeks, 2 sessions per week, and 1 daily session of 30 minutes of functional activity training at home. This means that in the EG, the therapist devoted 16 hours of work per patient and the patient invested 28 hours of his/her time. To evaluate the effects of the protocol, assessments on active

mobility and sensibility as well as the use of the upper limb in the ADL were conducted at the beginning, at the middle and at the end of the study. Figure 1 shows the different parts in which the protocol is divided. During the rehabilitation sessions at the center the EG patients had restricted use of the unaffected upper limb by using a rigid mitten that avoids both movement and sensory inputs to the hand, subjected at the patient’s back to avoid motion of elbow and shoulder joints (Fig. 2). This position makes the unaffected upper limb out of the sight of the patient. This is a

difference with the traditional CIMT, which can be a relevant aspect to consider in future research.

CONTROL GROUP 1. The intervention protocol is divided into the work that the patient does with the therapist during the rehabilitation sessions and the work that the patient does at home helped by the family. TheCGhad the usual treatment according to the Bobath concept, without prioritizing therapy of the upper limb, with 2 sessions per week. The protocol was conducted by two therapists (CD and SP) whilst a third one not involved in the study blindly evaluated the patients according to the assessment scales. To evaluate the effects of the protocol, assessments on active mobility and sensibility as well as the use of the upper limb in the ADL were conducted at the beginning, at the middle and at the end of the study. Figure 1 shows the different parts in which the protocol is

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## Dean et al. Task-Related Circuit Training Improves Performance of Locomotor Tasks in Chronic Stroke: A Randomized, Controlled Pilot Trial. ARCH PHYS MED REHABIL. 2000.

TREATMENT GROUP 1.Subjects in both groups participated in 1 hour of task-related training held at the rehabilitation center three times a week for 4 weeks. All training sessions were organized into a group exercise class, conducted by the one of the investigators (C.D.) who was assisted by another physiotherapist. For the experimental group, the exercise class was designed as a circuit program, with subjects completing practice at a series of work stations as well as participating in walking races and relays with other members of the group. The workstations were designed to strengthen the muscles in the affected leg in a functionally relevant way and provide for practice of locomotorrelated

tasks. The 10 workstations incorporated into the circuit were: (1) sitting at a table and reaching in different directions for objects located beyond arm’s length to promote loading of the affected leg and activation of affected leg muscles16,18,22; (2) sit-to-stand from various chair heights to strengthen the affected leg extensor muscles and practice this task22; (3) stepping forward, backward, and sideways onto blocks of various heights to strengthen the affected leg muscles18,19,22,23; (4) heel lifts in standing to strengthen the affected plantarflexor muscles22; (5) standing with the base of support constrained, with feet in parallel and tandem conditions reaching for objects, including down to the floor, to improve standing balance21; (6) reciprocal leg flexion and extension using the Kinetron in standing to strengthen leg muscles5,24; (7) standing up from a chair, walking a short distance, and returning to the chair25 to promote a smooth transition between the two tasks; the remaining stations (8) walking on a treadmill5,22,24,26,27; (9) walking over various surfaces and obstacles22,28; and (10) walking over slopes and stairs22 provided the opportunity for practice of walking under variant conditions. Each exercise class was 1 hour in duration, with subjects practicing for 5 minutes at each of the 10 workstations, and then spending 10 minutes participating in walking relays and races.

The classes, therefore, provided 1 hour of continuous practice of locomotor-related tasks incorporating aerobic and strengthening components. Two physiotherapists supervised each class and were responsible for ensuring that the amount and intensity of the exercise at each station was graded to each subject’s level of functioning. For example, the height of the blocks and chairs used in the stepping and sit-to-stand workstations were set at a level to promote the use of the affected lower-limb muscles and to discourage the use of maladaptive (compensatory) behaviors. Subjects were encouraged to work as hard as possible at each station and were also given verbal feedback and instructions aimed at improving performance. Subjects were also progressed through the 4-week program in a number of ways. Progression was determined by one of the physiotherapists (C.D.) and was based on observed performance. Progressions included increasing the number of repetitions completed within 5 minutes at a workstation and increasing complexity of the exercise performed at each workstation, such as increasing the speed of the treadmill, the distance reached in sitting and standing, the height of the blocks, and reducing the height of the chair during sit-to-stand.

CONTROL GROUP 1. Subjects in both groups participated in 1 hour of task-related training held at the rehabilitation center three times a week for 4 weeks. All training sessions were organized into a group exercise class, conducted by the one of the investigators (C.D.) who was assisted by another physiotherapist.The control group also participated in an exercise class. The organization and delivery of this training was similar in every respect to the experimental group training, except that the control class was designed to improve function of the affected upper limb. The control-group exercise class involved both a circuit component with subjects completing practice at a series of workstations (eg, wrist extension, supination, grasp, and release of various objects18-22,29) and also some exercises completed in small groups. Similar to the experimental group, subjects were progressed according to performance and given feedback (verbal and, in some instances, electromyographic biofeedback) and instructions designed to improve upper-limb function. This exercise class was considered ‘‘sham’’ lowerlimb training and was included so that subjects would consider themselves involved in a training program and to eliminate an effect as a result of placebo or an effect as a result of the physical effort required to get to and from the rehabilitation center 12 times.

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## Dean et al. Treadmill walking with body weight support in subacute non-ambulatory stroke improves walking capacity more than overground walking: a randomised trial. J PHYSIOTHERAPY. 2010.

TREATMENT GROUP 1. The experimental group practised walking on a treadmill while supported in a harness. Initial body weight support was set so that the knee was within 15 degrees of extension mid-stance. Initial speed of the treadmill was set so that the therapist had time to assist the leg to swing through while maintaining a reasonable step length. If a participant was too disabled to walk on a moving treadmill with the assistance of a therapist, they stepped on the spot. The amount of body support was reduced once participants could (i) swing their affected leg through without help, (ii) maintain a straight knee during stance phase without hyperextension, and (iii) maintain an adequate step length without help. Once the they attained a speed of 0.4 m/s without body weight suppot, 10 minutes of the seesion was devoted to overground walking (Crompton et al 2001). Both groups underwent a maximum of 30 minutes per day of walking practice with assistance from one therapist, five days a week, until the achieved independent walking or were discharged from the hopsital. Other intervention involving the lower limbs (ie, strengthening exercises, practising activities such as sitting, standing up and standing) was standardised to a mximum of 60 min per day. No other part of the multidisciplinary rehabilitation program was controlled. Therapsts were provided with written guidelines describing progression and were traind in delivering both interventions. Information describing the specific features of the walking sessions such as treadmill speed and amount of weight support or use of aids, distance waled, and assistance required were recorded for each session. Adherence to the guidelines by therapists was enhanced by training, regular review of hte recording sheets, and spot observations.

CONTROL GROUP 1. The control group practised assisted overground walking. Aids such as knee splints, ankle-foot orthoses, parallel bars, forearm support frames and walking sticks could be used as part of the intervention. If a participant was too disabled to walk with the help of a therapist, they practiced standing and shifting weight and stepping forwards and backwards. Once participants could walk with the assitance of one therapist, they were instructed to increase their speed, and assistance from both the therapist and aids was reduced. Both groups underwent a maximum of 30 minutes per day of walking practice with assistance from one therapist, five days a week, until the achieved independent walking or were discharged from the hopsital. Other intervention involving the lower limbs (ie, strengthening exercises, practising activities such as sitting, standing up and standing) was standardised to a mximum of 60 min per day. No other part of the multidisciplinary rehabilitation program was controlled. Therapsts were provided with written guidelines describing progression and were traind in delivering both interventions. Information describing the specific features of the walking sessions such as treadmill speed and amount of weight support or use of aids, distance waled, and assistance required were recorded for each session. Adherence to the guidelines by therapists was enhanced by training, regular review of hte recording sheets, and spot observations.

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## Desrosiers et al. Effectiveness of unilateral and symmetrical bilateral task training for arm during the subacute phase after stroke: a randomized controlled trial. CLIN REHABIL. 2005.

TREATMENT GROUP 1. Both experimental and control subjects continued to receive their usual occupational therapy and physical therapy treatments for retraining the affected arm. The experimental group subjects also received the new arm retraining programme given by an occupational therapist (OT) research assistant. To avoid possible bias associated with different therapy duration and frequency, the control subjects also received equivalent additional arm therapy, given by the same OT research assistant, based on the conventional approach currently used at the Institute (see below). Treatment duration and frequency were the same for both groups, namely four 45-min sessions per week for five weeks, for a total of between 15 and 20 sessions. The characteristics of those who dropped out during the study were documented with sociodemographic, clinical and control variables available at pretest. Experimental programme. The experimental group received a training programme mainly based on the practice of symmetrical bilateral tasks. The experimental programme was also based on motor learning model principles, including repeated practice and task variability26 (see Appendix for a specific example of the programme). The programme consisted of standardized activities related to everyday tasks involving the arms. The activities were graduated in terms of difficulty and task requirements, according to the impairment level of the arm of each experimental group participant. The tasks required the subject's active participation. There were various types of tasks: symmetrical and asymmetrical bilateral, unilateral for the affected side and unilateral for the less affected side. The symmetrical bilateral tasks involved reciprocal or similar use of the two arms (such as wringing a garment, rolling a cylinder or doing unilateral tasks simultaneously with both arms) while the asymmetrical bilateral tasks involved greater use of one of the arms (such as making coffee). This type of bilateral task can also be done with minimal capacities in the affected arm, which allows the programme to be used with patients with moderate to severe deficits. The unilateral tasks for the affected side consisted of gross and fine dexterity tasks, depending on the impairment. The unilateral tasks for the 'less affected' side mainly comprised dexterity and motor co-ordination activities requiring some precision and speed. These latter activities were retained because practising fine motor unilateral tasks on the less affected side could help improve the affected side.27

CONTROL GROUP 1. Both experimental and control subjects continued to receive their usual occupational therapy and physical therapy treatments for retraining the affected arm. The experimental group subjects also received the new arm retraining programme given by an occupational therapist (OT) research assistant. To avoid possible bias associated with different therapy duration and frequency, the control subjects also received equivalent additional arm therapy, given by the same OT research assistant, based on the conventional approach currently used at the Institute (see below). Treatment duration and frequency were the same for both groups, namely four 45-min sessions per week for five weeks, for a total of between 15 and 20 sessions. The characteristics of those who dropped out during the study were documented with sociodemographic, clinical and control variables available at pretest. Control programme. The control programme for the arm consisted of functional activities and exercises to enhance strength, active, assisted and passive movements, and sensorimotor skills of the arm. The control programme was also based on some components of a neurodevelopmental approach by inhibiting abnormal patterns of movement and stimulating normal active reactions of the affected arm. The programme began with passive and assisted movements of the affected arm, followed by unilateral tasks, such as putting blocks or cones in a pile, unscrewing a light bulb, and symnmetrical bilateral tasks, such as shuffling playing cards, putting a pillow in a pillowcase, tearing up sheets of paper. These tasks were adapted to the level of impairment

and recovery of each patient. No asymmetrical tasks were done nor were unilateral tasks of the less affected arm done. Contrary to the experimental programme, the tasks were not repeated in a systematic way and the mental and physical effort required by the patient was lower (less intense).

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## Di Lauro et al. A randomized trial on the efficacy of intensive rehabilitation in the acute phase of ischemic stroke. J NEUROL. 2003.

TREATMENT GROUP 1. Two different rehabilitative programs were set up and carried out during the first two weeks of hospitalization.On the basis of the content and the duration of each session one treatment was called “intensive” and the other “ordinary”.Bo th began within 24 hours after the stroke.1.I ntensive erhabilitative retatment. Duration: 2 hours a day with an interval of 6 hours between the morning and the afternoon treatment. Contents: a) Morning treatment

– exercises of mobilization according to the scheme of Knott&Voss [6], with “active” work (against resistance on the part of the therapist) for about 45 minutes; – exercises of proprioceptive recognition; – rehabilitative nursing (correct positioning in bed, bedsores prevention, intermittent bladder catheterisation) for 15 minutes. b) Afternoon treatment – exercises of mobilization for about 15 minutes; – tactile, kinesthetic and proprioceptive stimulation;

– exercises of visual stimulation (light sources that vary in intensity, such as television screen and stroboscopic light); – cognitive skill exercises; – exercises of acoustic stimulation (using a tape-recorder for 45 minutes).Follow-up: After 14 days of treatment in hospital and after evaluation by modified N.I.H. Stroke Scale and Barthel-Index, the patients were sent to a rehabilitation center for 60 days.Dur ing that period they were given the conventional treatment that was used in that center, regardless of whether they were in group A or in group B during the acute phase. At the end of the 60-day period, the patients left the center and continued the rehabilitative treatment at home or in a day hospital for another 4 months.This last phase of the treatment was not monitored.

CONTROL GROUP 1. 2.Or dinary erhabilitative retatment Duration: 45 minutes, once a day. Contents: passive and active (if possible) mobilization, bedsores prevention, correct positioning in bed. The patients in group A were given the intensive rehabilitative treatment; the patients in group B were given ordinary rehabilitative treatment.Follow-up: After 14 days of treatment in hospital and after evaluation by modified N.I.H. Stroke Scale and Barthel-Index, the patients were sent to a rehabilitation center for 60 days.Dur ing that period they were given the conventional treatment that was used in that center, regardless of whether they were in group A or in group B during the acute phase.

At the end of the 60-day period, the patients left the center and continued the rehabilitative treatment at home or in a day hospital for another 4 months.This last phase of the treatment was not monitored.

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## Dias et al. Can we improve gait skills in chronics hemiplegics? A randomised control trial with gait trainer. EURA MEDICOPHYS. 2007.

TREATMENT GROUP 1. For a five-week period and for 5 times a week, the CG followed the classical Bobath method, rehabilitation management, including an initial 20 min session for joint mobilisation and muscle strengthening, plus 20 min of a balance and gait training session using the Bobath methods.14 During the same period of time and frequency, the EG followed the gait trainer (REHA-STIM). The gait trainer is based on a doubled crank and rocker gear system, consisting of two footplates positioned on two bars (couplers), two rockers, and two cranks that provide the propulsion. In this device patients are harness secured and positioned on two footplates, whose movements simulate stance and swing phases,

with a ratio of 60% to 40% between the two phases. 15 A servo-controlled motor assists the gait movement by controlling the gear velocity and comparing it to the preselected velocity. The rotation of the planetary gear system, equalling one gait cycle, controls the movement of the centre of mass (CoM) in vertical and horizontal directions. Also, a pulley relieves part of the body weight, as required.15 The experimental treatment was also composed of a first 20 min session of joint mobilisation and muscle strengthening. In the following 20 min, patients were managed in the gait trainer and secured in a harness, with a maximum of 30% body weight relief during the first sessions, according to Hesse’s methodology.11 During the treatment the PBWS was progressively decreased. Each patient was supervised by a physiotherapist who corrected knee motion manually, whenever needed. The treatment time in each session was the same for both groups, i.e. approximately 40 min.

CONTROL GROUP 1. For a five-week period and for 5 times a week, the CG followed the classical Bobath method, rehabilitation management, including an initial 20 min session for joint mobilisation and muscle strengthening, plus 20 min of a balance and gait training session using the Bobath methods.14 The treatment time in each session was the same for both groups, i.e. approximately 40 min.

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## Dobkin et al. International Randomized Clinical Trial, Stroke Inpatient Rehabilitation with Reinforcement of Walking Speed (SIRROWS), Improves Outcomes. NNR. 2010.

TREATMENT GROUP 1. All participants received the site’s conventional inpatient rehabilitation. They also performed a daily 10-m walk (or shorter distance walk until 10 m was feasible) as part of a physical therapy session. The experimental group received feedback about walking speed (daily reinforcement of speed, DRS) after each day’s 10-m walk. The DRS participants were timed after being told to walk as quickly as they felt was safe, and then, they were given specific feedback and encouragement concerning speed. For example, “Very good! You walked that in (number of) seconds.” Then, (a) “This is better by (number of) seconds” or (b) “This shows you are holding your own” or (c) “I believe that you will soon be able to walk a bit faster.” The control group was not timed during its daily 10-m walk and received no information about walking speed (no reinforcement of speed, NRS).

CONTROL GROUP 1. All participants received the site’s conventional inpatient rehabilitation. They also performed a daily 10-m walk (or shorter distance walk until 10 m was feasible) as part of a physical therapy session.

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## Donaldson et al. Effects of Conventional Physical Therapy and Functional Strength Training on Upper Limb Motor Recovery After Stroke: A Randomized Phase II Study. NEUROREHABILITATION AND NEURAL REPAIR. 2009.

CONTROL GROUP 1. All subjects received CPT delivered by the clinical physiotherapists (see control condition below). All extra physical therapy, both CPT and FST, was delivered by the research physiotherapist (see experimental conditions below). To minimize the potential confounder of unintentional therapist bias all extra therapy was administered using standardized treatment schedules and the research physiotherapist was supervised closely throughout the course of the trial. To avoid potential bias of the clinical therapists the research physiotherapist provided extra intervention independently to the clinical team by not telling clinical therapists to which group subjects had been allocated and ensured that all extra treatment was delivered in an area where the clinical team were unable to observe which type of treatment was being provided. The control condition was CPT given by the physiotherapists in each clinical center using a standardized treatment schedule15 (treatment recording form and descriptive booklet) generated using established methods.16,17 The format of the CPT treatment schedule was similar to that produced for the lower limb16 and the content included soft tissue mobilization, facilitation of muscle activity/movement, positioning, and education for patient/carer.17 The CPT treatment schedule emphasizes interventions provided by a therapist facilitating and guiding movement (therapist hands-on) to provide sensory input to optimize joint alignment in preparation for voluntary movement. Key differences between CPT and FST are outlined in the Appendix.

TREATMENT GROUP 1. All subjects received CPT delivered by the clinical physiotherapists (see control condition below). All extra physical therapy, both CPT and FST, was delivered by the research physiotherapist (see experimental conditions below). To minimize the potential confounder of unintentional therapist bias all extra therapy was administered using standardized treatment schedules and the research physiotherapist was supervised closely throughout the course of the trial. To avoid potential bias of the clinical therapists the research physiotherapist provided extra intervention independently to the clinical team by not telling clinical therapists to which group subjects had been allocated and ensured that all extra treatment was delivered in an area where the clinical team were unable to observe which type of treatment was being provided. The control condition was CPT given by the physiotherapists in each clinical center using a standardized treatment schedule15 (treatment recording form and descriptive booklet) generated using established methods.16,17 The format of the CPT treatment schedule was similar to that produced for the lower limb16 and the content included soft tissue mobilization, facilitation of muscle activity/movement, positioning, and education for patient/carer.17 The CPT treatment schedule emphasizes interventions provided by a therapist facilitating and guiding movement (therapist hands-on) to provide sensory input to optimize joint alignment in preparation for voluntary movement. Key differences between CPT and FST are outlined in the Appendix. Experimental condition 1 was CPT plus extra CPT given by the research physiotherapist (CPT + CPT). The additional CPT was recorded using the treatment schedule.15

TREATMENT GROUP 2. All subjects received CPT delivered by the clinical physiotherapists (see control condition below). All extra physical therapy, both CPT and FST, was delivered by the research physiotherapist (see experimental conditions below). To minimize the potential confounder of unintentional therapist bias all extra therapy was administered using standardized treatment schedules and the research physiotherapist was supervised closely throughout the course of the trial. To avoid potential bias of the clinical therapists the research physiotherapist provided extra intervention independently to the clinical team by not telling clinical therapists to which group subjects had been allocated and ensured that all extra treatment was delivered in an area where the clinical team were unable to observe which type of treatment was being provided. Experimental condition 2 was CPT plus FST given by the research physiotherapist (CPT + FST). Delivery of FST gave prominence to: directing the subject’s attention to the exercise/ activity being performed,18 appropriate verbal feedback on performance, 18 repetition, and goal-directed functional activity (therapist hands-off). FST was based on the key elements of normal upper limb function, that is, on positioning the hand and then using it to manipulate objects. The focus was on improving the power of shoulder/elbow muscles to enable appropriate placing of the hand; improving the production of appropriate force in different muscles to achieve the specific task; and on specific interventions for the wrist and finger muscles to maximize ability to manipulate objects. The initial level of resistance was the maximum load that still permitted 5 repetitions of movement/action through the available range of muscle length. Treatment was progressed using repetition, altering the size and weight of items, and using heavier weights. The content of FST was divided into muscle group–specific movements, for example, elbow flexion/extension; upper limb gross movement patterns underlying functional activity (eg, shoulder flexion/abduction/external rotation + elbow flexion); hand reaching/retrieval activity (eg, reaching to a shelf while seated); hand grip activities; hand manipulation involving entire everyday activities and using objects such as screw top canisters, pegs, food items (eg, bag of dried pasta, tin of baked beans), shoe laces, mugs, and pens. Activities included using the paretic upper limb to place different food items into a shopping bag and then lift the bag onto a shelf; tighten/loosen nuts/bolts; and taking a pen cap on and off.

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## Dromerick et al. Does the Application of Constraint-Induced Movement Therapy During Acute Rehabilitation Reduce Arm Impairment After Ischemic Stroke? STROKE. 2000.

CONTROL GROUP 1. Treatment regimens were designed to ensure that patients in both groups received equivalent time and intensity of treatment directly supervised by the occupational therapist. All subjects received routine interdisciplinary stroke rehabilitation, except for the study treatment that occurred during the regularly scheduled occupational therapy sessions. Individualized and circuit-training techniques were used in control and experimental groups. All subjects received study treatment for 2 hours per day, 5 days per week, for 2 consecutive weeks. Control (Traditional) Occupational Therapy Treatment The control group received standard occupational therapy treatment

that included compensatory techniques for ADL, UE strength and range of motion, and traditional positioning. Subjects also participated in a circuit-training program allowing patients to perform bilateral self-range of motion and functional activities in a supervised setting.

TREATMENT GROUP 1. Treatment regimens were designed to ensure that patients in both groups received equivalent time and intensity of treatment directly supervised by the occupational therapist. All subjects received routine interdisciplinary stroke rehabilitation, except for the study treatment that occurred during the regularly scheduled occupational therapy sessions. Individualized and circuit-training techniques were used in control and experimental groups. All subjects received study treatment for 2 hours per day, 5 days per week, for 2 consecutive weeks.Experimental (CIM) Therapy Treatment Subjects in the experimental group received a CIM intervention that directed subject attention and effort toward the hemiparetic UE and minimized the use of the uninvolved UE during functional activities. To discourage the use of the unaffected hand outside of therapy sessions, subjects wore a padded mitten for at least 6 hours per day during the 14-day treatment period. This method allowed subjects to use the unaffected arm to prevent a fall. Occupational therapy treatment focused on ADLs, UE training which used the affected UE as much as possible. The CIM circuit training encouraged the use of the hemiplegic arm with a variety of UE and functional tasks.

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## Dromerick et al. Very Early Constraint-Induced Movement during Stroke Rehabilitation (VECTORS) A single-center RCT. NEUROLOGY. 2009.

CONTROL GROUP 1. Study treatments preempted occupational therapy and occurred 5 days per week for 2 consecutive weeks. Prespecified treatment protocols were developed based on our prior study and incorporated features of the EXCITE trial5 manual. Subjects otherwise received routine inpatient interdisciplinary stroke rehabilitation. Research clinicians trained in study procedures provided all study-related treatments; all were licensed occupational therapists or supervised assistants. The study clinical team met weekly to assure adherence to protocols. Individual sessions and circuit-training techniques were used in all three study groups. The same group of therapists delivered both the experimental and control treatments. Prespecified protocols, developed for both the control and CIMT treatments, were focused primarily on basic activities of daily living (ADL) tasks required for discharge to the community.The control treatment mimicked traditional occupational therapy, involving compensatory techniques for ADL, range of motion, and strengthening. This treatment consists of 1 hour of ADL retraining and 1 hour of UE bilateral training activities.

Adaptive equipment and positioning devices were used; a prespecified cueing strategy neither encouraged nor discouraged the use of the hemiparetic UE. Massed practice, shaping, and constraint were prohibited.

TREATMENT GROUP 1. Study treatments preempted occupational therapy and occurred 5 days per week for 2 consecutive weeks. Prespecified treatment protocols were developed based on our prior study and incorporated features of the EXCITE trial5 manual. Subjects otherwise received routine inpatient interdisciplinary stroke rehabilitation. Research clinicians trained in study procedures provided all study-related treatments; all were licensed occupational therapists or supervised assistants. The study clinical team met weekly to assure adherence to protocols. Individual sessions and circuit-training techniques were used in all three study groups. The same group of therapists delivered both the experimental and control treatments. Prespecified protocols, developed for both the control and CIMT treatments, were focused primarily on basic activities of daily living (ADL) tasks required for discharge to the community.The standard CIMT group received 2 hours of shaping therapy per day and wore a padded constraint mitten for 6 hours per day.This therapy consisted of performance of basic ADL together with supervised massed practice of skilled functional activities. These activities were graded per the study protocol by the treating occupational therapist to match the subject’s motor performance. Increasing levels of demand were based on increases in strength and coordination of the involved joints. As participants achieved successful completion of self-care activities and 80% of the trials for each specific motor activity, the complexity or difficulty of these activities were increased to the next level. Subjects received extensive verbal and written feedback about their performance, including a review of the prior day’s achievements, the day’s proposed goals, and reinforcement of new gains and maintenance of prior gains in graphic and verbal form appropriate to the activities selected for the treatment session.

TREATMENT GROUP 2. Study treatments preempted occupational therapy and occurred 5 days per week for 2 consecutive weeks. Prespecified treatment protocols were developed based on our prior study and incorporated features of the EXCITE trial5 manual. Subjects otherwise received routine inpatient interdisciplinary stroke rehabilitation. Research clinicians trained in study procedures provided all study-related treatments; all were licensed occupational therapists or supervised assistants. The study clinical team met weekly to assure adherence to protocols. Individual sessions and circuit-training techniques were used in all three study groups. The same group of therapists delivered both the experimental and control treatments. Prespecified protocols, developed for both the control and CIMT treatments, were focused primarily on basic activities of daily living (ADL) tasks required for discharge to the community.The high-intensity CIMT group underwent 3 hours per day of shaping and wore the mitten for 90% of waking hours. This therapy consisted of performance of basic ADL together with supervised massed practice of skilled functional activities. These

activities were graded per the study protocol by the treating occupational therapist to match the subject’s motor performance. Increasing levels of demand were based on increases in strength and coordination of the involved joints. As participants achieved successful completion of self-care activities and 80% of the trials for each specific motor activity, the complexity or difficulty of these activities were increased to the next level. Subjects received extensive verbal and written feedback about their performance, including a review of the prior day’s achievements, the day’s proposed goals, and reinforcement of new gains and maintenance of prior gains in graphic and verbal form appropriate to the activities selected for the treatment session.

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## Duncan et al. A randomized, controlled pilot study of a home-based exercise program for individuals with mild and moderate stroke. 1998.

TREATMENT GROUP 1. The exercise program was designed to improve strength, balance, and endurance and to encourage more use of the affected extremity. The experimental group did not receive any physical or occupational therapy other than that provided by the study. If an experimental group subject required speech therapy, the subject was treated by usual care providers. The experimental exercise intervention was initiated within 5 days of baseline testing. It was a home-based exercise program provided by a physical therapist. The study principal investigator (a physical therapist) and coinvestigator (an occupational therapist) observed at least 1 therapy session for each subject to ensure standard application of interventions. The program included 3 visits a week for 8 weeks, and the patients were instructed to continue the exercise program on their own for 4 additional weeks. Each exercise session lasted '1.5 hours. Exercise sessions were divided into 4 blocks preceded by a 10-minute warm-up session of stretching and flexibility exercise. The first block included assistive

and resistive exercises using Proprioceptive Neuromuscular Facilitation Patterns (PNF)29 or Theraband exercise (see below) to the major muscle groups of the upper and lower extremities. PNF exercises include upper and lower extremity patterns. The movement patterns included (1) flexion, abduction, and external rotation of shoulder with the elbow extended and with wrist and finger extension; (2) extension, adduction, and internal rotation of shoulder with elbow extended and with finger and wrist flexion; (3) flexion, adduction, external rotation of hips with knee flexion, and ankle dorsiflexion; and (4) extension, abduction, internal rotation of hips with knee extension, and ankle plantar flexion. Therabands are elastic bands of varying elasticity used as a means to provide resistance. Functional exercises in which body weight was used for resistance were also included. Assistive-resistive exercises that included PNF patterns were used only if the patient was too weak to use the elastic bands. Resistance progression was based on a protocol in which when subjects could complete 2 sets of 10 repetitions through the available range of motion, resistance was increased by progression of Theraband elasticity (levels of resistance) or by increased manual resistance in PNF exercises. The

second block included 15 minutes of balance exercises, which were progressively ordered by difficulty. In the third block, participants were encouraged to use the affected upper extremity in functional

activities. The final session included a progressive walking program or progressive exercise on a bicycle ergometer. The detailed protocol of the intervention used is available from the authors.

Exercise stress testing was not included in baseline assessment; therefore, progression of the aerobic component of the program was conservative. Individuals were instructed to walk at their usual pace

or bicycle at low revolutions per minute. The patients were then encouraged to increase their exercise time until they could exercise continuously for 20 minutes. Heart rate and blood pressure were monitored during the exercise sessions.

CONTROL GROUP 1. Subjects in the control group received usual care as prescribed by their physicians. Participants in this group were visited by a research assistant every 2 weeks to assess the patients’ exercise and activity level. The clinicians providing therapeutic interventions to the usual care group were asked to complete an intervention log to capture type of exercises and frequency and duration of therapy visits during treatment or in a home exercise program. The study coordinator met

with the treating therapists at least twice to discuss the therapy logs and intervention programs.

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## Duncan et al. Randomized clinical trial of therapeutic exercise in subacute stroke. 2003.

TREATMENT GROUP 1. The exercise program was designed to improve strength, balance, and endurance and to encourage more use of the affected extremity (Table 1). It was supervised by a physical or occupational therapist at home and included 36 sessions of 90-minute duration over 12 to 14 weeks. The intervention group did not receive therapy other than that provided by the study unless they required speech therapy, which was provided outside the study by usual care providers. There were structured protocols for the exercise tasks, criteria for progression, and guidelines for reintroducing therapy after intercurrent illness. The exercises completed during each session were recorded in a treatment log.

TABLE 1. Components of the Intervention Program Range of Motion and Flexibility Range of motion and stretching to the shoulder, elbow, wrist, fingers, hip, ankle, and trunk Strengthening Active motion in PNF unilateral patterns with manual resistance progressing to Theraband repetitions (2 sets of 10) in

anatomical planes. Targeted movements for Theraband exercises were shoulder flexion/external rotation, elbow flexion/extension, wrist extension, hip abduction, knee flexion/extension, and ankle dorsiflexion. Once exercise was completed with little difficulty, the resistance of the band used was increased. Balance Step-ups: repeated stepping anteriorly and laterally onto a step: up with affected LE and down with unaffected LE, progressing to higher step and decreasing upper extremity support.

Chair rises: repeated rising from a seated position, progressing from using arms to not using arms and from high surface to lower. Wall exercise: repetitions of standing from a wall and falling backwards with the trunk straight to contact the wall with the upper back and bouncing upright again, progressing to greater distances from the wall. Marching: repeated marching in place, progressing from UE support to no support. Toe rises: repeated rising up on toes, progressing from UE support to no support and from bilateral rises to unilateral rises on affected LE only. Other: kicking a ball with either foot, simulated batting/golfing, abrupt stops and turns while walking. UE Functional Use Practicing the use of the UE in real-life tasks with an emphasis on increasing coordination requirements, eg, washing countertops, opening drawers, putting away dishes, folding towels, closing blinds, counting change, writing. Endurance Riding a stationary bike, progressing in time up to 30 min with increasing speed and resistance. Exercise duration was initially increased in 2- to 5-min-increments until 20 to 30 min of continuous cycling at 40 rpm was achieved. Interval training was then instituted and used periods of increased speed to achieve a higher heart rate. Intervals were completed in blocks of 5 minutes (ie, 1-min interval at 50 rpm and 4-min interval at 40 rpm; 1 1/2 min at 50 rpm and 3 1/2 min at 40 rpm; 2 min at 50 rpm and 3 min at 40 rpm). Resistance was increased once the subject could complete 4 2-min intervals. Next phase of endurance training began with continuous cycling at 40 rpm for 25 to 30 min at next level of resistance. Progression continued with interval training as previously described. PNF indicates proprioceptive neuromuscular facilitation; LE, lower extremity; and UE, upper extremity.

CONTROL GROUP 1. Subjects in the usual care group had services as prescribed by their physicians. Treating therapists for usual care subjects completed a treatment log. Usual care subjects received home visits by research staff every 2 weeks for health education, vital signs, and a test of oxygen saturation.

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## Duncan et al. Body-weight-supported treadmill rehabilitation after stroke. 2011.

TREATMENT GROUP 1. Physical therapists at each site were trained according to a standardized protocol for the locomotor-training and home-exercise interventions.8 The programs were controlled for exercise frequency (90-minute sessions, three times per week) and duration (12 to 16 weeks); participants had to complete between 30 and 36 exercise sessions within this period. Participants also received usual care during the study period. Locomotor training included stepping on a treadmill with partial body-weight support and manual assistance as needed for 20 to 30 minutes at 3.2 km per hour (0.89 m per second [2.0 mi per hour]), followed by a progressive program of walking over ground for 15 minutes. The bodyweight support system (manufactured by Robomedica) provided dynamic, pneumatic control of the patient’s weight throughout the gait cycle and provided ergonomic seating for trainers assisting with patients’ leg movements. The treadmill (Biodex Medical Systems) speeds ranged from 0 to 1.6 km per hour (0 to 10 mi per hour), increasing by increments of 0.16 km per hour (0.1 mi per hour). The harness (Robertson Harness) could be adjusted for trunk and pelvic support.

TREATMENT GROUP 2. Physical therapists at each site were trained according to a standardized protocol for the locomotor-training and home-exercise interventions.8 The programs were controlled for exercise frequency (90-minute sessions, three times per week) and duration (12 to 16 weeks); participants had to complete between 30 and 36 exercise sessions within this period. Participants also received usual care during the study period. Locomotor training included stepping on a treadmill with partial body-weight support and manual assistance as needed for 20 to 30 minutes at 3.2 km per hour (0.89 m per second [2.0 mi per hour]), followed by a progressive program of walking over ground for 15 minutes. The bodyweight support system (manufactured by Robomedica) provided dynamic, pneumatic control of the patient’s weight throughout the gait cycle and provided ergonomic seating for trainers assisting with patients’ leg movements. The treadmill (Biodex Medical Systems) speeds ranged from 0 to 1.6 km per hour (0 to 10 mi per hour), increasing by increments of 0.16 km per hour (0.1 mi per hour). The harness (Robertson Harness) could be adjusted for trunk and pelvic support.

CONTROL GROUP 1. Physical therapists at each site were trained according to a standardized protocol for the locomotor-training and home-exercise interventions.8 The home-exercise program was designed as an active control, not as a high-intensity, taskspecific walking program. Progression through the program was managed by a physical therapist in the home, with the goals of enhancing flexibility, range of motion in joints, strength of arms and legs, coordination, and static and dynamic balance. Participants in this program were encouraged to walk daily.

# E Authors

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## Eich et al. Aerobic treadmill plus Bobath walking training improves walking in subacute stroke: a randomized controlled trial. CLIN REHABIL. 2004.

TREATMENT GROUP 1. GROUP A. All patients received 60 min of individual therapy time on each of 30 consecutive working days. Patients of group A received treadmill training for 30 min and other individual physiotherapy for 30 min. Patients of group B received 60 min of individual physiotherapy. During treadmill training, patients wore a modified parachute harness to prevent falls. The body weight (BW) was either not supported or supported to a maximum of 15% of BW according to individual needs. If necessary, one or two therapists provided help with setting the paretic limb or assisting weight-sifting and hip extension. During treadmill training, patients wore a modified parachute harness to prevent falls. The body weight (BW) was either not supported or supported to a maximum of 15% of BW according to individual needs. If necessary, one or two therapists provided help with setting the paretic limb or assisting weight-sifting and hip extension. The aerobic treadmill training programme consisted of 30 sessions of 30 min of graded treadmill walking (see above) at a defined training heart rate (THR). THR was determined according to the following formula: THR = (HRmax - HRrest)\*0.6 +HRrest, and controlled during the treatment with the help of a chest belt electrocardiography and a display mounted on the treadmill. Maximal heart rate was defined as the highest observed during a preceding bicycle ergometry (see inclusion criteria). Short treadmill warm-up and cool-down periods of 1-2 min duration accompanied each training session, two short pauses were optional. Further, blood lactate levels, taken immediately from the hyperaemized ear lobe after the 5th, 10th, 15th, 20th and 25th session, were analysed by photometer to ensure aerobic training conditions. The individual physiotherapy in both groups was Bobath oriented; it exclusively concentrated on walking rehabilitation. It included tone-inhibiting and gait preparatory manoeuvres (comprising approximately 20-30% of each session) and walking practice on the floor and on the stairs. Necessary orthoses and walking aids were provided at the beginning of the study. Occupational therapy, speech therapy and neuropsychology were administered according to individual needs.

CONTROL GROUP 1. GROUP B. All patients received 60 min of individual therapy time on each of 30 consecutive working days. Patients of group A received treadmill training for 30 min and other individual physiotherapy for 30 min. Patients of group B received 60 min of individual physiotherapy. During treadmill training, patients wore a modified parachute harness to prevent falls. The body weight (BW) was either not supported or supported to a maximum of 15% of BW according to individual needs. If necessary, one or two therapists provided help with setting the paretic limb or assisting weight-sifting and hip extension. The individual physiotherapy in both groups was Bobath oriented; it exclusively concentrated on walking rehabilitation. It included tone-inhibiting and gait preparatory manoeuvres (comprising approximately 20-30% of each session) and walking practice on the floor and on the stairs. Necessary orthoses and walking aids were provided at the beginning of the study. Occupational therapy, speech therapy and neuropsychology were administered according to individual needs.

# F Authors

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## Fang et al. A study on additional early phyiotherapy after stroke and factors affecting functional recovery. 2003.

TREATMENT GROUP 1. Early physiotherapy intervention procedures. Additional early physiotherapy was provided to subjects in the treatment group by two experienced rehabilitation therapists from the department of rehabilitation in the hospital. Therapists were blinded to patients’ groupings. The early therapy included Bobath techniques and passive movements training of the affected limb, and was initiated within the ?rst week after stroke onset. Passive movement training included a series movements of the joints of completely paralytic limbs to prevent contracture and malformation. Each subject received the therapy for 45 minutes a day, ?ve days a week for four weeks. Subjects from the routine therapy group received no professional or regular physiotherapy during the whole hospitalization period. Stroke related symptoms and complications in each group were treated with multidisciplinary approaches in the stroke centre by a special team. No speci?c cognitive or acupuncture therapy was administered.

CONTROL GROUP 1. Each subject received the therapy for 45 minutes a day, ?ve days a week for four weeks. Subjects from the routine therapy group received no professional or regular physiotherapy during the whole hospitalization period. Stroke related symptoms and complications in each group were treated with multidisciplinary approaches in the stroke centre by a special team. No speci?c cognitive or acupuncture therapy was administered.

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## Feys et al. Effect of a therapeutic intervention for the hemiplegic upper limb in the acute phase after stroke: A single blind, randomized, controlled, multicenter trial. 1998.

TREATMENT GROUP 1. The therapeutic intervention was carried out on a daily basis (5 days/week) during a period of 6 weeks. Each treatment session lasted 30 minutes. The intervention was in addition to the usual rehabilitation procedures.

The experimental treatment was applied with the patient positioned in a rocking chair. An inflatable splint was used to support the affected arm. The shoulder was positioned in 80° flexion and slight abduction. The elbow was in extension and the wrist in dorsiflexion. The distal part of the splint was fixed with two straps in a gutter. The patients were asked to perform rocking movements for 30 minutes, pushing with the heels and/or the hemiplegic arm. The chair was balanced in such a way that during the rocking movements patients fell slightly forward and had to actively push backward. Patients were encouraged to do this with their hemiplegic arm. Initially, the therapist guided the movements of the rocking chair. Once the patient could control the movements, he/she performed them independently. The experimental intervention was hypothesized to contain three major elements. Motor stimulation through the repeated movements would facilitate muscle activity. Sensory stimulation was applied through approximation of different joints (proprioceptive) and through the varying pressures exerted on the arm through the splint during repeated movements (exteroceptive). The placement of the arm in a position contrary to the typical pattern of spasticity was thought to contribute to a reduction of muscle tone. The additional therapeutic intervention was performed by the same therapists for patients in the control and experimental groups to prevent bias that could be introduced by personality of therapists. All patients of both groups received the full 30 sessions of treatment.

CONTROL GROUP 1. The patients in the control group were also positioned in a rocking chair and rocked for the same period of time. The arm was rested on a cushion on the patient’s lap, and no additional stimulation was given. To allow for attention, motivation, and expectations regarding the placebo treatment, patients in the control group received fake short wave therapy on the shoulder during the 30 minutes of rocking. The additional therapeutic intervention was performed by the same therapists for patients in the control and experimental groups to prevent bias that could be introduced by personality of therapists. All patients of both groups received the full 30 sessions of treatment.

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## Fisher et al. Robot-assisted gait training for patients with hemiparesis due to stroke. 2011.

CONTROL GROUP 1. After consenting to enter the study, each participant underwent a walking assessment consisting of 3 components. First, participants performed an 8-m walk test by walking for a distance of 8 m in a wide, empty hallway. Participants were allowed to use canes or walkers as necessary. The time to complete this task was recorded. If a participant could not complete the task in 4 minutes, the test was terminated and a score of 240 seconds was recorded. Next, in a 3-minute walk test, participants were instructed to walk as far as they could for 3 minutes, and the distance traveled was recorded. Later in the day, participants completed the Tinetti balance assessment20; their total score (out of 28) was recorded. After the baseline walking assessment, each participant was randomly assigned to 1 of 2 groups. A sequence of 20 one-digit numbers was selected from a random number table by the research coordinator, and participants were assigned in the order of their enrollment. If the digit corresponding to their enrollment was between 0 and 4, they were assigned to the fi rst group, referred to as the control group, and received 24 one-hour sessions of goal-oriented physical therapy administered by a highly trained neurorehabilitation team consisting of a physical therapist and 2 physical therapy assistants. These sessions consisted of stretching and strengthening exercises of the affected lower extremity, as well as overground walking exercises using durable medical equipment such as canes and walkers. During these exercises, therapists used neurofacilitation techniques by applying appropriate manual assistance when needed.

TREATMENT GROUP 1. After consenting to enter the study, each participant underwent a walking assessment consisting of 3 components. First, participants performed an 8-m walk test by walking for a distance of 8 m in a wide, empty hallway. Participants were allowed to use canes or walkers as necessary. The time to complete this task was recorded. If a participant could not complete the task in 4 minutes, the test was terminated and a score of 240 seconds was recorded. Next, in a 3-minute walk test, participants were instructed to walk as far as they could for 3 minutes, and the distance traveled was recorded. Later in the day, participants completed the Tinetti balance assessment20; their total score (out of 28) was recorded. After the baseline walking assessment, each participant was randomly assigned to 1 of 2 groups. A sequence of 20 one-digit numbers was selected from a random number table by the research coordinator, and participants were assigned in the order of their enrollment. The second group, referred to as the RAGT group, also received 24 one-hour sessions of therapy. These sessions consisted of 30 minutes of goal-oriented physical therapy (as per the control group) followed by 30 minutes of RAGT using the HealthSouth Autoambulator. Illustrated in Figure 1, the Autoambulator is a device consisting of a treadmill, an overhead lift, a pair of articulated arms, and 2 upright structures housing the computer controls and parts of the mechanism.14 Individuals, when placed in the machine and fi tted with a special harness, are attached to the overhead lift and raised to a standing position over the treadmill where weight-bearing can be assessed. The articulated robot arms mounted to the upright structures are hinged outward and are mechanically driven for vertical adjustment. The gait drive components are computer controlled through position, time, and distance to provide a smooth, accurate, and coordinated movement of the legs and treadmill through variable speeds. The control interface is through a touch screen computer display that can collect, process, display, and archive pertinent session data. The device is equipped with safety interlocks, redundant travel limits, variable torque limits, and other means to detect and clear inordinate safety situations. The robot arms move with 4 degrees of freedom corresponding to hip fl exion/extension and knee flexion/extension bilaterally. The robot arms provide assistance in the sagittal plane only. The patient is physically connected to the robot via a set of cuffs worn at the mid-thigh and calves. The device produces symmetrical reciprocal gait by providing forces throughout the entire gait cycle, including swing phase. A handlebar is fi xed to the chassis of the device in front of the patient, which he or she can hold onto as though pushing a cart. Treatment began immediately following group assignment. All participants started the study as inpatients and were scheduled for 5 therapy sessions per week with at least a 1-day interval between sessions. Most participants were discharged from inpatient care before completing all 24 sessions. At discharge, participants were moved to a residence outside of the hospital and transferred immediately to an outpatient schedule of 3 sessions per week. Participants completed the study in roughly 6 to 8 weeks, according to the duration of their inpatient stay, which depended on factors not controlled by this study. Following the completion of all treatment sessions, participants repeated the 8-m walk test, 3-minute walk test, and Tinetti balance assessment.

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## Franceschini et al. Walking after stroke: What does treadmill training with body weight support add to overground gait training in patients early after stroke?: A single-blind, randomized, controlled trial.

TREATMENT GROUP 1. Patients in the EG did 20 minutes of gait training on a treadmill (RHC500; AirMachine Com srl) with BWS (Unweighing System; Biodex Medical Systems, Shirley, NY) followed by 40 minutes of conventional training. Training was administered 5 times a week for an overall number of 20 sessions, which should have been completed within 5 weeks of inclusion in the study. We considered only the net training time on the treadmill, ie, the time actually spent walking and not the time required for getting the patient on and off. The quantity of BWS was tailored to the patient’s capability and was limited to 40% of body weight. BWS was applied by means of a climbing harness and was gradually reduced during the sessions depending on the patient’s compliance and progress. Gait training with BWS was performed with the help of 2 trained physical therapists for each patient to control the paretic lower extremity and pelvis. Treadmill velocity was adjusted to enable gait training at increasing speeds, starting from 0.1 m/s and aiming at 1.2 m/s according to the patient’s compliance and progress. When pelvic and paretic lower extremity control was considered adequate, gait training was administered by one physical therapist only. Conventional treatment was performed for 40 minutes, not immediately after treadmill training. No specific indications were given to the rehabilitation team, and the treatment was tailored to the patient’s needs and the rehabilitation team’s goals. Skilled therapists performed treatment according to the person’s needs.

CONTROL GROUP 1. Patients in the CG underwent 20 sessions of conventional treatment (consisting of overground gait training) of 60 minutes each. Treatment was administered 5 times per week for an overall number of 20 sessions, which should have been completed within 5 weeks of inclusion in the study. No specific indications were given to the rehabilitation team, and the treatment was tailored to the patient’s needs and the rehabilitation team’s goals. Skilled therapists performed treatment according to the person’s needs. Patients of both groups were allowed to receive additional neuropsychological and occupational therapy sessions if needed. No specific indications were given regarding pharmacological treatment in the study patients. The use of antispastic drugs and/or botulinum toxin was recorded but not considered as an independent variable. The therapists who treated EG patients were not the same as those who treated CG patients.

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## Fuzaro et al. Modified constraint-induced movement therapy and modified forced-use therapy for stroke patients are both effective to promote balance and gait improvements. 2011.

TREATMENT GROUP 1. During the study, subjects declared that they were not participating in any other rehabilitation protocol. Immobilization, mobilization, and stretching of the NPUL Immobilization was performed by means of a tubular mesh involving the NPUL in abduction, rotating the shoulder internally, allowing elbow flexion above 90o (Figure 2). This immobilization was maintained for 23 hours during five days a week over a period of four weeks. The tubular mesh was removed every day by the researchers for cleaning, mobilization, and stretching the UL. On Saturdays, the caregiver or family members were instructed to remove the tubular mesh of the participants, at the same hour the physical therapy sessions. Throughout the weekend, the patient was then free to move both UL normally. The NPUL mobilization was performed by using traction techniques and joint circular movements, with 30 repetitions for each joint. All muscle groups of the UL were stretched. A total of three repetition consisted of keeping the extension pressure for 45 seconds were performed. This procedure enabled the patient to have unrestricted movements for at least 60 minutes. Then, another immobilization was prepared using a new tubular mesh. Motor stimulation of PUL Subjects in the mCIMT attended an exercise-training program for 5 days a week. The program was applied only to the PUL. Each session lasted 50 minutes on average of and during this period the NPUL was maintained free next to the body. Bimanual activity was only permitted in special tasks, i.e. manipulation tasks with paper clip, but the PUL should be the main conductor of activity. Each session included a 5-10 minutes warm-up periods, scapula mobilization, flexion exercises that were combined with shoulder abduction, elbow extension and wrist extension flexion movements. In addition trunk extension and rotation

associated with UL movements, and functional activities such as unlocking a door, among other tasks were performed30-33. All exercises were performed using three series of 10 repetitions and the rest interval was determined for each subject in order to avoid fatigue and excessive tiredness. LL was not stimulated in both groups. Exercises were performed with subjects sitting on a chair with standard dimensions at a maximum range and with some resistance by the physical therapist, whenever possible. For the functional activities we used a support table.

TREATMENT GROUP 2. During the study, subjects declared that they were not participating in any other rehabilitation protocol. Immobilization, mobilization, and stretching of the NPUL Immobilization was performed by means of a tubular mesh involving the NPUL in abduction, rotating the shoulder internally, allowing elbow flexion above 90o (Figure 2). This immobilization was maintained for 23 hours during five days a week over a period of four weeks. The tubular mesh was removed every day by the researchers for cleaning, mobilization, and stretching the UL. On Saturdays, the caregiver or family members were instructed to remove the tubular mesh of the participants, at the same hour the physical therapy sessions. Throughout the weekend, the patient was then free to move both UL normally. The NPUL mobilization was performed by using traction techniques and joint circular movements, with 30 repetitions for each joint. All muscle groups of the UL were stretched. A total of three repetition consisted of keeping the extension pressure for 45 seconds were performed. This procedure enabled the patient to have unrestricted movements for at least 60 minutes. Then, another immobilization was prepared using a new tubular mesh.

# G Authors

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## Galvin et al. Family-Mediated Exercise Intervention (FAME) Evaluation of a Novel Form of Exercise Delivery After Stroke. STROKE. 2011.

CONTROL GROUP 1: Both members of the control group and the experimental FAME group received “routine” physiotherapy for the duration of the 8-week trial. All “routine” therapy was delivered by physiotherapy staff who were not linked to the project. Participants attended “routine” therapy as inpatients in the acute hospital or inpatients in a rehabilitation unit. A “rehabilitation unit” is a unit where patients who are not longer in the acute phase of their admission are located and where the focus is on multidisciplinary rehabilitation. This may be a unit within an acute hospital or linked to the hospital but geographically elsewhere. Individuals who were discharged home from these units before the end of the trial received “routine” therapy as outpatients in that particular unit. The duration of “routine” therapy received by participants in each group was not recorded.

TREATMENT GROUP 1: Both members of the control group and the experimental FAME group received “routine” physiotherapy for the duration of the 8-week trial. All “routine” therapy was delivered by physiotherapy staff who were not linked to the project. Participants attended “routine” therapy as inpatients in the acute hospital or inpatients in a rehabilitation unit. A “rehabilitation unit” is a unit where patients who are not longer in the acute phase of their admission are located and where the focus is on multidisciplinary rehabilitation. This may be a unit within an acute hospital or linked to the hospital but geographically elsewhere. Individuals who were discharged home from these units before the end of the trial received “routine” therapy as outpatients in that particular unit. The duration of “routine” therapy received by participants in each group was not recorded. In addition, participants in the experimental group received individualized FAME programs that were conducted for 35 minutes

daily at the bedside with the assistance of their nominated family member. This may have been delivered in the hospital or the home setting, depending on the location of the individual. Each program comprised training the family member with the skills necessary to carry out the additional exercises. In instances in which the nominated family member was unable to complete the exercises, a second family member attended the FAME session that particular week. The treatment protocol for each patient was individual with the exception of the time component. Treatment goals were set weekly after feedback from the treating physiotherapist, the individual with stroke, and their family member. Exercises were designed according to the participants’ ability and were progressed accordingly. The emphasis of the program was on achieving stability and improving gait velocity and lower limb strength based on patterns derived from findings reported in a systematic review of 151 intervention studies on stroke rehabilitation.8 Compliance with therapy time was documented through the use of an exercise diary, in which the number of exercises completed and time taken to complete the exercises were recorded daily.

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## GAPS. Can augmented physiotherapy input enhance recovery of mobility after stroke? A randomized controlled trial. 2004.

TREATMENT GROUP 1. The three chosen centres were felt to be representative of physiotherapy approaches in normal UK practice.5 1 We considered it impossible to designate in advance a standard treatment for all patients but outline treatment schedules were discussed (based on Edwards et al. 18) by the trial management group to ensure consistency of treatment categories. A standard format for recording the type, amount and focus of treatment was developed and piloted. Treatment was broadly based on the 'Normal Movement' (Bobath) approach. Specific functional objectives included the establishment of independent dynamic sitting balance, standing balance, upper limb function and walking, and other functional mobility tasks. The additional therapy time was provided to the augmented group by the usual therapy staff. Two half-time study therapists were employed to provide 'back fill' time support for physiotherapists delivering the extra therapy while a third half-time therapist carried out blinded assessments of outcome. There was no difference in staff grade or type (skill mix) between the two groups. Patients in both groups had the normal access to all other interventions (e.g., nursing, occupational therapy) in hospital and after discharge in the community.

CONTROL GROUP 1. The three chosen centres were felt to be representative of physiotherapy approaches in normal UK practice.5 1 We considered it impossible to designate in advance a standard treatment for all patients but outline treatment schedules were discussed (based on Edwards et al. 18) by the trial management group to ensure consistency of treatment categories. A standard format for recording the type, amount and focus of treatment was developed and piloted. Treatment was broadly based on the 'Normal Movement' (Bobath) approach. Specific functional objectives included the establishment of independent dynamic sitting balance, standing balance, upper limb function and walking, and other functional mobility tasks. The additional therapy time was provided to the augmented group by the usual therapy staff. Two half-time study therapists were employed to provide 'back fill' time support for physiotherapists delivering the extra therapy while a third half-time therapist carried out blinded assessments of outcome. There was no difference in staff grade or type (skill mix) between the two groups. Patients in both groups had the normal access to all other interventions (e.g., nursing, occupational therapy) in hospital and after discharge in the community.

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## Gelber et al. Comparison of two therapy approaches in the rehabilitation of the pure motor hemiparetic stroke patient. 1995.

CONTROL GROUP 1. NDT Approach - this treatment philosophy stresses inhibition of abnormal muscle tone and initiation of normal (good quality) motor movements with progression through developmental sequences prior to advancing functional activities. Therapy techniques included tone inhibition and weight-bearing activities, and encouraged patients to use their affected side. Resistive exercises and use of abnormal reflexes and mass movements were avioded (3,16).functional activities.These therapy approaches were instituted by the physical and occupational therapists treating these patients and were continued for the duration of the inpatient and outpatient rehabilitation programs. Participating therapists were all trained in the therapy techniques being evaluated and were given strict guidelines for treatment. Specific NDT and TFR skills, such as transfer techniques, were practiced by patients outside of therapy sessions and were reinforced by nursing staff. Rehabilitation length of stay and total inpatient rehabilitation hospital costs were recorded for all patients. Functional status was assessed by the Functional Independence Measure (FIM) scale (1?). The FIM score is calculated based on the patient’s ability to perform eighteen different mobility skills, activities of daily living (ADL), and cognitive tasks, with a maximum score of 126. Time from stroke to the consistent achievement of various motor and ADL milestones was recorded by patients on calendars and reviewed during follow-up visits or by telephone interview. If patients were inaccurate in recording, the data was not included in formal analysis

TREATMENT GROUP 1. TFR approach-this treatment philosophy stresses practicing functional tasks as early as possible even in the presence of spasticity or abnormal postures. Therapy techniques included passive range of motion in anatomic planes, progressive resistive exercises, early use of assistive devices and bracing, and allowed patients to use their unaffected side to perform functional tasks (1,2,12). These therapy approaches were instituted by the physical and occupational therapists treating these patients and were continued for the duration of the inpatient and outpatient rehabilitation programs. Participating therapists were all trained in the therapy techniques being evaluated and were given strict guidelines for treatment. Specific NDT and TFR skills, such as transfer techniques, were practiced by patients outside of therapy sessions and were reinforced by nursing staff. Rehabilitation length of stay and total inpatient rehabilitation hospital costs were recorded for all patients. Functional status was assessed by the Functional Independence Measure (FIM) scale (1?). The FIM score is calculated based on the patient’s ability to perform eighteen different mobility skills, activities of daily living (ADL), and cognitive tasks, with a maximum score of 126. Time from stroke to the consistent achievement of various motor and ADL milestones was recorded by patients on calendars and reviewed during follow-up visits or by telephone interview. If patients were inaccurate in recording, the data was not included in formal analysis

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## Gilbertson et al. Domiciliary occupational therapy for patients with stroke discharged from hospital: Randomised controlled trial. 2000.

CONTROL GROUP 1. Routine services Routine services included inpatient multidisciplinary rehabilitation, a predischarge home visit for selected patients, the provision of support services and equipment, regular multidisciplinary review at a stroke clinic, and selected patients referred to a medical day hospital.

TREATMENT GROUP 1. Intervention service The intervention service was designed to be client centred and was developed through focus group sessions with patients, carers, and local occupational therapy staff.3 From these sessions a six week domiciliary programme was developed (comprising around 10 visits lasting 30­45 minutes) tailored to recovery goals identified by the patient such as regaining self care or domestic or leisure activities. The therapist workedwith the patient to achieve these goals and also liaised with other agencies for advice, services, and equipment.

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## Gladman et al. A randomised controlled trial of domiciliary and hospital-based rehabilitation for stroke patients after discharge from hospital. 1993.

TREATMENT GROUP 1. The domiciliary service was provided by 2 half time physiotherapists and 1 occupational therapist who assessed all patients referred to it at home then organised or provided appropriate therapy and arranged other relevant help. Patients were treated by the domiciliary team for up to six months, after which those requiring further rehabilitation were referred back to the routine services. Since the domiciliary service was new, a run-in period of

four months was allowed before the randomised trial began and the members of the domiciliary team visited domiciliary services in other areas. The aim was to operate a service along the usual lines of a NHS service.

CONTROL GROUP 1. Patients allocated to the hospital-based rehabilitation service were eligible for outpatient rehabilitation according to the usual practices in Nottingham, where there had hitherto been no domiciliary rehabilitation

service. For patients discharged from Health Care of the Elderly wards the main option was a day hospital while for patients on General Medical wards, outpatient physiotherapy or occupational therapy could be arranged. A few Health Care of the Elderly patients were referred to outpatient therapy departments and a minority of General Medical patients were referred to a geriatrician for day hospital follow up

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## Globas et al. Chronic stroke survivors benefit from high-intensity aerobic treadmill exercise: A randomized control trial. 2012.

TREATMENT GROUP 1. Treadmill Training Treadmill training (TAEX) consisted of 39 sessions (3×/ week; 3 months) supervised by a physician and/or physiotherapist in an outpatient rehabilitation center. The goal was to achieve 30 to 50 minutes of training (beginning with 10-20 minutes) at 60% to 80% of the maximum heart rate reserve (HRR) (starting with 40% to 50% HRR) determined according to the formula of Karvonen (Training HR = intensity factor (%) × [HRmax - HRrest] + HRrest). HRmax was defined as peak heart rate obtained from the maximum effort treadmill exercise test performed before training. These training intensities were chosen according to the recommendations of the AHA22 and on the experience of former trials.17 Nevertheless, with regard to several limitations on heart rate–based training (eg, beta-blocker medication, arrhythmia), intensity of training was additionally monitored by ratings of perceived exertion (Borg Scale37). Duration was increased as tolerated by 1 to 5 min/ wk, and treadmill speed was progressed by 0.1 to 0.3 km/h every 1 to 2 weeks. The progression of each protocol was determined by the trainer, adjusted for individual capability. Treadmill inclination remained at 0°. Subjects were allowed to use the handrail or forearm support while being encouraged to walk without support if possible. Hip protection devices were used in subjects with poor balance and osteoporosis. Participants with silent, reversible myocardial ischemia in peak exercise testing were enrolled if their primary physicians and cardiologist approved the intervention. These subjects were trained at intensities below their myocardial ischemia level similar to cardiac rehabilitation protocols.22 Training was carried out as a group intervention with subjects being trained on 3 treadmills in parallel. Interruption to a maximum of 3 consecutive training sessions was allowed. Missed sessions—the maximum was 6—were added at the end. Participants initially assigned to the control group crossed over to TAEX (TAEX-cross). They were trained using a slightly modified protocol. Because Werner et al20 proposed that walking on a treadmill at moderate inclination (2% to 8%) promotes gait symmetry in hemiparetic subjects, TAEXcross subjects were trained at an inclination of 2%. Target training duration and intensity were the same as for the TAEX group. Participants were allowed to obtain prescribed therapy sessions during the study, if therapy did not comprise training elements for the lower extremities or cardiorespiratory fitness (eg, isolated arm training or speech therapy).

CONTROL GROUP 1. Conventional Care Physiotherapy Conventional care physiotherapy included passive, muscle tone–regulating exercises for the upper and lower extremities with elements of balance training conducted on an outpatient basis in physiotherapy practices or rehabilitation centers. No aerobic fitness training was performed. Duration of therapy sessions was 1 hour for 1 to 3 times per week as prescribed by the primary physician or neurologist over 3 months (13 weeks). The exposure to training was less in controls than in TAEX patients; therefore, the control intervention cannot be considered as an attention control.

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## Green et al. Physiotherapy for patients with mobility problems more than 1 year after stroke: A randomised controlled trial. 2002.

TREATMENT GROUP 1. Patients were assigned either community physiotherapy treatment (treatment group) or no treatment (controls) by an assistant, who was otherwise unconnected with the study. There was no contact between physiotherapists who treated participants and the researcher who did assessments. Physiotherapy treatment was done by an established community physiotherapy service (13 staff) as part of their usual work. Initially, all patients were assessed by a

physiotherapist and then treated with a problem solving approach at home or in outpatient rehabilitation centres. A standard3,15 maximum contact period of 13 weeks with a minimum of three contacts per patient was agreed with the physiotherapists before the start of the trial. Usual handwritten records were kept by the physiotherapists and used to code patients’ problems and treatment.

CONTROL GROUP 1. No assigned treatment.

# H Authors

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## Han et al. Effects of intensity of arm training on hemiplegic upper extremity motor recovery in stroke patients: a randomized controlled trial. CLIN REHABIL. 2013.

CONTROL GROUP 1: All patients received regular rehabilitation therapy and medical treatment. The content of the arm treatment was determined by motor relearning programme. Depending on the patient’s impairments, arm training included correct positioning and caring of the arm; passive, assisted and active movements; strength training; practice of functional activities. Each group received arm treatment for 1 hour (group A), 2 hours (group B) and 3 hours (group C) a day respectively, 5 days per week, for a period of six weeks. If the patients felt tired or uncomfortable, the duration of the therapy could be distributed during the day.

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TREATMENT GROUP 2: All patients received regular rehabilitation therapy and medical treatment. The content of the arm treatment was determined by motor relearning programme. Depending on the patient’s impairments, arm training included correct positioning and caring of the arm; passive, assisted and active movements; strength training; practice of functional activities. Each group received arm treatment for 1 hour (group A), 2 hours (group B) and 3 hours (group C) a day respectively, 5 days per week, for a period of six weeks. If the patients felt tired or uncomfortable, the duration of the therapy could be distributed during the day.

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## Harris et al. A self-administered graded repetitive arm supplementary program (GRASP) improves arm function during inpatient stroke rehabilitation: A multi-site randomized controlled trial. STROKE. 2009.

TREATMENT GROUP 1: The experimental group received the GRASP protocol, which is a self-administered homework-based exercise program designed to improve paretic upper performance, and to encourage the use of the paretic upper limb in ADL. Three exercise protocols were developed

into exercise books and kits based on the Fugl-Meyer Motor Impairment Scale (mild, moderate, severe). Each exercise book contained written and pictorial instructions for each exercise, and the

kits contained inexpensive equipment (eg, ball, bean bag, towel, paper clips) to complete the exercises. Each exercise was graded by varying repetitions to meet each participant’s need. Exercises included

strengthening of the arm and hand (small wrist weight, putty, hand gripper), range of motion (stretching, active exercises), and gross and fine motor skills (eg, blocks, Lego, pegs). Repetitive goal

and task oriented activities were designed to simulate partial or whole skill sets required in ADL (eg, folding, buttoning, pouring, and lifting). The site coordinator taught and monitored (once per week) the GRASP protocol. Each participant was asked to complete the exercises 6 days per week for 60 minutes each day. A log sheet was included in each exercise book for participants to track the amount of time and number of days the protocol was completed, as well as any pain and fatigue experienced. At the end of the 4-week program (which coincided approximately with discharge from the rehabilitation unit), participants kept the exercise book and kit, and were asked to continue with the program at home until the next assessment session in three months time (retention). No monitoring or follow-up was provided during the 3-month community period. The participants were given log sheets to track their exercise routine at home. At the time of retention testing all participants were living at home.

CONTROL GROUP 1: The control group received an education book with 4 modules. The modules contained information on stroke recovery and general heath. At the end of each module was a homework assignment related to the topic. Control group participants met with the site coordinator once per week to review the information and the homework assignment. The control and experimental group received the same amount of time from the site coordinator over the 4-week intervention period (Table 3).

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## Hayner et al. Comparison of Constraint-Induced Movement Therapy and Bilateral Treatment of Equal Intensity in People With Chronic Upper-Extremity Dysfunction After Cerebrovascular Accident. AJOT.

TREATMENT GROUP 1: The CIMT and the bilateral group interventions differed in the following ways: The CIMT group participants wore a padded mitt ( J. T. Posey Co., Arcadia, CA; Model No. 2811) on the unaffected hand and practiced functional activities with only the affected UE. The CIMT group participants were prevented from using the unaffected UE for almost all activities, including stabilizing objects (the mitt was removed only for restroom use). The “bilateral” group participants were provided with repetitive and intrusive cuing to use both hands during all activities (even tasks normally performed unilaterally). Little attempt was made to facilitate “normal” movement in either group. Tasks were structured to be just within the participants’ ability to perform either individually or with others, or the participant was afforded just as much assistance as was necessary for task performance. Assistive devices were used when required by a participant in the CIMT group to accomplish a task with one hand (e.g., universal cuff for self-feeding; scrub brush with suction cups for hand washing). Many of the tasks involved repetition (e.g., chopping vegetables), and many occurred each day (e.g., hand washing, eating). Tasks requiring repetition, daily performance, or both are likely to improve motor control (Davis, 2006). Treatment activities were designed to promote function and active range of motion, were routine and purposeful (e.g., setting the table, washing hands, washing dishes), and were intended to be meaningful, but they were not client-selected occupations (i.e., client-preferred meaningful customary activities). Treatment began each day with a morning meeting and ended with an afternoon meeting. On the first day of treatment, the morning meeting was used for introductions and study orientation. On subsequent days, the morning meeting was used to elicit from participants the time that they had spent at home either performing activities with constraint or performing tasks bilaterally. Attempts were made to encourage home activities and to be as neutral as possible regarding reports of nonperformance. The morning continued with stretching and warm-up activities (e.g., balloon volleyball). A major focus for the day’s routine was lunch. Participants were divided into teams to retrieve equipment and ingredients and worked together on meal subcomponents, cooking, table setting, and serving. After lunch, the afternoon was devoted to clean up, a craft activity, or table games. The daily afternoon meeting was used as a wrap up. The participants were encouraged to devote as much time as possible to the home program and to report the time each day, but there was no minimum requirement for home compliance.

CONTROL GROUP 1: The “bilateral” group participants were provided with repetitive and intrusive cuing to use both hands during all activities (even tasks normally performed unilaterally). Little attempt was made to facilitate “normal” movement in either group. Tasks were structured to be just within the participants’ ability to perform either individually or with others, or the participant was afforded just as much assistance as was necessary for task performance. Assistive devices were used when required by a participant in the CIMT group to accomplish a task with one hand (e.g., universal cuff for self-feeding; scrub brush with suction cups for hand washing). Many of the tasks involved repetition (e.g., chopping vegetables), and many occurred each day (e.g., hand washing, eating). Tasks requiring repetition, daily performance, or both are likely to improve motor control (Davis, 2006). Treatment activities were designed to promote function and active range of motion, were routine and purposeful (e.g., setting the table, washing hands, washing dishes), and were intended to be meaningful, but they were not client-selected occupations (i.e., client-preferred meaningful customary activities). Treatment began each day with a morning meeting and ended with an afternoon meeting. On the first day of treatment, the morning meeting was used for introductions and study orientation. On subsequent days, the morning meeting was used to elicit from participants the time that they had spent at home either performing activities with constraint or performing tasks bilaterally. Attempts were made to encourage home activities and to be as neutral as possible regarding reports of nonperformance. The morning continued with stretching and warm-up activities (e.g., balloon volleyball). A major focus for the day’s routine was lunch. Participants were divided into teams to retrieve equipment and ingredients and worked together on meal subcomponents, cooking, table setting, and serving. After lunch, the afternoon was devoted to clean up, a craft activity, or table games. The daily afternoon meeting was used as a wrap up. The participants were encouraged to devote as much time as possible to the home program and to report the time each day, but there was no minimum requirement for home compliance.

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## Hesse et al. Computerized Arm Training Improves the Motor Control of the Severely Affected Arm after stroke: A single-blinded randomized controlled trial in two centers. STROKE. 2005.

TREATMENT GROUP 1: In addition to their standard inpatient rehabilitation program, the patients practiced with an AT (AT group; Bi-Manu-Track) or ES of their paretic wrist extensors (ES group; Bentrofit M13 and F12) for 20 minutes every workday for 6 weeks (30 sessions). The AT11 enabled the mirror-like practice of 2 movement cycles: forearm pro-supination and wrist flexion extension. The patients sat at a height-adjustable table with their elbows bent at 90° and put their forearms in the mid-position into an arm trough. Each hand grasped a handle; a strap led the paretic hand in place. To switch movement direction, the device was tilted 90° downward and the handles position changed. Three computer-controlled modes were offered: (1) passive–passive, with both arms being moved by the machine; (2) active–passive, with the nonaffected arm driving the affected side; and (3) active–active, with both arms actively moving against resistance. Within 1 session, each patient practiced 200 of the elbow and 200 of the wrist cycles, totaling 400 cycles, or 800 repetitions, half in mode 1 and half in mode 2. Additionally, the patients could practice 25 to 50 repetitions in mode 3. Both treatments (AT or ES) were performed by the same therapists and in the same room to limit external influences. After help with the set-up (2 to 3 minutes for AT and ES), the patients practiced themselves, and a therapist remained within shouting distance in case of problems. AT patients received additional help tilting the device and exchanging the handles, which took another 1 to 2 minutes. The ongoing standard rehabilitation program comprised 5 45- minute sessions of physiotherapy (PT) and 4 30-minute sessions of occupational therapy (OT) based on the neurodevelopmental technique concept every week. Restoration of stance and gait and activities of daily living competence were primary targets. Upper limb exercises took 20% of PT and OT, mostly devoted to tone-inhibiting maneuvers and improving proximal muscle control (eg, weight acceptance over the shoulder girdle).

TREATMENT GROUP 2: In addition to their standard inpatient rehabilitation program, the patients practiced with an AT (AT group; Bi-Manu-Track) or ES of their paretic wrist extensors (ES group; Bentrofit M13 and F12) for 20 minutes every workday for 6 weeks (30 sessions). In the ES group, the patients sat at a height-adjustable table with their elbows bent 90° and their forearms in pro-nation. Four- to 7-s trains of monophasic exponential pulses (75 Hz; 0.5 ms; 0 to 80 mA) were applied by 2 self-adhesive flexible electrodes (2.53 cm). The intensity was set to produce maximum wrist extension. Patients performed 60 to 80 wrist extensions per session, with an interstimulus interval between 8 and 15 s. If the patient could volitionally activate the wrist extensor muscle during the study, an EMG-initiated ES was applied. A third flexible self-adhesive electrode, placed between the 2 stimulation electrodes, recorded the volitional muscular activity. The EMG activity level required to trigger the ES was continuously adjusted near the patients’ highest level. Again, 60 to 80 wrist extensions were

practiced per session. Both treatments (AT or ES) were performed by the same therapists and in the same room to limit external influences. After help with the set-up (2 to 3 minutes for AT and ES), the patients practiced themselves, and a therapist remained within shouting distance in case of problems. AT patients received additional help tilting the device and exchanging the handles, which took another 1 to 2 minutes. The ongoing standard rehabilitation program comprised 5 45-minute sessions of physiotherapy (PT) and 4 30-minute sessions of occupational therapy (OT) based on the neurodevelopmental technique concept every week. Restoration of stance and gait and activities of daily living competence were primary targets. Upper limb exercises took 20% of PT and OT, mostly devoted to tone-inhibiting maneuvers and improving proximal muscle control (eg, weight acceptance over the shoulder girdle).

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## Hesse et al. Comparison of an intermittent high-intensity vs continuous low-intensity physiotherapy service over 12 months in community-dwelling people with stroke: A randomized trial. 2011.

TREATMENT GROUP 1. Group A received an intermittent high-intensity physiotherapy programme at home, i.e. during a period of 12 months the patients received three two-month blocks (months 1þ2, months 5þ6, months 9þ10), consisting of four therapy sessions every week, one session lasted 30 to 45 minutes net. The three two-month blocks totalled 96 30 to 45 minute sessions. Two physiotherapists were the care providers who treated all group A patients during the intervention

period. Both of them had a Bobath background and have been working in stroke rehabilitation for five and 13 years, respectively. One of them visited the patient at their home applying an eclectic treatment approach aimed at the improvement of motor functions relevant for the patients’ everyday life. This was based both on the Bobath approach, in order to lessen an elevated muscle tone, and on the principles of the motor relearning programme, to train specific

motor functions which the patient and caregiver had named as relevant for their daily life, e.g. climbing up- and downstairs, walking in- and outside the house, bath and toilet use, passing traffic lights, shopping etc. Between the treatment blocks (months 3þ4, months 7þ8, months 11þ12) the patients and their relatives were instructed in a self-therapy programme, individually set at the end of each of the three intervention blocks. The self-programme, consisting of various stretching, strengthening and motor tasks, had to be followed every workday for at least 30 minutes. The patients and their caregivers kept a diary, in addition the therapists phoned the patients every 14 days.

CONTROL GROUP 1. Group B patients received the regular physiotherapy programme for home-based chronic stroke patients according to the national guidelines. 7 It consisted of continuous provision of two weekly 30 to 45 minute physiotherapy sessions in the private unit of a physiotherapist, totalling 104 sessions per year. An eclectic approach, similar to the one of group A patients, was to be adopted. Care providers were experienced physiotherapists

working in five private physiotherapy cabinets.

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## Hilder et al. Multicenter Randomized Clinical Trial Evaluating the Effectiveness of the Lokomat in Subacute Stroke. NNR. 2009.

CONTROL GROUP 1: Conventional Gait Training. Conventional gait training was performed by skilled and experienced physical therapists. The goal of the intervention was to facilitate improvements in walking ability, characterized by improved walking speed, endurance, postural stability, and symmetry. The structure of the intervention was customized to each individual’s functional level. Early training sessions in very impaired individuals focused on static and dynamic postural tasks, trunk positioning,

improving lower and upper extremity range of motion, and overground walking. As participants progressed in these areas, or entered the study at a higher functioning level, higher-level balance and gait activities were performed. Such activities included walking speed tasks, symmetry of lower limb movements, stair climbing, and locomotor training on a treadmill. As treadmill training is now commonly used in many rehabilitation settings, the conventional gait training group was allowed up to 15 minutes per session as deemed appropriate.

TREATMENT GROUP 1: Lokomat Gait Training. For the Lokomat group, participants were fitted with a harness so that a portion of their body weight could be supported when walking in the device. The

first training session focused on patient setup and adjustments within the device, and allowed the participant to acclimate to robotic-assisted walking. To minimize the incidence of skin abrasions, soccer-style shin guards were placed on the participant’s shins prior to walking in the Lokomat. All participants in the Lokomat group were initially trained using a foot lifter on the forefoot of the affected leg to help provide toe clearance during swing. As ankle strength and control improved in

the participant, the tension was reduced in the straps. In some sessions the tension would begin at low levels, however, as the participant fatigued, the tension was increased. If the participant’s ankle function progressed to the point where he or she was able to demonstrate volitional dorsiflexion, we

would begin the training session with no strap but would often add the strap during the session (eg, as the participant fatigued). In some participants, function and endurance progressed to the point where we were able to keep the strap off for the entire session. With the device properly adjusted, the Lokomat initiated stepping patterns after which the participant was instructed to follow. Specifically, their goal was to move their legs like the device, trying to minimize the amount of assistance provided

by the Lokomat. For this first session, up to 40% body-weight support was provided to allow participants to focus on establishing the timing in their gait patterns under only moderate

intensity levels. Initial walking speeds were normally around 1.5 km/h (0.42 m/s). In subsequent sessions, training intensity was increased progressively by changing walking speed, level of body-weight support, and duration of continuous walking. The amount of body-weight support was fixed so that the participant could achieve adequate knee extension during stance and toe clearance

during swing at 1.5 km/h (0.42 m/s). When this level of weight support was found, the speed of the Lokomat was increased in increments of 0.2 km/h (0.06 m/s) per session up to 3.0 km/h (0.83 m/s) with fixed body-weight support. When the participant was able to ambulate at that level of bodyweight support at the highest speed, the level of weight support was reduced in increments of 5% to 10% per session and the speed reduced (if necessary). If a participant’s walking ability improved to the point that he or she could ambulate at the highest training speed under his or her full body weight, the guidance force was reduced in the Lokomat, which effectively decreases the amount of assistance

the device provides. At 100% guidance force, the device offers maximal assistance in achieving symmetrical, consistent gait patterns. At 0% guidance force, the device only compensates for the weight and inertia of the linkages, but will not move the limbs. The ultimate goal for each participant was to have him or her walk for a total of 45 minutes in the Lokomat under no body-weight support, at 3.0 km/h (0.83 m/s), and 0% guidance force. During Lokomat training, the participant was instructed to

try and match the movement of the Lokomat. A computer monitor located in front of the participants provided them with biofeedback of their performance at both the hip and knee joints. The biofeedback provided an estimate of participant performance during robotic-assisted stepping so that participants

could alter the timing and magnitude of their leg movements to reduce performance errors. Therapists also provided constant verbal encouragement and cueing during the training. It should be noted that at low levels of body-weight support, an error signal in the kinematic trajectory of the Lokomat would terminate walking when participants did not generate substantial volitional activity to continue stepping. This safety feature helped ensure that the participant was engaged and not completely

passive thereby letting the Lokomat do all the work.

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## Holmquist et al. A Randomized Controlled Trial of Rehabilitation at Home After Stroke in Southwest Stockholm. STROKE. 1998.

TREATMENT GROUP 1: Rehabilitation at Home

Two physical therapists, two occupational therapists, and one speech therapist associated with the stroke unit formed the team of the home rehabilitation outreach service. A social worker was attached to the team on a consulting basis. One of the therapists was assigned as a case manager for the patient, which implied that she coped with a wider domain of function than is currently in vogue and that she constituted the link between hospital and outpatient care. In each case, the case manager was responsible for coordination of the discharge procedure, most of the at-home therapy, coordination between therapists in the home rehabilitation team, and contact with the neurologist responsible. A program approximately 3 to 4 months in duration was tailored for each patient. The frequency of therapy contacts for the patients receiving rehabilitation at home was decided by the providing therapist in consultation with the patient and his or her family. The frequency of home visits was gradually reduced until the therapist discharged the patient. Two half-hour meetings per week were

scheduled for coordination purposes by the home rehabilitation team. If continued rehabilitation was required after such a period, the patient was referred to routine outpatient rehabilitation. The intervention strategy was based on prior experience.9 The home rehabilitation program emphasized a task- and context-oriented approach, which implies that the patient performs guided, supervised,

or self-directed activities in a functional and familiar context. The choice of activities was based on patients’ personal interests, and adherence to structured training between therapy sessions was promoted. The spouse, when available, was encouraged to be an active participant in the rehabilitation process. Individual counseling, which focused on education, applying information learned in practical

situations, and solving problems occurring in the home, was offered to the spouse if needed. The duration and type of therapy were recorded in a protocol by the therapists. Patients were asked to keep diaries between therapy sessions on time and type of training.

CONTROL GROUP 1: Routine Rehabilitation The control group consisted of the stroke patients who received routine rehabilitation service. All patients in this group were also admitted to the Department of Neurology. If required (and after evaluation by specialists from geriatric or rehabilitation clinics) the

patients were transferred for continued inpatient rehabilitation and/or day care. In this context, routine rehabilitation denotes a heterogeneous set of interventions ranging from the best established in the hospital, day care, and/or outpatient care, to others introduced during the study period, such as daily afferent sensory stimulation by low-frequency transcutaneous electrical nerve stimulation and homebased rehabilitation initiated by the Department of Geriatrics.

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## Hornby et al. Enhanced Gait-Related Improvements After Therapist- Versus Robotic-Assisted Locomotor Training in Subjects With Chronic Stroke: A Randomized Controlled Study. STROKE. 2008.

CONTROL GROUP 1: LT in both treatment groups consisted of 12 sessions (30 minutes/session) with therapist- or robotic-assistance. In both groups, subjects wore a harness attached to a counterweight system to provide body weight support. Approximately 30% to 40% of a subject’s body weight was supported during the first session, and decreased in approximately 10% increments per session as tolerated without substantial knee buckling or toe drag. LT started at 2.0 kmph during the initial session, was increased by 0.5 kmph every 10 minutes as tolerated to 3.0 kmph, and remained there for subsequent visits. Blood pressure and heart rate were assessed during LT and maintained below 220/110 mm Hg and 85% of age-predicted maximum heart rate. Rest breaks were provided as necessary, with LT performed within 1 hour. Subjects randomized to therapist-assisted LT were trained at similar weight support and speeds as the robotic-assisted group. In place of robotic assistance, a single therapist provided manual facilitation at the paretic limb to facilitate stepping. Assistance was

provided only as necessary to ensure continuous walking14 as opposed to approximating normal kinematics.3,9 Visual feedback from a mirror and verbal encouragement were also provided. Lower

extremity orthoses were removed if stepping could proceed with minimal risk of orthopedic injury.

TREATMENT GROUP 1: LT in both treatment groups consisted of 12 sessions (30 minutes/session) with therapist- or robotic-assistance. In both groups, subjects wore a harness attached to a counterweight system to provide body weight support. Approximately 30% to 40% of a subject’s body weight was supported during the first session, and decreased in approximately 10% increments per session as tolerated without substantial knee buckling or toe drag. LT started at 2.0 kmph during the initial session, was increased by 0.5 kmph every 10 minutes as tolerated to 3.0 kmph, and remained there for subsequent visits. Blood pressure and heart rate were assessed during LT and maintained below 220/110 mm Hg and 85% of age-predicted maximum heart rate. Rest breaks were provided as necessary, with LT performed within 1 hour. Subjects randomized to robotic-assisted LT were provided continuous symmetrical stepping assistance using the Lokomat. The design and control of this device have been described previously.21 With body weight support, subjects were attached to the device at the trunk, pelvis, and bilateral lower extremities with hip and knee joints aligned to computer-controlled actuators, and elastic straps were used to assist toe clearance. The robotic device provided continuous sagittal plane assistance of the hip and knee joints in trajectories approximating symmetrical reciprocal human gait. Assistance was provided during both stance and swing phases, and subjects were given continuous visual feedback of estimates of bilateral hip and knee torques during walking. Subjects were encouraged to generate maximal effort throughout training, particularly in the paretic limb. Visual feedback from a full-length mirror and verbal encouragement from therapists were also provided.

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## Housman et al. A Randomized Controlled Trial of Gravity-Supported, Computer-Enhanced Arm Exercise for Individuals with severe hemiparesis. NNR. 2009.

CONTROL GROUP 1: This study compared the arm movement of subjects who participated in T-WREX training with control subjects who exercised for the same duration without the device and received approximately the same amount of supervision from a therapist. All subjects participated in twenty-four 1-hour treatment sessions, approximately 3 times per week for 8 to 9 weeks. All treatment sessions were performed in a research laboratory at the RIC. All subjects received 60 minutes of

direct training with an occupational therapist, the first 3 sessions to ensure competence with T-WREX and control protocols. After the third treatment, subjects exercised with intermittent supervision from the therapist. The amount of direct therapist intervention or cueing was recorded via stopwatch, over and beyond the time spent performing passive ROM (5 minutes) and obtaining blood pressure and pain ratings (3 minutes) each session. Blood pressure and pain ratings were obtained on all subjects directly before and after treatment each session. Subjects were randomly assigned to T-WREX or control group by the supervising therapist. To achieve approximately equal numbers for each group, 4 subjects at a time were randomly assigned by lottery. The treating therapist and subjects were blinded to assignment until each subject was consented and enrolled in the project. In the initial stages of recruitment, only a “left-handed” version of T-WREX was available; therefore, only subjects with left hemiparesis were initially recruited. By midway through the study a “right-handed” version had been built, and individuals with right hemiparesis were included. Subjects assigned to the control group participated in conventional exercises, which are the standard of care for therapy groups and home exercise programs at the RIC for individuals with moderate to severe upper limb hemiparesis. Such exercises have been prescribed by therapists in the United States for years,34-38 and per the authors’ clinical experience, these exercises continue to be widely accepted and used. Control activities consisted of selfrange of motion (SROM) stretches and active range of motion (AROM) strengthening exercises throughout the hemiparetic upper extremity.35,36,38 During SROM stretches, participants

clasped the hands or arms together and used the strength of the less-affected arm to move the affected arm through the available ROM at each joint. During AROM exercises, the hemiparetic arm

was supported against gravity by a tabletop, and a towel was placed under the arm to decrease friction as subjects completed specified movements unilaterally. Additional activities consisted of using the affected arm as a functional assist during a prescribed list of activities of daily living (ADL) tasks (such as wiping a table or holding a container while the less-affected hand opened the lid) as well as hemiparetic upper extremity weight bearing on an open hand with the affected arm extended at the side of the body.34,35,37 After 3 sessions of direct training with a therapist, subjects completed

the control exercises semiautonomously (in the research clinic, with intermittent therapist supervision) by progressing through a handout containing written descriptions and photographs of each activity (Figure 1B). All subjects concluded treatment after 24 training sessions. A home exercise program was not provided to either group for continued training during the 6-month follow-up period.

TREATMENT GROUP 1: This study compared the arm movement of subjects who participated in T-WREX training with control subjects who exercised for the same duration without the device and received approximately the same amount of supervision from a therapist. All subjects participated in twenty-four 1-hour treatment sessions, approximately 3 times per week for 8 to 9 weeks. All treatment sessions were performed in a research laboratory at the RIC. All subjects received 60 minutes of

direct training with an occupational therapist, the first 3 sessions to ensure competence with T-WREX and control protocols. After the third treatment, subjects exercised with intermittent supervision from the therapist. The amount of direct therapist intervention or cueing was recorded via stopwatch, over and beyond the time spent performing passive ROM (5 minutes) and obtaining blood pressure and pain ratings (3 minutes) each session. Blood pressure and pain ratings were obtained on all subjects directly before and after treatment each session. Subjects were randomly assigned to T-WREX or control group by the supervising therapist. To achieve approximately equal numbers for each group, 4 subjects at a time were randomly assigned by lottery. The treating therapist and subjects were blinded to assignment until each subject was consented and enrolled in the project. In the initial stages of recruitment, only a “left-handed” version of T-WREX was available; therefore, only subjects with left hemiparesis were initially recruited. By midway through the study a “right-handed” version had been built, and individuals with right hemiparesis were included. Individuals in the experimental group participated in training with T-WREX as described above. After 3 sessions of direct training with a therapist, subjects completed approximately 3 repetitions of 10 therapy games semiautonomously

each session (in the research clinic, with intermittent therapist supervision). The initial amount of gravity support provided by T-WREX supported the subject’s arm in a neutral, “weightless” position of approximately 45° shoulder flexion and 80° of elbow flexion. After the first 3 days of training, gravity balance compensation was gradually decreased as deemed appropriate by the supervising therapist (ie, 1 rubber band was removed every third treatment session if the subject demonstrated the ability to complete the games successfully without increased compensatory movements). If compensatory movements were noted with rubber band removal, the band was replaced, and the process was repeated in 3 treatment sessions. All subjects concluded treatment after 24 training sessions. A home exercise program was not provided to either group for continued training during the 6-month follow-up period.

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## Hsieh et al. Effects of Treatment Intensity in Upper Limb Robot-Assisted Therapy for Chronic Stroke : A Pilot Randomized Controlled Trial. NNR. 2011.

TREATMENT GROUP 1: Patients received higher intensity RT, lower intensity RT, or CR intervention for 20 training sessions (90-105 min/d, 5 d/wk for 4 weeks). Licensed occupational therapists trained in study procedures provided the treatments. All patients otherwise received routine interdisciplinary stroke rehabilitation. Higher intensity RT protocol. The robot-assisted arm trainer, Bi-Manu-Track (Reha-Stim Co, Berlin, Germany; Figure 2), was used in this study. The Bi-Manu-Track enables the symmetrical practice of 2 movement patterns: forearm pronation–supination and wrist flexion–extension.5 Each movement pattern has 3 computer-controlled modes: passive–passive (mode 1), active–passive (mode 2, the unaffected arm actively driving the affected arm), and active–active (mode 3). The speed of movement, the amount of resistance, and range of movement can be adjusted individually. The patients sat at a height-adjustable table with their elbows bent at 90° and put their forearms in the midposition into an arm trough. A simple computer game (eg, picking up apples) that tracks patient movements was placed in front of the patients to provide instant visual movement feedback and to increase participation. The therapist also provided verbal feedback. Within 1 training session, each patient in the higher intensity RT group practiced 600 to 800 repetitions of mode 1 for 15 minutes, 600 to 800 repetitions of mode 2 for 15 to 20 minutes, and 150 to 200 repetitions of mode 3 for 5 minutes, respectively, for the forearm and the wrist movements. One repetition indicates 1 movement direction; for example, 1 pronation or 1 supination of the forearm counts as 1 repetition. If the affected arm can actively perform forearm pronation–supination or wrist flexion–extension, mode 2 can be adjusted to the affected arm actively driving the unaffected arm (300-400 maximal repetitions) to encourage more active movements of the affected arm. We reduced the number of repetitions of mode 1 into this mode (affected arm actively driving), and thus the total number of repetitions was still the same. Before the RT commenced, 5 to 10 minutes of passive range of motion was provided as a warm-up. After the RT, patients received 15 to 20 minutes of functional activities

training to help them transfer the acquired motor ability into daily activities performance. The functional activities were selected by patients and therapists and included opening a can or jar, turning a door knob, carrying heavy objects, writing, picking up a phone for listening, using chopsticks, twisting a towel, turning pages of a book, and so on.

TREATMENT GROUP 2: Patients received higher intensity RT, lower intensity RT, or CR intervention for 20 training sessions (90-105 min/d, 5 d/wk for 4 weeks). Licensed occupational therapists trained in study procedures provided the treatments. All patients otherwise received routine interdisciplinary stroke rehabilitation. Lower intensity RT protocol. Except for the treatment intensity, other training principles and practice parameters were the same as with the higher intensity RT group. Within

1 training session, patients in this lower intensity RT group practiced 300 to 400 repetitions of mode 1 for 15 minutes, 300 to 400 repetitions of mode 2 for 15 to 20 minutes, and 70 to 100 repetitions of mode 3 for 5 minutes, respectively, for the forearm and the wrist movements. In addition, if the

affected arm could actively perform forearm pronation– supination or wrist flexion–extension, mode 2 could be adjusted to the affected arm actively driving the unaffected arm (150-200 maximal repetitions) to encourage more active movements of the affected arm. The dosage of the higher intensity and lower intensity RT groups was determined from findings of animal studies, previous

research on the Bi-Manu-Track, and practical concerns. Data from 2 animal studies showed that performing about 400 to 600 repetitions of upper limb tasks per session during motor skill learning induced neural plastic changes.30,31 Furthermore, 200 to 500 repetitions per session for mode 1

and mode 2 were used in prior studies of the Bi-Manu- Track5,32 in which positive benefits of therapy were found. This range might be viewed as the lowest limit of dosage for the Bi-Manu-Track training to have positive outcomes based on current evidence. In addition, the speed of movements and patients’ tolerance were taken into consideration. Therefore, 300 to 400 repetitions of mode 1 and mode 2 for 15 minutes were selected for the low-intensity RT group. A higher dose, 2-fold of the repetitions in the low-intensity RT group, was set as the intensity of the higher intensity RT group.

CONTROL GROUP 1: Patients received higher intensity RT, lower intensity RT, or CR intervention for 20 training sessions (90-105 min/d, 5 d/wk for 4 weeks). Licensed occupational therapists trained in study procedures provided the treatments. All patients otherwise received routine interdisciplinary stroke rehabilitation. CR protocol. The CR group received a structured protocol using conventional occupational therapy techniques such as neurodevelopmental techniques33 with emphasis on functional tasks and muscle strengthening. The protocol included (a) passive range of motion exercises, stretching of the affected limb, or facilitatory and inhibitory techniques for 15 to 20 minutes; (b) fine motor or dexterity training for 20 minutes; (c) arm exercises or gross motor training for 20 minutes; (d) muscle strengthening of the affected upper limb for 15 to 20 minutes; and (e) activities of daily living or functional tasks training for 15 to 20 minutes. The activities were adapted based on the level of motor impairment and functional needs of individual patients.

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## Hsieh et al. Dose-response relationship of robot-assisted stroke motor rehabilitation: The impact of initial motor status. 2012.

TREATMENT GROUP 1. All participants received a duration-matched intervention for 90 to 105 minutes/day, 5 days/week for 4 weeks. The patients in the 2 RT groups practiced with the Bi-Manu-Track (Reha-Stim Co, Berlin, Germany; Figure 1), which allows 2 movement patterns: forearm pronation–supination and wrist flexion– extension.14 Each movement pattern is enabled by 3 computer-controlled modes: passive– passive (mode 1), active–passive (mode 2), and active–active mode (mode 3). The parameters of movement and resistance can be adjusted individually. The robot was equipped with a computer game to provide instant visual movement feedback and to increase participation. Within one training session, the patients in the higher-intensity RT group practiced 600 to 800 repetitions of modes 1 and 2 for 15 to 20 minutes and 150 to 200 repetitions of mode 3 for 3 to 5 minutes for bilateral forearm and wrist movements. One repetition indicated one movement direction. Patients in the higher-intensity RT received twice the number of the repetitions per unit of time than patients in the lower-intensity RT group.15 Before the RT training, 5 minutes of mobilization warm-up were

provided. After the training, the patients received 15 to 20 minutes of functional activities practice to help them transfer the acquired motor ability to their performance of daily activities.

TREATMENT GROUP 2. All participants received a duration-matched intervention for 90 to 105 minutes/day, 5 days/week for 4 weeks. The patients in the 2 RT groups practiced with the Bi-Manu-Track (Reha-Stim Co, Berlin, Germany; Figure 1), which allows 2 movement patterns: forearm pronation–supination and wrist flexion– extension.14 Each movement pattern is enabled by 3 computer-controlled modes: passive– passive (mode 1), active–passive (mode 2), and active–active mode (mode 3). The parameters of movement and resistance can be adjusted individually. The robot was equipped with a computer game to provide instant visual movement feedback and to increase participation. Within one training session, the patients in the higher-intensity RT group practiced 600 to 800 repetitions of modes 1 and 2 for 15 to 20 minutes and 150 to 200 repetitions of mode 3 for 3 to 5 minutes for bilateral forearm and wrist movements. One repetition indicated one movement direction. Patients in the higher-intensity RT received twice the number of the repetitions per unit of time than patients in the lower-intensity RT group.15 Before the RT training, 5 minutes of mobilization warm-up were

provided. After the training, the patients received 15 to 20 minutes of functional activities practice to help them transfer the acquired motor ability to their performance of daily activities.

CONTROL GROUP 1. All participants received a duration-matched intervention for 90 to 105 minutes/day, 5 days/week for 4 weeks.The CT group received an intensive therapist-administered control therapy matched in duration with the RT groups. Occupational therapy techniques used in the treatment protocols included neurodevelopmental treatment, muscle strengthening, fine-motor training, and functional task training.

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## Hui-Chan et al. Effectiveness of a home-based rehabilitation programme on lower limb functions after stroke. HONG KONG MED J. 2009.

CONTROL GROUP 1: The control group received no treatment.

TREATMENT GROUP 1: Subjects were required to perform the home rehabilitation programme daily, 5 days a week for 4 weeks. The treatment compliance and safety of the programme was closely monitored by the physiotherapist-in-charge. The TENS group received 60 minutes of TENS from a TENS stimulator. Electrodes were placed over four acupuncture points on the affected leg, namely ST 36 (Zusanli), LV 3 (Taichong), GB 34 (Yanglinquan), and UB 60 (Kunlun).

TREATMENT GROUP 2: Subjects were required to perform the home rehabilitation programme daily, 5 days a week for 4 weeks. The treatment compliance and safety of the programme was closely monitored by the physiotherapist-in-charge. The PLBO+TRT group received 60 minutes of placebo-TENS from TENS devices with the electrical circuit disconnected inside, followed by 60 minutes of TRT as described below.

TREATMENT GROUP 3: Subjects were required to perform the home rehabilitation programme daily, 5 days a week for 4 weeks. The treatment compliance and safety of the programme was closely monitored by the physiotherapist-in-charge. The TENS+TRT group received 60 minutes of TENS

followed by 60 minutes of TRT which included six exercises: (1) loading exercise on the affected leg, (2)

stepping up exercise with the affected leg, (3) stepping down exercise with the unaffected leg, (4) heel lifts from a dorsiflexed position when standing, (5) standing up from a chair, walking a short distance, and returning to the chair, and (6) walking with rhythmic auditory cues generated by a metronome. The physiotherapist oversaw standardized progression.

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## Hunter et al. Dose-response study of mobilisation and tactile stimulation therapy for the upper extremity early after stroke: A phase I trial. 2011.

CONTROL GROUP 1. All participants received their routine conventional physical therapy (CPT) from the clinical physiotherapists. The amount and content of upper-limb CPT given to participants during the intervention phase of this trial was documented using a treatment schedule with acceptable reliability that has been used to record CPT in a trial of functional strength training.18,19 The clinical physiotherapists at each center were trained to use the treatment schedule and asked to record treatment given on each of the 14 intervention days for each participant (no upper-limb treatment was recorded as 0 minutes). The research physiotherapists collected the completed forms regularly. CPT

was recorded to inform interpretation of the degree to which therapists’ knowledge of group allocation might influence the treatment they provide and to enhance interpretation of generalizability of results because processes of routine care vary with geographical location.20 Participants randomized to the control condition (group 1) received the CPT provided by the clinical physiotherapists and no experimental therapy.

TREATMENT GROUP 1. All participants received their routine conventional physical therapy (CPT) from the clinical physiotherapists. The amount and content of upper-limb CPT given to participants during the intervention phase of this trial was documented using a treatment schedule with acceptable reliability that has been used to record CPT in a trial of functional strength training.18,19 The clinical physiotherapists at each center were trained to use the treatment schedule and asked to record treatment given on each of the 14 intervention days for each participant (no upper-limb treatment was recorded as 0 minutes). The research physiotherapists collected the completed forms regularly. CPT

was recorded to inform interpretation of the degree to which therapists’ knowledge of group allocation might influence the treatment they provide and to enhance interpretation of generalizability of results because processes of routine care vary with geographical location.20 Participants randomized to experimental groups 2, 3, and 4 received up to 30, 60, or 120 minutes of MTS, respectively, every working day for 14 days from the research physiotherapist in addition to CPT. MTS was given either on the ward or in the participants’ own homes if they had been discharged. Experimental interventions had to fit around routine care and not interfere with therapy sessions, ward rounds, meal times, or medical investigations. In addition, the delivery of MTS was done taking into account participants’ experience of fatigue, their preferences for timing of the intervention, and the visits of their family and friends. All these factors could potentially reduce the planned amount of MTS. Consequently, the research therapists paid particular attention to communication with clinical staff and participants regarding the flexible timing of intervention. MTS, defined in a standardized schedule (Box 2), consists of the provision of tactile and proprioceptive stimulation through actions such as guided sensory exploration, massage, passive joint/soft-tissue mobilization techniques, active assisted movements, and active movements where possible.3 Details of the aims, content, and duration of each treatment session were documented by the research physiotherapists who had received training in the provision and recording of MTS.

Components of MTS

Passive movements through anatomical range Accessory movements (eg, glide, distraction)

• Radio-ulnar pronation/supination • Radio-ulnar joint

• Wrist flexion/extension • Wrist joint

• Wrist radio-ulnar deviation • MCPJ1

• Thumb MCPJ flexion/extension • MCPJ2-5

• Thumb IPJ flexion/extension • IPJ1

• Thumb abduction/adduction • PIPJ2-5

• Thumb opposition • DIPJ2-5

• Finger MCPJ flexion/extension Soft-tissue stretch

• Finger IPJ flexion/extension • Longitudinal

• Finger abduction/adduction • End of range

Massage

• Transverse

• Effleurage • Diagonal

• Circular kneading • Sustained

• Picking up • Other (state)

• Wringing Isolated/selective joint movement

• Other (state) • Radio-ulnar

Placing the hand on • Wrist

• Flat surface • MCPJ1

• Edge/corner • MCPJ2-5 (lumbrical action)

Compression • IPJ1-5

• MCP joints Specific sensory input

• Palm • Visual

• Wrist • Auditory

• Other • Active touch (objects/body parts)

Patterns of coordinated movement

underlying functional activity

• Passive touch (objects/body parts)

Guidance to therapistsa

• Treatment is of forearm and hand only (ie,

up to the joint line of the elbow)

• Reach—with/without object

• Grasp and release—with/without object

• Fine finger activity—with/without object • Adapt treatment (ie, combination of techniques used) to suit the presentation of the individual

• Weight bearing through limb

• Other

Abbreviations: MTS, Mobilisation and Tactile Stimulation; 1, thumb; 2-5, index, middle, ring, and little fingers; DIPJ, distal interphalangeal joint; IPJ, interphalangeal joint; MCPJ, metacarpophalangeal joint; PIPJ, proximal interphalangeal joint. Adapted from Hunter et al.3

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## Huseman et al. Effects of Locomotion Training With Assistance of a Robot-Driven Gait Orthosis in Hemiparetic Patients after Stroke: A Randomized Controlled Trial. STROKE. 2007.

TREATMENT GROUP 1: Patients walked on a treadmill with the help of a robotic-driven gait orthosis (Lokomat; Hocoma). The basic version of the Lokomat system consists of the Lokomat (robotic gait orthosis) and the Lokobasis (body weight support system). It is used in combination with a Woodway treadmill (Weil am Rhein, Germany). The patient’s legs are guided according to a preprogrammed physiological gait pattern. The knee and hip joints are controlled by position and force sensors, which allow individual adjustments. The torque of the knee and hip drives can be adjusted from 100% to 0% for one or both legs. The speed of the treadmill can be adjusted from 0 km/h to approximately 3 km/h and body weight support from 0% to 100%.6,7,12 At the beginning of the treatment period, 30% of the body weight of each subject was supported. The walking sessions in the Lokomat group were kept at a

demanding level; the velocity of the treadmill was set to the maximum speed tolerated by the patients, the force of the drives was regulated, and body weight support was reduced as soon as the patients could tolerate it. Therapists motivated patients to actively move their legs. All patients in the treatment group were scheduled for one 60-minute session per workday. This resulted in 30 minutes

of real walking time, because mounting, dismounting, and adjusting the patient in the device took approximately 30 minutes.

CONTROL GROUP 1: Patients in the control group received 30 minutes of conventional physiotherapy per workday. Focus on this training was gait rehabilitation. The patients exercised trunk stability and symmetry, step initiation, and weight support on the paretic leg. In every session, the patient walked some steps with the help of therapists. Patients received treadmill training, if possible, with the help of one or 2 therapists. Lokomat therapy was compared with conventional physiotherapy because treadmill training with severely handicapped people was not possible, at least in the beginning.

Both groups received 20 treatment sessions plus an additional 20 sessions of conventional physiotherapy. The final measurements were performed after 40 sessions of therapy, which was reached for most patients after a 4-week period. Final measurements could be done between 4 and 5 weeks.

# I Authors

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## In et al. Virtual Reality Reflection Therapy Improves Motor Recovery and Motor Function in the Upper Extremities of People with Chronic Stroke. INT J PHYS THER SCI. 2012.

CONTROL GROUP 1: ln　preparation　for　treatment，　each　patient in　the　experimental　group　had　their　affected　hand　put　in　the box　while　the　other　one　was　placed　directly　under　the　camera （Fig　1）．　Each　participant　then　had　to　line　up　his　or　her　arm with　the　image　of　the　other　one　displayed　on　the　screen　and decide　on　a　speed　of　motion　that　was　comfortable．　Patients had　to　look　at　the　monitor　during　this　assignment．　Treatment was　given　to　patients　for　30　minutes　a　day，　5　days　a　week for　a　total　of　4　weeks．　Completing　the　exercise　meant　a　total of　3　sets　of　10　repetitions．　P　atients　performed　the　steps　under the　supervision　of　caregivers　and　had　to　fi11　out　a　checklist after　finishing　the　exercise．　The　control　group　received　the same　treatment，　except　they　had　to　look　at　their　unaffected hand　as　the　monitor　was　off． A　new　therapeutic　procedure　for　training　was　provided for　the　patients　in　the　first　week　following　suggestions by　Stevens　and　StoykoviO）．　The　program　was　designed with　progressively　harder　tasks　to　complete　as　a　way　of maintaining　participant　interest．　Detailed　procedures　were broken　up　into　week－long　segments．　ln　the　first　week，　the patients　started　with　an　easy　program：　wrist　flexion　and extension，　forearm　pronation　and　supination，　and　clenching and　opening　the　hand．　ln　the　second　week，　the　aim　was　to exercise　gross　movement　of　the　hand　with　simple　tasks like　picking　up　cups　of　different　sizes　and　weights．　Fine hand　motion　was　the　aim　of　the　third　week．　Patients　had　to complete　these　assignments：　pegging　clothespins，　pushing buttons　on　a　calculator，　using　chopsticks　and　opening　a　bottle． The　fourth　week　was　more　complicated，　as　the　patients　had to　put　together　a　puzzle，　draw　a　circle　and　square　with　a　pen，and　play　a　game　of　toy　golf.

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## Indredavik et al. Benefit of a stroke unit: a randomized controlled trial. STROKE. 1991.

TREATMENT GROUP 1: The stroke unit was organized with a team approach to the patient's care. Then a patient arrived, diagnostic and functional evaluation was done immediately and a treatment plan was made. The staff was well trained in the rehabilitation of stroke patients, and a systematic program for recovery of function was started soon after arrival. We believed that giving information to the patient and relatives was extremely important and designated a particular stroke nurse to manage these aspects. The maximum period for treatment in the stroke unit was 42 days. If the patient had not returned home within 42 days, he was transferred to the general medical wards, a rehabilitation clinic, or a nursing home. There was no difference between the groups in the patients' ability to get treatment in rehabilitation clinics or nursing homes. After discharge, the family physicians were responsible for the patients' treatment; however, we recorded each patient's treatment during the period from 42 to 365 days and found no significant differences between groups.

TREATMENT GROUP 2: Six wards in the Department of Medicine received stroke patients. Treatment in these wards was the common one for patients with acute stroke in Norwegian hospitals, but there was no standardized program for diagnostic evaluation and treatment. Physical therapy and occupational therapy were given when the physicians in the wards prescribed it.

# J Authors

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## Janssen et al. Effects of Electric StimulationAssisted Cycling Training in People With Chronic Stroke. APMR. 2008.

TREATMENT GROUP 1: Experimental Design Before baseline testing, the subjects were randomly assigned to 1 of 2 groups: a group performing leg cycling exercise with maximally tolerable ES (ES-LCE) that evoked muscle contractions and a control group (LCE) performing cycling with just sensible ES (ie, the stimulation could just be felt but did not evoke muscle contractions). The goal of the latter procedure was to blind the subjects for group assignment. We informed all subjects before the experiments that they would receive ES, without disclosing the exact degree of ES or the fact that 1

group would receive more than the other. Hence, they were unaware that contractions were important and only focused on the fact that they received ES. Before the training period, subjects came once to the laboratory to get acquainted with the cycle ergometer and to determine the individually preferred cadence and current amplitude of the ES. In 2 subsequent sessions, baseline measurements (cycling graded exercise test [GXT], functional performance test, muscle strength test) were performed, separated by at least 1 day. After the 6-week training program, the same measurements were performed during 2 separate sessions. ES-Assisted Cycling Exercise All cycling was performed on a semirecumbent Ergys2 bicycle ergometer.a The ergometer, originally developed for people with SCI, uses computer-controlled ES to activate the quadriceps, gluteal, and hamstring muscles. In the (adapted) Ergys2, several parameters can be set, including the target cadence. The Ergys2 raises the current amplitude to a predefined maximum when cadence falls below the target cadence, most commonly because of fatigue. The purpose of this procedure is to recruit additional muscle fibers to maintain the target cadence. When cadence is above the target cadence, current amplitude will decrease again. To ensure that subjects received maximal ES during (almost) the entire training in the

present experiments, the target cadence was set higher than the individually preferred cadence. The ES current amplitude for the ES-LCE group was set as high as tolerated, resulting in current levels that induced muscle contractions in all subjects, as determined by visual observation. For the LCE group, the current was set to just sensible stimulation not evoking muscle contractions. The stimulation used was a 60-Hz symmetrical, biphasic sine pulse and a pulse duration of 450s.

TREATMENT GROUP 2: Experimental Design Before baseline testing, the subjects were randomly assigned to 1 of 2 groups: a group performing leg cycling exercise with maximally tolerable ES (ES-LCE) that evoked muscle contractions and a control group (LCE) performing cycling with just sensible ES (ie, the stimulation could just be felt but did not evoke muscle contractions). The goal of the latter procedure was to blind the subjects for group assignment. We informed all subjects before the experiments that they would receive ES, without disclosing the exact degree of ES or the fact that 1

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## Jin et al. Intensive aerobic cycling training with lower limb weights in Chinese patients with chronic stroke: discordance between improved cardiovascular fitness and walking ability. DISABIL REHABIL. 2012.

TREATMENT GROUP 1: Exercise training The aerobic cycling exercise training was administered for 40 minutes per day for five times a week at a target aerobic intensity of 50%–70% heart rate reserve (HRR) [15,23], which should have been completed within 8 weeks of inclusion in the study. The training was started at a low intensity (40%–50% HRR) for 10 to 20 minutes and increased approximately 5 minutes every 2 weeks as tolerated. Aerobic intensity was similarly progressed by 5% HRR every 2 weeks. The amount of added weight was 3% of the body weight up to the maximum tolerated for patients to ensure that they could complete the task. Only the paretic lower limb was loaded. Patients pedaled for 6–10 minutes in each task condition, and 2–3 minutes of rest were provided between each task. No subject accepted antispastic drugs and/or botulinum toxin during the study period. The therapists who treated the aerobic cycling exercise training patients were not

the same as those who treated the control group patients.

CONTROL GROUP 1: The control groups participated in a matched duration of low-intensity overground walking training at 20–30% HRR lasting 40 minutes. In addition, both of the two groups were engaged in a balance exercise (standing on a balance disc or a tilting board) that lasted 30 minutes and in supervised stretching movements that lasted 20 minutes. The treatment was administered five times per week. No subject accepted antispastic drugs and/or botulinum toxin during the study period. The therapists who treated the aerobic cycling exercise training patients were not

the same as those who treated the control group patients.

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## Jin et al. Effects of aerobic cycling training on cardiovascular fitness and heart rate recovery in patients with chronic stroke. NEUROREHABILITATION. 2013.

TREATMENT GROUP 1: The aerobic cycling training was administered for 40 minutes per day for 5 times a week at a target aerobic intensity of 50% to 70% HR reserve [5], which was a primary goal to complete within 12 weeks of inclusion in the study. The training was started at a low intensity (40% to 50% HR reserve) for 10 to 20 minutes and increased by approximately 5 minutes every 2 weeks as

tolerated. Aerobic intensity was similarly progressed by 5% HR reserve every 2 weeks. Patients pedaled

for 6–10 minutes in each task condition, and 2–3 minutes of rest were provided between each task. HR was tracked by a polar chest belt heart rate monitor (Polar Electro,Woodbury, New York). All sessions were held under the supervision of the therapists and cardiologists.

CONTROL GROUP 1: The control group participated in a matched duration of conventional therapy,

including supervised stretching movements lasting 35 minutes and 5-minute low-intensity overground walking training at 20–30% HR reserve. The treatment was administered 5 times per week. The activity for the control group was not designed to improve cardiovascular performance. All sessions were held under the supervision of the therapists and cardiologists.

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## Johannsen et al. Seated Bilateral Leg Exercise Effects on Hemiparetic Lower Extremity Function in Chronic Stroke. NNR. 2010.

TREATMENT GROUP 1: Bilateral LE Intervention Training of the BLETRAC group involved a custom designed apparatus. It comprised a reclining seat and foot supports by which the legs could be moved independently through flexion and extension using a pair of low-friction sliding carriages running along 2 linear tracks that guided the path taken by the foot. This followed a principle similar to the BATRAC approach in guiding hand movement while supporting the weight of the effector.29 The BLETRAC apparatus allows various bilateral coordination patterns: bilateral in-phase or antiphase actions using simultaneous or sequential leg movements. Furthermore, movements of the hip or the knee can be emphasized, thus modifying intralimb coordination, by varying seat height and backrest inclination. Settings chosen for the current study resulted in leg movements that required both hip and knee joint movement. The tracks’ inclination was 6° so that gravity did not facilitate leg extension. Extreme plantar flexion during the exercise was prevented by limiting ankle movements with a thermoplastic brace mounted by a hinge on the back of each sliding carriage. When necessary, the research physiotherapist provided minimal manual support to prevent medial or lateral rotation of the affected hip. Each participant received ten 45-minute sessions of bilateral LE exercise. In each training session, the exercise consisted of 3 blocks of 10 minutes duration during which the participant actively performed periodic simultaneous bilateral antiphase limb movements. Each training block was followed by a rest period of 5 minutes duration. Limb movements were paced by an auditory metronome that was set to each participant’s individual, comfortable level of perceived exertion that was felt to be sustainable for the duration of the session. Participants could request an increase or reduction of the rate at the beginning of each session; however, once set, it remained constant until the end of the session. Two training sessions were performed each week so that the 10-session protocol was completed in 5 weeks.

TREATMENT GROUP 2: Bilateral UE Intervention. The BATRAC group received the same dose of an exercise equivalent to BLETRAC, that is, bilateral alternating UE movements with the hands moving vertical grips forward and backward in reciprocal fashion.29 Each participant received ten 45-minute sessions of bilateral LE exercise. In each training session, the exercise consisted of 3 blocks of 10 minutes duration during which the participant actively performed periodic simultaneous bilateral antiphase limb movements. Each training block was followed by a rest period of 5 minutes duration. Limb movements were paced by an auditory metronome that was set to each participant’s individual, comfortable level of perceived exertion that was felt to be sustainable for the duration of the session. Participants could request an increase or reduction of the rate at the beginning of each session; however, once set, it remained constant until the end of the session. Two training sessions were performed each week so that the 10-session protocol was completed in 5 weeks.

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## Jongbloed et al. Stroke Rehabilitation: Sensorimotor Integrative Treatment Versus Functional Treatment. AJOT. 1989.

TREATMENT GROUP 1: Therapists who had attended a workshop on sensorimotor integrative treatment techniques and had practiced using these techniques treated subjects assigned to the sensorimotor integration treatment group. Similarly, therapists who had attended a workshop on functional treatment and had used such treatment in the past treated subjects assigned to the functional treatment group. The project coordinator regularly observed therapists treating subjects to ensure that treatment reflected the written protocol for that treatment group. The coordinator also met regularly with therapists to reinforce the treatment principles they were using. An individual treatment program was designed for each subject and each subject usually received treatment from the same occupational therapist. All subjects received similar assistance in morning and evening self-care. For example, subjects dressed their affected side first and transfers were performed to the unaffected side. After the self-care routine had been established by the occupational therapist, it was carried out by a nurse's aide. All subjects received similar medical and nursing care and physical therapy.

CONTROL GROUP 1: Therapists who had attended a workshop on sensorimotor integrative treatment techniques and had practiced using these techniques treated subjects assigned to the sensorimotor integration treatment group. Similarly, therapists who had attended a workshop on functional treatment and had used such treatment in the past treated subjects assigned to the functional treatment group. The project coordinator regularly observed therapists treating subjects to ensure that treatment reflected the written protocol for that treatment group. The coordinator also met regularly with therapists to reinforce the treatment principles they were using. An individual treatment program was designed for each subject and each subject usually received treatment from the same occupational therapist. All subjects received similar assistance in morning and evening self-care. For example, subjects dressed their affected side first and transfers were performed to the unaffected side. After the self-care routine had been established by the occupational therapist, it was carried out by a nurse's aide. All subjects received similar medical and nursing care and physical therapy.

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## Jonsdottir et al. Task-Oriented Biofeedback to Improve Gait in Individuals With Chronic Stroke: Motor Learning Approach. NNR. 2010.

TREATMENT GROUP 1: One group received the experimental protocol, whereas the other group received traditional physical therapy. Both groups were subjected to quantitative gait analysis at 3

time points: before the beginning of treatment (pretreatment), at the end of 20 treatment sessions (posttreatment), and 6 weeks after the post–gait analysis (FU). The gait analysis assessor was blinded to group assignment of the participants. The BFB consisted of an acoustic signal driven by the EMG recorded from the gastrocnemius lateralis during gait. The signal was used as feedback of performance, the goal being to increase the power production of the ankle during the push-off phase, with the functional goal of increasing velocity. The functional goal was not stated to participants in either group to reduce risk of compliance to goal expectations during post–gait analysis and FU gait analyses. In accordance with theories of motor learning, the rehabilitation program was divided into different phases. The aims of these phases were the following: to improve gait performance, to increase patient’s error self-detection, and to transfer acquired skills during the BFB condition to a context in which the feedback was no longer available. In the first phase (first to fifth session), constant BFB and verbal instructions were used to improve the performance. In this phase, practice was kept constant; that is, EMG-BFB was applied during comfortable overground gait of the patient in which the patient was instructed to lift the heel and allow the knee to bend while pushing and leaving the ground. In the second phase (6th to 15th session), a variable practice paradigm (eg, different step lengths, variable speed, variable terrain, direction changes) was applied with intermittent EMG-BFB. In the third phase (16th to 20th), BFB was mostly withdrawn, and practice continued to be variable. The participant was asked to keep in mind the optimal performance. If the physical therapist felt it was needed, BFB was applied briefly as a reminder in this phase (for further details see Jonsdottir et al7). All participants, irrespective of group assignment, received 20 treatment sessions, lasting 45 minutes each, 3 times per week. Efficacy of the treatment was evaluated posttreatment and at 6 weeks FU (see Figure 1, flow chart).

CONTROL GROUP 1: The control group received the usual rehabilitation care administered in the center. The usual rehabilitation care is typically a mixture of therapeutic approaches, including

Neurodevelopmental and neurofacilitation techniques, taskspecific training, and/or task-oriented training. Treating therapists were not guided in the treatment application; they were only asked to devote at least 15 minutes of each session to gait training. Participants in both groups had regular contact with the main investigator to minimize the difference in attention. All participants, irrespective of group assignment, received 20 treatment sessions, lasting 45 minutes each, 3 times per week. Efficacy of the treatment was evaluated posttreatment and at 6 weeks FU (see Figure 1, flow chart).

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## Jung et al. Effect of virtual reality treadmill training on balance and balance self-efficacy in stroke patients with a history of falling. J PHYS THER SCI. 2012.

TREATMENT GROUP 1: The experimental group performed virtual reality treadmill training 30 minutes a day, 5 times a week for 3 weeks. The control group received treadmill training, without control over the slope of the treadmill, on the same schedule. Subjects receiving virtual reality treadmill training wore a head mounted device (HMD), watched the virtual reality program on the screen of the HMD and walked on the treadmill. The virtual reality program simulated a park stroll. Computer hardware on the HMD recorded output data (Mybud, Accupix, Gyeonggi-do, Korea). The HMD consisted of a 100 inch screen and built in earphones. All subjects started each training session at a self-selected comfortable walking speed. The treadmill speed was increased by 0.1 km/h each time the patient was able to walk stably for more than 20 seconds12). All subjects wore a non-weight-bearing harness (Shuma DA-2000, Daean medical, Seoul, Korea) for safety purposes.

CONTROL GROUP 1: The experimental group performed virtual reality treadmill training 30 minutes a day, 5 times a week for 3 weeks. The control group received treadmill training, without control over the slope of the treadmill, on the same schedule.

# K Authors

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## Kahn et al. Robot-assisted reaching exercise promotes arm movement recovery in chronic hemiparetic stroke: a randomized controlled pilot study. J NEUROENGINEERING REHABIL. 2006.

TREATMENT GROUP 1. Active-assist training Active assistance to movement was provided using a simple robotic device (the Assisted Rehabilitation and Measurement Guide, ARM Guide) that uses a motor and chain drive to move the user's hand along a linear rail in a manner similar to a trombone slide (Figure 1A) [21]. The linear rail can be oriented at different yaw and pitch angles to allow reaching to different workspace regions. The device is statically counterbalanced so that it does not gravitationally load the arm. The hand piece consists of a trough for the forearm and a 2 cm diameter cylinder placed in the palm of the user's hand. Regardless of whether the user was capable of grasping the cylinder, two elastic straps around the proximal and distal forearm fixed this segment to the trough (Figure 1A) and ensured coupling of the user to the device. A strap across the sternum and over the shoulders minimized trunk movement during the reaching tasks. More details of the device design

can be found in earlier publications [22-24]. Subjects randomized to the robotic training group performed reaching movements under their own power and control while receiving active assistance from the device. The targeted normative movements were along a straight line path (linear rail of the ARM Guide) and followed the smooth translation profile with a bell-shaped velocity typical of unimpaired reaching movements [25-28] (Figure 1B). The active assistance algorithm remained idle until a subject initiated movement through at least 1 cm along the track in the outward direction toward the target. After the user advanced the hand piece by 1 cm, the controller would monitor the velocity and position trajectories to detect deviations from the targeted movement in real time. To emphasize the importance of subjects moving under their own efforts, a one centimeter deadband in the position trajectory allowed a subject to be within a small margin of error along the planned path before the motor would provide assistance. Outside of this deadband the motor assisted the subject in maintaining the correct trajectory with a force proportional to a weighted sum of the position and velocity errors. All reaching movements were practiced over the subject's entire supported passive range of motion (ROM) (i.e. the ROM while reaching along the ARM Guide). Targets were located at the limit of the subject's workspace in each of the pre-assigned directions, where this limit was individualized for each subject with the elbow extended and the shoulder flexed as much as possible without pain. For subjects who could not voluntarily move through this entire passive ROM (8 subjects out of 10), the training task was to reach as fast and as far as possible and prescribed trajectories for the active assistance were planned at velocities 20% greater than those that they were able to

achieve without assistance. The screening process for this study did not exclude individuals with significant spasticity. While many participants tended to co-contract during volitional movement, none exhibited hyperactive stretch reflex in the range of speeds used for training – namely speeds slightly greater than their maximum voluntary speeds – as confirmed by electromyographical (EMG)

recordings during the pre-training evaluations. The choice of training at speeds 20% greater than the maximum voluntary speed was somewhat arbitrary, but was chosen to reinforce movements that were marginally better than their current abilities demonstrated during the eight pretraining reaches at each session. For subjects who could achieve full ROM before training (N = 2), movements were planned by the device at velocities equal to those measured using their ipsilesional arms during unsupported

reaches at a self-selected, comfortable speed. Graphical feedback of the amount of assistance provided by the motor was provided after every fifth reach, and subjects were instructed to try to reduce this assistance level. The feedback was used not only to inform subjects of how they were interacting with the device, but also as a motivational factor to encourage improvement of the reaching performance and to keep them intellectually involved in the task.

CONTROL GROUP 1: Unassisted free reaching training Subjects randomized to the free reaching training group performed a matched number of reaches to the same targets as those in the active-assist training group. In this case, the subjects were not attached to the device, and there was no limb support against gravity or any mechanical constraint for arm movement. The initiation point for

every movement was with the hand resting on the lap at the umbilicus. All movements were recorded using the Flock of Birds three-dimensional electromagnetic motion capture system (Ascension Technologies, Burlington, Vermont). Subjects were instructed to reach as fast as possible to the target, maintain their position for one second, and then relax. For this task a graph of how close each reach

was to the target and a graph indicating the straightness of each movement (described in the Free Reaching Analysis subsection) were provided as feedback after every fifth trial.

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## Kang et al. Effects of treadmill training with optic flow on balance and gait in individuals following stroke: randomized controlled trials. CLIN REHABIL. 2012.

TREATMENT GROUP 1: The treadmill with optic flow group underwent the exercises for four weeks, three times a week, for 30 minutes each day, whereas the treadmill and control groups received treadmill training only and stretching added range of motion exercises for the same time. The treadmill with optic flow group can control and adjust the speed of optic flow applied to each patient, and the treadmill with optic flow environment is a programme which reproduces the environment of walking on a street. The treadmill with the optic flow programme employed computer hardware for the

output, and was applied to the subjects using a head-mounted device (MSP-209, Kowon Technology, Seoul, Korea). Before applying the optic flow speed, the gait speed of each subject was evaluated by performing a 10-m gait test, and was re-tested every week. Based on the studies by Lamontegne et al.6, stable and inconsistent optic flow was determined, and applied in seven sections: 0.25, 0.5, 1.0, 1.5, 2, and 1.5, and 1.0 times the gait speed of each patient, and a training period of 1, 1, 2, 3, 4,

3, and 1 minute for each section. This study was performed two times for 15 minutes, and a set interval of five minutes was taken for the resting time. The patients wore earphones to adapt to the head-mounted device for five minutes before the experiment and for auditory control. Treadmill (Sky Life 5300, Iljin Sports, Seoul, Korea) training measured the 10-m gait speed of the patients, and then executed the treadmill training based on the measured stable gait speed. The treadmill speed was increased by 0.1 km/h each time once the patient could walk stably for more than 20 seconds.14 All patients who participated in this study received conventional physical therapy five times a week for four weeks (Figure 2).

TREATMENT GROUP 2: The treadmill with optic flow group underwent the exercises for four weeks, three times a week, for 30 minutes each day, whereas the treadmill and control groups received treadmill training only and stretching added range of motion exercises for the same time. The treadmill group underwent treadmill training only, controlling the difficulty using the same method in the treadmill with optic flow group, i.e. treadmill speed was increased by 0.1 km/h each time once the participants could walk stably for more than 20 seconds. This study was performed two times for 15 minutes, and a set interval of five minutes was taken for the resting time. All patients who participated in this study received conventional physical therapy five times a week for four weeks (Figure 2).

CONTROL GROUP 1: The treadmill group underwent treadmill training only, controlling the difficulty using the same method in the treadmill with optic flow group, i.e. treadmill speed was increased by

0.1 km/h each time once the participants could walk stably for more than 20 seconds. This study was performed two times for 15 minutes, and a set interval of five minutes was taken for the resting time. The control group received general stretching added range of motion exercises in the less and more affected sides of the trunk, arms and legs for the same time. For conventional physical therapy, exercise therapy was performed using the traditional motor development theory and neurodevelopmental treatment based on motor learning theory. All patients who participated in this study received conventional physical therapy five times a week for four weeks (Figure 2).

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## Katz-Leurer et al. The influence of early cycling training on balance in stroke patients at the subacute stage. Results of a preliminary trial. CLIN REHABIL. 2006.

TREATMENT GROUP 1: Study group The patients continued with regular therapy in the rehabilitation department. In addition they all trained on a leg cycle ergometer (Active Passive Trainer (Tzora Active Systems Ltd, Kibbutz Tzora, Israel), which is an electrically powered trainer, operated by hand or foot pedals) five days a week for three weeks. A physiotherapist supervised the training. Based on the initial cycling performance, each patient was assigned an individualized exercise programme. Patients were instructed to pedal at their comfortable speed. Intensity was limited to less then 400/) of heart rate reserve adjusted for age. Throughout the training period heart rate was continuously monitored by a pulse watch (Polar Vantage NV; Polar Electro Oy, Kempele, Finland). The training period lasted for three weeks. The training started with multiple short workout periods of 2 min each according to patient tolerance, with 1 -min rest between consecutive periods for up to 10 min in the first day. Each patient was instructed to add 1 min to each workout period on the second and third day. In the next two days, the patient was instructed to add 3 min to three workout periods. At the end of the first week the patient could work for 30 min. In the following two weeks, patients worked 30 min, five times per week.

CONTROL GROUP 1: Control group The patients continued with the regular therapy in the rehabilitation department which included physical therapy (based on the Bobath approach),

occupational therapy, speech therapy if needed, and five days a week of group activity for general

exercise.

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## Khan et al. Potential effectiveness of three different treatment approaches to improve minimal to moderate arm and hand function after stroke – a pilot randomized clinical trial.

CONTROL GROUP 1: The primary goal of all interventions was to improve arm and hand function. As the intensity of treatment for restoring arm and hand function after stroke was considered to be crucial, it was an important prerequisite of this study to provide a high amount of therapy in all three intervention groups. Therefore, in addition to individual treatment sessions resource-friendly group therapies were included in the treatment programme. Conventional neurological therapy included

individual physiotherapy (5 hours) and occupational therapy (2.5 hours) per week, including postural control during task performance, inhibition of uneconomic and therefore ineffective synergistic movements and facilitation of economic movements to relearn efficient movement strategies for functional task performance. In addition, participants received general activation in a group setting for 5 hours per week and, depending on their motor skills, either 3 hours of garden group or wood-workshop group or 2 hours of fine motor dexterity group. If required, patients were instructed or

assisted while washing and grooming in the morning and while eating with the affected hand. Total

treatment time was 15–20 hours per week.

TREATMENT GROUP 1: The primary goal of all interventions was to improve arm and hand function. As the intensity of treatment for restoring arm and hand function after stroke was considered to be crucial, it was an important prerequisite of this study to provide a high amount of therapy in all three intervention groups. In the constraint induced therapy individual physiotherapy and occupational therapy were each performed for 2.5 hours per week, focusing on constraint training. The 5 hours of group therapy consisted of specific arm and hand function training with individual task-oriented exercises. To enable patients with minimal function to perform their task-oriented exercises, adaptations such as hand fixation with a bandage to the object, use of magnets or hooks attached to objects to imitate grasping activities while enhancing shoulder and elbow movements, or choice of positions requiring less strain against gravity were used. Participants trained their arm and hand function while washing, grooming and eating with assistance. In addition to the same total of 15–20 hours per week, the constraint induced therapy group performed 5 hours of self-training (30 minutes after every physiotherapy and occupational therapy session), continuing their repetitive task-oriented training. During the therapies participants wore a constraining mitt, and they were also encouraged to wear it outside the sessions depending on their functional skills.

TREATMENT GROUP 2: Therapeutic climbing consisted of the same treatment protocol and the same amount of therapies as the conventional neurological therapy group except that at least 80% of the individual physiotherapy sessions consisted of climbing-specific exercises performed at the climbing wall inside the clinic. Depending on their motor skills, participants were asked to hold, reach, grasp different sized grips, to lean or push on them or to pin small objects to the wall with either hand, maintaining the position with the other hand. Participants were standing on the floor or, with increased function, climbing horizontally or vertically on the wall.

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## Kihoon et al. Effect of virtual reality based rehabilitation on upper extremity function and visual perception in stroke patients: a randomized control trial. J PHYS THER SCI. 2012.

CONTROL GROUP 1: Two groups (VR training and control [CON] group) were randomized using

a table of random sampling numbers. The subjects in the 2 groups were provided traditional therapy in 30-min sessions, 3 times a week for 4 weeks. For single blind analyses, the 2 groups were segregated. VR-based training was conducted in 60-min sessions, 5 times a week for 4 weeks. One group received treatment in the morning, and the other group received treatment in the afternoon. Subjects in both groups were forbidden to talk about the treatment. After 4 weeks of intervention, a post-intervention test was performed, and the obtained data were analyzed. One subject from each group withdrew from the experiment. Thus, the final number of subjects who participated in the post-intervention test

were 15 in the VR group and 14 in the CON group. The demographic characteristics of each group are shown in Table 1.

TREATMENT GROUP 1: Two groups (VR training and control [CON] group) were randomized using

a table of random sampling numbers. The subjects in the 2 groups were provided traditional therapy in 30-min sessions, 3 times a week for 4 weeks. For single blind analyses, the 2 groups were segregated. VR-based training was conducted in 60-min sessions, 5 times a week for 4 weeks. One group received treatment in the morning, and the other group received treatment in the afternoon. Subjects in both groups were forbidden to talk about the treatment. After 4 weeks of intervention, a post-intervention test was performed, and the obtained data were analyzed. One subject from each group withdrew from the experiment. Thus, the final number of subjects who participated in the post-intervention test

were 15 in the VR group and 14 in the CON group. The demographic characteristics of each group are shown in Table 1. The Interactive Rehabilitation and Exercise System (IREX; Vivid Group, Toronto, Canada) was used for VR-based training. The VR environment consisted of a chair, monitor, virtual game program, data gloves, and video cameras. We selected 6 VR programs for our study: bird and balls, coconuts, drums, juggler, conveyor, and soccer. Each program was performed for 5 min, with a 1-min break between programs. Subjects were asked to move the affected upper extremity. If the subjects could not perform well, the therapist gave verbal cues or physical assistance. The level of difficulty of all programs could be controlled by adjusting the velocity, quantity, distance, and angle of the VR object.

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## Kim et al. Use of virtual reality to enhance balance and ambulation in chronic stroke: A double-blind, randomized controlled study. 2009.

TREATMENT GROUP 1. The experimental and control groups underwent the same CPT, 40 mins a day, 4 days a week for 4 wks. The CPT program involves a patient specific neurofacilitation technique. The experimental group received a 30-min of VR in addition to CPT. The CPT protocol was designed to facilitate symmetrical static and dynamic standing balance function during walking in individuals with chronic hemiparetic stroke, as a part of regular neurorehabilitation regimen. In brief, for static balance training, the patients were encouraged to shift their weight onto the paretic limb through verbal and tactile cues. For example, rhythmic stabilization and approximation exercises on the affected hip joint and musculature were provided to increase proximal joint stability during the static weight bearing task. A muscle-strengthening exercise for the gluteus medius muscle was also given to improve eccentric controlled mobility of pelvis during the stance phase of gait so as to prevent pelvic drop. Different heights of objects or platform surfaces for the nonparetic limb were used to increase weight shifting to the paretic limb to improve symmetrical weight bearing on the affected side. Treatment progression from static to dynamic balance occurred as the patients obtained the established goals: the ability to shift their weight in the AP and ML planes while performing functional reaching or picking up tasks. For dynamic balance training, the kinesthetic tactile inputs in relation to pelvic rotation and weight shifting were provided during the gait training.25 The IREX VR system was used to empower the

motivation and static and dynamic balance performance associated with gait in patients with stroke. This portable VR system comprises a television monitor, a video camera, cyber gloves and virtual

objects, scenes, and a large screen. The video camera system captures body images, and the subject is

then immersed inside a VR scene, interacting with virtual environments and objects. This system is

preferable to other current VR systems because it does not require a heavy head-mounted display,

data gloves, or other peripheral devices that connect to the computer. Subjects can move freely in

the real world while manipulating virtual objects in the 3D virtual world. For example, in this study, the

stepping up/down, sharkbait, and snowboard games were interfaced with virtual environments to increase the range of motion, balance, mobility, stepping, and ambulation skills. The VR tasks were

designed to stimulate the development of diverse balance, weight shifting, and stepping skills to improve the reacquisition of locomotor skills, with each game programmed to exercise one or multiple

aspects of trunk, pelvis, hip, knee, and ankle movement. This program progressed along with the

motor-relearning principles of specificity and hierarchy of balance and locomotion skills. As the patients’ ability to perform the exercise games increased, we gradually challenged them by either

increasing resistive force (i.e., adding weights) or speed of the stimulus. Initially, a high frequency

(!90%) of augmented knowledge of performance or knowledge of result feedback was gradually lessened as performance improved. Each game was practiced five times, and depending on a game,

within each game, there were three levels of 88–131 opportunities to perform the exercise. The intervention was given for 30 mins per day, 4 times per week for 4 wks.15 A detailed description of the VR intervention protocol is available in the Appendix.

CONTROL GROUP 1. The experimental and control groups underwent the same CPT, 40 mins a day, 4 days a week for 4 wks. The CPT program involves a patient specific neurofacilitation technique. The CPT protocol was designed to facilitate symmetrical static and dynamic standing balance function during walking in individuals with chronic hemiparetic stroke, as a part of regular neurorehabilitation

regimen. In brief, for static balance training, the patients were encouraged to shift their weight onto the paretic limb through verbal and tactile cues. For example, rhythmic stabilization and approximation exercises on the affected hip joint and musculature were provided to increase proximal joint stability during the static weight bearing task. A muscle-strengthening exercise for the gluteus medius muscle was also given to improve eccentric controlled mobility of pelvis during the stance phase of gait so as to prevent pelvic drop. Different heights of objects or platform surfaces for the nonparetic limb were used to increase weight shifting to the paretic limb to improve symmetrical weight bearing on the affected side. Treatment progression from static to dynamic balance occurred as the patients obtained the established goals: the ability to shift their weight in the AP and ML planes while performing functional reaching or picking up tasks. For dynamic balance training, the kinesthetic tactile inputs in relation to pelvic rotation and weight shifting were provided during the gait training.25

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## Kim et al. Clinical feasibility of interactive commercial nintendo gaming for chronic stroke rehabilitation. 2012.

TREATMENT GROUP 1. The 1 O patients in the experimental group played Nintendo Wii games (Nintendo lnc., Japan), while the 10 patients in the control group did not. A 30-inch TV set placed at the height of 60 cm from the ground was used and the motion sensor was mounted on the TV set. The distance between the sensor and the remote control was set at 1.5 meters. Because the patients had different physical characteristics, the distance between the remote control and the sensor was

adjusted for each individual prior to exercise. The subjects in the experimental group played the game by holding the Wii remote and Nunchuk controllers. Some participants who had diMculty in holding the controllers played the game with fabric grasp assistance or by strapping them to their hands with a thin bandage. All the games were performed with the players maintaining an upright posture. Tennis games were played by the patients with the remote control held in the hand on the normal side, and boxing games were played with the remote control held in the hand on the normal side and the Nunchuk controller in the hand ofthe paralyzed side. The game software used in this study was Wii Sports (Nintendo Inc., Japan). All the games provided by the software require motions in different directions and with differing acceleration. To control these differences, the games played were confined to certain games for consistency, The patients were informed of their game scores. Knowledge of scores motivated subjects in their task, encouraging greater effort to obtain higher scores, and active participation. The exercise was canied out 3 times per week for 3 weeks, a tota1 of g sessions. The term of each session was 30 minutes: 15 minutes of the tennis game and 15 minutes of the boxing game. Prior to their participation in the gaming exercise, all the subj ects in the experimental and control groups received general exercise for 30 minutes and electrical stimulation the tibialis anterior on affected side for 15 minutes.

CONTROL GROUP 1. The 10 patients in the experimental group played Nintendo Wii games (Nintendo lnc., Japan), while the 10 patients in the control group did not.

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## Kiper et al. The effectiveness of reinforced feedback in virtual environment in the first 12 months after stroke. NEUROLOGIA NEUROCHIRURGIA POLSKA. 2011.

TREATMENT GROUP 1: The RFVE training group consisted of 40 patients who underwent a TNR and the RFVE treatment (including 24 patients with ischaemic stroke and 16 patients with haemorrhagic stroke). Both treatments lasted 1 hour a day, five days weekly for four weeks. During the experiment, patients in the RFVE training group received 1 hour of TNR treatment and 1 hour of RFVE therapy. The TNR training group patients were treated totally for two hours daily by means of a TNR programme. At the beginning and at the end of the treatment, four weeks thereafter, the motor deficit and the functional activities of the upper extremity were assessed with the Fugl-Meyer scale for the upper extremity (F-M UE) [30].

TREATMENT GROUP 1: The TNR training group included 40 patients who were undergoing TNR training with further treatment dedicated to the upper extremity (including 24 patients with ischaemic stroke and 16 patients with haemorrhagic stroke). Both treatments lasted 1 hour a day, five days weekly for four weeks. During the experiment, patients in the RFVE training group received 1 hour of TNR treatment and 1 hour of RFVE therapy. The TNR training group patients were treated totally for two hours daily by means of a TNR programme. At the beginning and at the end of the treatment, four weeks thereafter, the motor deficit and the functional activities of the upper extremity were assessed with the Fugl-Meyer scale for the upper extremity (F-M UE) [30].

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## Kuys et al. Higher-intensity treadmill walking during rehabilitation after stroke in feasible and not detrimental to walking pattern or quality: A pilot randomized trial. 2011.

TREATMENT GROUP 1. The experimental group walked on the treadmill for 30 minutes (excluding rests), three times a week for six weeks, at an intensity of 40–60% heart rate reserve or a Borg Rating of Perceived Exertion19 of 11–14; the minimum required for training cardiorespiratory fitness.20 Target heart rates were calculated according to Karvonen method20 adjusting for beta-blockers for those taking heart rate lowering medication, as has been used previously in people with stroke.1,2 Participants commenced at an intensity level of 40% heart rate reserve for 30 minutes, progressing each week aiming for a 5–10% increase until 60% heart rate reserve was reached. For participants unable to reach 40% heart rate reserve on commencement of treadmill walking; treadmill speeds were set as fast as tolerated and progressed as quickly as possible. Heart rate was recorded via a portable heart rate monitor (Polar S610i). While on the treadmill, participants were encouraged to hold the handrail and a physiotherapist provided assistance as required to ensure foot clearance during swing phase. In addition, an assistant was available to operate the controls and assist with safety and the safety stop cord was attached to participants at all times. If participants were unable to walk for the entire 30 minutes, the actual intervention time was recorded. The experimental group also received usual physiotherapy intervention, comprising approximately one hour per day of comprehensive therapy1 using a task-oriented approach21 targeting impairments and activity limitations specific to each participant.

CONTROL GROUP 1. The control group received usual physiotherapy intervention only. Intervention for both groups was delivered by the physiotherapists who normally treated the participants, and they were encouraged to continue with their usual intervention, which could include treadmill walking. The higher-intensity treadmill walking was delivered by a study investigator in a physiotherapy treatment area of each participating hospital.

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## Kwakkel et al. Intensity of leg and arm training after primary middle-cerebral-artery stroke: A randomised trial. 1999.

CONTROL GROUP 1. Immobilization. The first group was scheduled for immobilisation of the paretic arm and leg by means of an inflatable pressure splint (Svend Andersen, Haarlev, Denmark); the splint was applied with the patient supine for 30 min on 5 days per week (control treat~nent). In addition, all three groups received 15 min per day leg rehabilitation, 15 min per day arm rehabilitation, and 1.5 h per week ADL training by an occupational therapist. Before randomisation, patients and family were informed that all interventions might improve outcome, but were kept naive with respect to the assumed efficacy of the experimental condition applied. After enrolment, which included the first assessment of outcome variables, restricted randomisation (permutated blocks of nine) was applied with random number tables for each participating hospital. Allocation was concealed by use of sealed envelopes. Nurses, speech therapists, and social workers provided usual care depending on patients’ needs without knowledge of treatment assignment. With the exception of preventive medication, no other medical interventions or therapies to improve skills were allowed during the first 20 weeks after stroke. From week 20 onwards, decisions about type of treatment and its intensity (average three times, 30 min per week) for each patient were made by the relevant stroke management team. We wrote a treatment protocol of evidence-based guidelines for stroke rehabilitation. The guidelines were based on patterns derived from findings reported in 165 intervention studies on stroke rehabilitation.’ They advocated an eclectic approach to neurofacilitation techniques. Arm rehabilitation included functional exercises that facilitated forced arm and hand activity such as leaning, punching a ball, grasping, and moving objects. The key elements in leg rehabilitation were sitting, standing, and weight-bearing exercises during standing and walking, with an emphasis on achieving stability and improving gait velocity. Treadmill training was promoted if equipment was available. If treatment at disability level was not possible, strengthening exercises for arms and legs were promoted. All participating therapists were instructed during a course on rehabilitation of arm and leg function. Amount of therapy, measured in 15 rnin time units of one-toone contact benveen therapist and patient, was documented in a diary after each treatment session. Content of therapy was reported daily with 25 different codes representing task-specific goals for the

arm and leg. In this way, adherence to therapy was assessed. Care of patients was coordinated by two physical therapists.

TREATMENT GROUP 1. The other groups were assigned arm or leg training, which was individually applied by local physical and occupational therapists, for 30 min on 5 days per week for 20 weeks after the stroke. In addition, all three groups received 15 min per day leg rehabilitation, 15 min per day arm rehabilitation, and 1.5 h per week ADL training by an occupational therapist. Before randomisation, patients and family were informed that all interventions might improve outcome, but were kept naive with respect to the assumed efficacy of the experimental condition applied. After enrolment, which included the first assessment of outcome variables, restricted randomisation (permutated blocks of nine) was applied with random number tables for each participating hospital. Allocation was concealed by use of sealed envelopes. Nurses, speech therapists, and social workers provided usual care depending on patients’ needs without knowledge of treatment assignment. With the exception of preventive medication, no other medical interventions or therapies to improve skills were allowed during the first 20 weeks after stroke. From week 20 onwards, decisions about type of treatment and its intensity (average three times, 30 min per week) for each patient were made by the relevant stroke management team. We wrote a treatment protocol of evidence-based guidelines for stroke rehabilitation. The guidelines were based on patterns derived from findings reported in 165 intervention studies on stroke rehabilitation.’ They advocated an eclectic approach to neurofacilitation techniques. Arm rehabilitation included functional exercises that facilitated forced arm and hand activity such as leaning, punching a ball, grasping, and moving objects. The key elements in leg rehabilitation were sitting, standing, and weight-bearing exercises during standing and walking, with an emphasis on achieving stability and improving gait velocity. Treadmill training was promoted if equipment was available. If treatment at disability level was not possible, strengthening exercises for arms and legs were promoted. All participating therapists were instructed during a course on rehabilitation of arm and leg function. Amount of therapy, measured in 15 rnin time units of one-toone contact benveen therapist and patient, was documented in a diary after each treatment session. Content of therapy was reported daily with 25 different codes representing task-specific goals for the

arm and leg. In this way, adherence to therapy was assessed. Care of patients was coordinated by two physical therapists.

TREATMENT GROUP 2. The other groups were assigned arm or leg training, which was individually applied by local physical and occupational therapists, for 30 min on 5 days per week for 20 weeks after the stroke. In addition, all three groups received 15 min per day leg rehabilitation, 15 min per day arm rehabilitation, and 1.5 h per week ADL training by an occupational therapist. Before randomisation, patients and family were informed that all interventions might improve outcome, but were kept naive with respect to the assumed efficacy of the experimental condition applied. After enrolment, which included the first assessment of outcome variables, restricted randomisation (permutated blocks of nine) was applied with random number tables for each participating hospital. Allocation was concealed by use of sealed envelopes. Nurses, speech therapists, and social workers provided usual care depending on patients’ needs without knowledge of treatment assignment. With the exception of preventive medication, no other medical interventions or therapies to improve skills were allowed during the first 20 weeks after stroke. From week 20 onwards, decisions about type of treatment and its intensity (average three times, 30 min per week) for each patient were made by the relevant stroke management team. We wrote a treatment protocol of evidence-based guidelines for stroke rehabilitation. The guidelines were based on patterns derived from findings reported in 165 intervention studies on stroke rehabilitation.’ They advocated an eclectic approach to neurofacilitation techniques. Arm rehabilitation included functional exercises that facilitated forced arm and hand activity such as leaning, punching a ball, grasping, and moving objects. The key elements in leg rehabilitation were sitting, standing, and weight-bearing exercises during standing and walking, with an emphasis on achieving stability and improving gait velocity. Treadmill training was promoted if equipment was available. If treatment at disability level was not possible, strengthening exercises for arms and legs were promoted. All participating therapists were instructed during a course on rehabilitation of arm and leg function. Amount of therapy, measured in 15 rnin time units of one-toone contact benveen therapist and patient, was documented in a diary after each treatment session. Content of therapy was reported daily with 25 different codes representing task-specific goals for the

arm and leg. In this way, adherence to therapy was assessed. Care of patients was coordinated by two physical therapists.

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## Kwon et al. Effects of virtual reality on upper extremity function and activities of daily living performance in acute stroke: A double-blind randomized clinical trial. NEUROREHABILITATION. 2012.

TREATMENT GROUP 1: The VR intervention was conducted using the IREX VR system. This VR system consists of a television monitor, a video camera, cyber gloves and virtual objects, and scenes displayed on a large back screen. The video camera system captures body images, and the subject then becomes immersed in the VR scene, interacting with virtual environments and objects. Because this system requires no connection wires between the computer and peripheral devices, subjects can move freely in the real world while manipulating virtual objects in the 3-D virtual world. In this study, five VR games that were deemed to induce reaching and lifting motor skills of the upper limb at various angles were

selected: Bird and Ball, Drum, Coconutz, Soccer and Conveyor games. Further information about IREX VR system can be obtained from the IREX VR manual [6]. VR was provided for 30 minutes per day, 5 days per week for 4 weeks in addition to CT.

CONTROL GROUP 1: Conventional therapy consisted of routine physical and occupational therapy such as gait training, balance training, table-top activities, strengthening exercise of upper limb, and ADL training. CT was provided for 70 minutes per day, 5 days per week for 4 weeks.

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## Langhammer et al. Bobath or motor relearning programme? A comparison of two different approaches of physiotherapy in stroke rehabilitation a randomized controlled study. CLIN REHABIL. 2000.

TREATMENT GROUP 1: The two physiotherapy programmes were standardized as follows; a manual describing the main philosophy behind the two physiotherapy methods was produced according to background literature.7,8 Workshops were organized with stroke patients not included in the study, and physiotherapists, in order to coordinate treatment according to the Bobath and MRP manuals.

These treatments were discussed among the physiotherapists and the project leader in order to coordinate and as far as possible identify treatment variables in a ‘Bobath respectively MRP manner’ and as described in the manuals true to the background literature. This procedure was continued throughout the project period, in order to keep the methods up to date. The patients included in the study were given physiotherapy five days weekly with a minimum of 40 minutes duration as long as they were hospitalized.1 Besides physiotherapy the patients received the same comprehensive, multidisciplinary treatment for stroke patients from doctors, nurses, occupational therapists and speech therapists according to recommendations for stroke units in Norway.9 After discharge, the patients received physiotherapy in their homes, at rehabilitation centres in the community or in private outpatient departments. The aim was that every patient should continue the same type of physiotherapy that he or she had received during the hospital stay. Thus, individual treatment programmes and instructions were sent from the physiotherapist in the hospital to the patient’s physiotherapist outside the hospital. All physiotherapists involved were invited to meetings in the hospital where the purpose of the study, design and methods were presented and discussed. There were also several informal meetings between the project leader and the local physiotherapists as a followup of these meetings. Some patients, however, did not receive any follow-up physiotherapy.

These patients were considered independent in daily life activities and had minor physical problems

at discharge. Patients with major physical problems who were totally dependent on personal care in their daily life activities after several weeks in hospital were transferred to nursing homes, and because of staff shortages few of these patients had further physiotherapy.

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## Langhammer et al. Stroke patients and long-term training: is it worthwhile? A randomized comparison of two different training strategies after rehabilitation. CLIN REHABIL. 2007.

TREATMENT GROUP 1: During the acute phase of rehabilitation at the hospital both groups received functional task-oriented training tailored to their specific needs. The amount of training was equal in the two groups, with two periods per day, the two periods comprising a total of 1 hour of physiotherapy in combination with other specialized therapies according to the patients’ needs. At discharge the patients were randomized into two separate groups, an intensive exercise group and a regular exercise group, as described above. The subsequent training for the intensive exercise group included a functional exercise programme with emphasis on high intensity of endurance, strength and

balance. The individualized training programmes were aimed at functional improvements but with variations, for example: getting up from a chair, walking indoors, Nordic walking outdoors, stationary bicycling, and stair walking, where the physiotherapist monitored the levels of intensity through Borg’s Scale or through the pulse rate. A protocol with suggestions of types of exercises and levels of intensity was developed in discussion with all physiotherapists involved. This protocol was intended as a guideline. The goal of these exercises was to improve and maintain motor function, activities of daily living and grip strength. Patients in the intensive exercise group were also encouraged to maintain a high activity level apart from that in the training sessions. In order to standardize the follow-up treatment and exercises given to the patients in the intensive exercise group, physiotherapists in the two communities to which the patients were transferred from the local hospital were contacted in advance of the study. A group of physiotherapists in the rehabilitation departments, homes for the elderly /community home services, and physiotherapists in private practices, agreed to receive the patients allocated to the intensive exercise group and treat them according to the training principles described in the protocol. Arrangements were made for patients allocated to the intensive exercise group to have physiotherapy during four periods, with a minimum of 20 hours every third month, in the first year after the stroke (see Figure 1). The intervention sessions started immediately after discharge, two or three times a week if the patient was at home or attending a private physiotherapy

practice, and daily if he or she was in a rehabilitation ward. This intervention was repeated after three

months, six months and one year. A simplified description of these exercises and of what was actually done in the intensive and regular exercise groups is given in Table 1a and b.

CONTROL GROUP 1: During the acute phase of rehabilitation at the hospital both groups received functional task-oriented training tailored to their specific needs. The amount of training was equal in the two groups, with two periods per day, the two periods comprising a total of 1 hour of physiotherapy in combination with other specialized therapies according to the patients’ needs. At discharge the patients were randomized into two separate groups, an intensive exercise group and a regular exercise group, as described above. If the patients in the regular exercise group were considered to be in need of follow-up treatment or rehabilitation they were assigned to that, but not on a regular basis. No specific treatment was recommended to this group. On the other hand, the same encouragement to maintain a high activity level besides the training, if any, was given to the regular exercise group. The regular exercise group patients were given follow-up treatment according to their needs, as considered by the rehabilitation staff at the stroke unit/rehabilitation department and by the rehabilitation team in the community after discharge. A simplified description of these exercises and of what was actually done in the intensive and regular exercise groups is given in Table 1a and b.

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## Langhammer et al. Exercise on a treadmill or walking outdoors? A randomized controlled trial comparing effectiveness of two walking exercise programmes late after stroke. 2010.

CONTROL GROUP 1. The group randomized to the treadmill exercises were supposed to do walking exercises for up to 30 minutes five days a week while they attended the private rehabilitation centre. The treadmill had hand railings to hold on to, otherwise there were no safety precautions or body support. The participants walked on the treadmill, and the exercises were carried out with the treadmill in a flat position. The speed was started on the lowest level and was increased within the first minutes to the working level. The working load was increased in cooperation with the participants to a level they felt comfortable with and they felt no insecurity in balance or discomfort otherwise. The group randomized to outdoor walking also exercised five days a week at a comfortable speed and with the use of ordinary assistive devices when necessary. The walk was performed regardless of weather conditions. The length of the walk was dependent on time rather than distance, and the intention was a 30-minute continuous walk. The other activities in the physiotherapy department were the same in the two groups. Each patient had a programme consisting of 30 minutes with individual therapy, with the main focus on balance, strength and coordination, 60 minutes of circle training, with the main focus on endurance, strength, flexibility and balance, and 30 minutes of group exercise training in a sitting position with a therapist. A group therapy session with the main focus on coping for patients with stroke was also offered. This group was led by a nurse. All participants were encouraged to do 30 minutes of exercise on their own every afternoon with an individually tailored programme. In addition, a relaxation group of 20 minutes was offered twice a week. The total amount of physiotherapy during a day was 3 hours with an additional 20 minutes relaxation and 30 minutes of education, giving a total of approximately 21 hours of therapy per week.

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## Lau et al. SPEED-DEPENDENT TREADMILL TRAINING IS EFFECTIVE TO IMPROVE GAIT AND BALANCE PERFORMANCE IN PATIENTS WITH SUB-ACUTE STROKE. J REHABIL MED. 2011.

TREATMENT GROUP 1: Subjects in both the experimental (SDT) and control groups received 30

minutes of locomotion training on a treadmill. Before the gait training, subjects were fitted with a harness for safety purposes; no body-weight support was given. The need to use the handrail for support was assessed before each session and minimal hand support was encouraged during training sessions. The initial belt speed of the treadmill was determined by the fastest over-ground gait speed obtained from the subject’s 10-m walk (10MW) test before each training session. For SDT training, subjects received short intervals of locomotion training with a treadmill. After walking for 30 s, the subjects had a 2-min rest. If they completed the first walking trial safely and without stumbling, the belt speed was increased by 10% on the next trial. However, if a subject failed to complete the first trial, the belt speed was decreased by 10% on the next trial. The speed of the treadmill was adjusted in each subsequent trial according to the same principle. In a single training session, subjects usually completed 7–8 walking trials in approximately 4 min. The belt speed was increased by a maximum of

5 increments within one training session.

CONTROL GROUP 1: Subjects in both the experimental (SDT) and control groups received 30

minutes of locomotion training on a treadmill. Subjects in the control group walked on the treadmill with the belt speed adjusted according to their fastest over-ground gait speed. There was no adjustment of the belt speed throughout the 30-min steady-speed treadmill training (SST) session. During both SDT and SST, close supervision was provided by a physiotherapist to monitor subjects’ cardiac condition, discomfort level, and musculoskeletal problems during training, and to prevent loss of balance. In addition to locomotion training on the treadmill, subjects in both groups also received 90 min of rehabilitation, which included motor relearning, neuro-development techniques, integrated sensory stimulation, and

conventional gait training.

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## Laufer et al. The effect of treadmill training on the ambulation of stroke survivors in the early stages of rehabilitation: a randomized study. JRRD. 2001.

CONTROL GROUP 1: During this interval groups continued to receive five daily physical therapy treatments per week. The treatmetns were based on the Bobath approach (16), and were provided by staff therapists who were blinded as to subjects’ group placement. Occupational therapy and speech therapy were administered according to individual needs. In addition to the routine treatment, all stroke survivors received five gait training sessions a week (total of 15 sessions), performed by other staff therapists. Gait training of the control group consisted of ambulating on floor surface at a comfortable speed using walking aids, assistance, and resting periods as needed.

TREATMENT GROUP 1: During this interval groups continued to receive five daily physical therapy treatments per week. The treatmetns were based on the Bobath approach (16), and were provided by staff therapists who were blinded as to subjects’ group placement. Occupational therapy and speech therapy were administered according to individual needs. In addition to the routine treatment, all stroke survivors received five gait training sessions a week (total of 15 sessions), performed by other staff therapists. Gait training of the control group consisted of ambulating on floor surface at a comfortable speed using walking aids, assistance, and resting periods as needed. Gait training of the experimental group consisted of ambulating on a motor driven treadmill (RTM3 Rehabilitation treadmill, Biodex Medical Systems), which was adjusted to the subject’s comfortable walking speed. Generally, during the treadmill training, the subjects held onto a horizontal bat at their side, and a therapist standing on the floor beside them provided assistance with hip flexion and foot placement as needed. However, with more limited or apprehensive subjects, treadmill training began with the treating therapist standing behind the subject on the treadmill, guarding the subject and providing manual assistance with hip flexion as needed. In most cases, after 2 or 3 sessions, the subjects were willing to stand alone on the treadmill and receive assistance from the therapist who stood on the floor alongside the subjects.

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## Laver et al. Use of an interactive video gaming program compared with conventional physiotherapy for hospitalised older adults: a feasibility trial. DISABIL & REHABIL. 2012.

TREATMENT GROUP 1: Participants in the Nintendo Wii Fit group participated in Wii Fit activities selected by the treating physiotherapist to match the patient’s individual abilities and treatment needs and included tasks that focussed on balance, strength or developing aerobic capacity. Interaction between the user and program occurs via a wireless pointer and balance board. Balance tasks involved weight shift on the balance board (e.g. in one activity the participant is represented on screen as a penguin and has to shift their weight laterally to balance on an iceberg and ‘catch fish’). Strength tasks involved exercises for the lower limb, such as sustained squats or single leg extension, and aerobic tasks included stepping on and off the balance board or walking on the spot. Physiotherapists were trained in using the Wii Fit program with older people and intervention was based on a protocol that outlined appropriate activities from the program and modifications of the activities for older people. Intervention was provided for 25 min/day, 5 days/ week for the duration of the participant’s stay on the unit and took place in an activity room on the unit. During the activity, participants were closely supervised by the physiotherapist and were able to use their walking frame or prop their arm

on a sturdy chair for safety if required and all activities were performed while standing. The same physiotherapists provided both interventions.

CONTROL GROUP 1: Participants in the conventional therapy group also participated in activities designed to match their abilities and treatment needs. The purpose of conventional physiotherapy

was to maximise functional mobility (walking and transfers) in order for the person to be discharged from the unit (preferably to their preadmission place of residence). Treatment sessions included walking, practise of transfers, walking up and down steps, balance tasks (such as standing on a foam block, tapping a balloon or reaching for objects) and strengthening, conditioning and flexibility exercises (e.g. use of light weights or stretches). As per the Wii Fit group, intervention was provided for 25 min/day, 5 days/ week for the duration of the participant’s stay. Treatment was provided in a gym located on the unit equipped with parallel bars, a treadmill and small equipment items, such as weights. The same physiotherapists provided both interventions.

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## Lee et al. Comparison of Effect of Aerobic Cycle Training and Progressive Resistance Training on Walking Ability After Stroke: A Randomized Sham Exercise–Controlled Study. JAGS. 2008

TREATMENT GROUP 1- cycling+PRT: Participants undertook 30 exercise sessions over 10 to 12 weeks. Depending on group allocation, individuals underwent aerobic cycling plus sham progressive resistance training (PRT) (n513), sham cycling plus PRT (n513), aerobic cycling plus PRT (n514), or sham cycling plus sham PRT (n512). Each intervention comprised thirty 60-minute supervised sessions conducted three times per week over 10 to 12 weeks, with makeup sessions allowed within this time frame. Subjects were asked not to start any other exercise regimen during the course of the study, but habitual activity levels were maintained. Participants undertook 30 minutes of leg cycling per session using a semi-recumbent motorized isokinetic cycle ergometer with calf supports (MOTOMed VIVA Cycle, Reek Medizintechnik GmBH, Betzenweiler, Germany). Pedaling cadence was set at 40 rev/min, and resistance was adjusted to elicit a target heart rate (HR) equivalent to 50% of peak oxygen uptake (VO2peak) in the initial 1 to 2 weeks; this was increased to 70% VO2peak by Week 4. The initial exercise prescription was based on the maximal effort cycling test performed at baseline assessment. The Borg Scale of Perceived Exertion19 was used to adjust the intensity to achieve an effort of hard to very hard. Participants were reassessed after 6 weeks on a maximal effort cycle test to adjust their training HR for the final 4 to 6 weeks. Participants wore an HR monitor during all exercise sessions, and HR and blood pressure were monitored before, every 5 minutes during, and 5 minutes after completion of training. participants undertook PRTof the lower limb extensors, knee extensors and flexors, and ankle plantarflexors using pneumatic resistance equipment (Keiser Sports Health Equipment, Inc.) except hip abductors and dorsiflexors, which used free weights and isometric training, respectively. Participants performed two sets of eight repetitions unilaterally, commencing at 50% of baseline 1 repetition maximum (1RM) and progressing to 80% 1RM by Week 2. The load was increased after each session to achieve theoretical gains of strength approximating 3% per session20 and adjusted using the Borg Scale of Perceived Exertion to achieve an effort of very hard. In addition, for

each exercise, the 1RM was assessed fortnightly for the purpose of represcribing the resistance dose.

CONTROL GROUP 1: Participants undertook 30 exercise sessions over 10 to 12 weeks. Depending on group allocation, individuals underwent aerobic cycling plus sham progressive resistance training (PRT) (n513), sham cycling plus PRT (n513), aerobic cycling plus PRT (n514), or sham cycling plus sham PRT (n512). Each intervention comprised thirty 60-minute supervised sessions conducted three times per week over 10 to 12 weeks, with makeup sessions allowed within this time frame. Subjects were asked not to start any other exercise regimen during the course of the study, but habitual activity levels were maintained. The initial exercise prescription was based on the maximal effort cycling test performed at baseline assessment. The Borg Scale of Perceived Exertion19 was used to adjust the intensity to achieve an effort of hard to very hard. Participants were reassessed after 6 weeks on a maximal effort cycle test to adjust their training HR for the final 4 to 6 weeks. Participants wore an HR monitor during all exercise sessions, and HR and blood pressure were monitored before, every 5 minutes during, and 5 minutes after completion of training. Participants commenced 30 minutes of sham aerobic exercise of motorized passive leg cycling whereby the motor JAGS JUNE 2008–VOL. 56, NO. 6 EFFECT OF EXERCISE ON WALKING FOLLOWING STROKE 977 rotated their legs in the same cycle ergometer as that used in the cycling group. In addition, the participants’ HR and blood pressure were monitored in a fashion identical to that of those who were undertaking the aerobic training. After sham cycling, participants undertook PRTof the lower limb extensors, knee extensors and flexors, and ankle plantarflexors using pneumatic resistance equipment (Keiser Sports Health Equipment, Inc.) except hip abductors and dorsiflexors, which used free weights and isometric training, respectively. Participants performed two sets of eight repetitions unilaterally, commencing at 50% of baseline 1 repetition maximum (1RM) and progressing to 80% 1RM by Week 2. The load was increased after each session to achieve theoretical gains of strength approximating 3% per session20 and adjusted using the Borg Scale of Perceived Exertion to achieve an effort of very hard. In addition, for each exercise, the 1RM was assessed fortnightly for the purpose of represcribing the resistance dose.

TREATMENT GROUP 2: Participants undertook 30 exercise sessions over 10 to 12 weeks. Depending on group allocation, individuals underwent aerobic cycling plus sham progressive resistance training (PRT) (n513), sham cycling plus PRT (n513), aerobic cycling plus PRT (n514), or sham cycling plus sham PRT (n512). Each intervention comprised thirty 60-minute supervised sessions conducted three times per week over 10 to 12 weeks, with makeup sessions allowed within this time frame. Subjects were asked not to start any other exercise regimen during the course of the study, but habitual activity levels were maintained. Participants undertook 30 minutes of leg cycling per session using a semi-recumbent motorized isokinetic cycle ergometer with calf supports (MOTOMed VIVA Cycle, Reek Medizintechnik GmBH, Betzenweiler, Germany). Pedaling cadence was set at 40 rev/min, and resistance was adjusted to elicit a target heart rate (HR) equivalent to 50% of peak oxygen uptake (VO2peak) in the initial 1 to 2 weeks; this was increased to 70% VO2peak by Week 4. The initial exercise prescription was based on the maximal effort cycling test performed at baseline assessment. The Borg Scale of Perceived Exertion19 was used to adjust the intensity to achieve an effort of hard to very hard. Participants were reassessed after 6 weeks on a maximal effort cycle test to adjust their training HR for the final 4 to 6 weeks. Participants wore an HR monitor during all exercise sessions, and HR and blood pressure were monitored before, every 5 minutes during, and 5 minutes after completion of training. After sham cycling, participants undertook PRTof the lower limb extensors, knee extensors and flexors, and ankle plantarflexors using pneumatic resistance equipment (Keiser Sports Health Equipment, Inc.) except hip abductors and dorsiflexors, which used free weights and isometric training, respectively. Participants performed two sets of eight repetitions unilaterally, commencing at 50% of baseline 1 repetition maximum (1RM) and progressing to 80% 1RM by Week 2. The load was increased after each session to achieve theoretical gains of strength approximating 3% per session20 and adjusted using the Borg Scale of Perceived Exertion to achieve an effort of very hard. In addition, for each exercise, the 1RM was assessed fortnightly for the purpose of represcribing the resistance dose.

TREATMENT GROUP 3: Participants undertook 30 exercise sessions over 10 to 12 weeks. Depending on group allocation, individuals underwent aerobic cycling plus sham progressive resistance training (PRT) (n513), sham cycling plus PRT (n513), aerobic cycling plus PRT (n514), or sham cycling plus sham PRT (n512). Each intervention comprised thirty 60-minute supervised sessions conducted three times per week over 10 to 12 weeks, with makeup sessions allowed within this time frame. Subjects were asked not to start any other exercise regimen during the course of the study, but habitual activity levels were maintained. The initial exercise prescription was based on the maximal effort cycling test performed at baseline assessment. The Borg Scale of Perceived Exertion19 was used to adjust the intensity to achieve an effort of hard to very hard. Participants were reassessed after 6 weeks on a maximal effort cycle test to adjust their training HR for the final 4 to 6 weeks. Participants wore an HR monitor during all exercise sessions, and HR and blood pressure were monitored before, every 5 minutes during, and 5 minutes after completion of training. Participants commenced 30 minutes of sham aerobic exercise of motorized passive leg cycling whereby the motor JAGS JUNE 2008–VOL. 56, NO. 6 EFFECT OF EXERCISE ON WALKING FOLLOWING STROKE 977 rotated their legs in the same cycle ergometer as that used in the cycling group. In addition, the participants’ HR and blood pressure were monitored in a fashion identical to that of those who were undertaking the aerobic training. After sham cycling, participants undertook PRTof the lower limb extensors, knee extensors and flexors, and ankle plantarflexors using pneumatic resistance equipment (Keiser Sports Health Equipment, Inc.) except hip abductors and dorsiflexors, which used free weights and isometric training, respectively. Participants performed two sets of eight repetitions unilaterally, commencing at 50% of baseline 1 repetition maximum (1RM) and progressing to 80% 1RM by Week 2. The load was increased after each session to achieve theoretical gains of strength approximating 3% per session20 and adjusted using the Borg Scale of Perceived Exertion to achieve an effort of very hard. In addition, for each exercise, the 1RM was assessed fortnightly for the purpose of represcribing the resistance dose.

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## Lee et al. The Mirror Therapy Program Enhances Upper-Limb Motor Recovery and Motor Function in Acute Stroke Patients. AJMPR. 2012.

CONTROL GROUP: Both the experimental group and the control group participated in a standard rehabilitation program, but only members of the experimental group additionally underwent MTP. Therapeutic intervention was given to the subjects for 4 wks after pretest, and posttest was conducted 1 day after the end of intervention. The experimental procedure is illustrated in Figure 1. Standard rehabilitation comprised therapeutic exercise, occupational therapy, and functional electrical stimulation, and all 26 subjects participated. Therapeutic exercise targeted lower-limb muscle strength and gait and was performed for 30 mins twice a day, five times a week, for 4 wks. For the first 30-min session of therapeutic exercise, Bobath Neuro Developmental Treatment was performed. Occupational therapy, an upper-limb training program for activities of daily living, was performed for 30 mins a day, five times a week, for 4 wks. Functional electrical stimulation was applied to both upper and lower limbs simultaneously for 15 mins a day, five times a week, for 4 wks. Outcome was determined using measures of upper-limb motor recovery and motor function. Upper-limb motor recovery was measured using the Fugl-Meyer Assessment (FMA) method and Brunnstrom stages. FMA was used to assess motor recovery of upper-limb items,20 which comprised 18 items dealing with shoulder/elbow/forearm, 5 items dealing with wrist, 7 items dealing with hand, and 3 items dealing with coordination. The maximum score of the FMA is 66. The interrater reliability of the upperlimb scale of the FMA was r = 0.99, and its test-retest reliability was r = 0.99.21 Brunnstrom stages qualitatively assess motor recovery of hemiplegic arms and hands after stoke. The Manual Function Test (Sakai Rehabilitation Instruments, Japan) was used to assess upper-limb motor function. This instrument is commonly used to measure upper-limb motor function and movement ability in stroke patients during the initial stage of rehabilitation

TREATMENT GROUP: Both the experimental group and the control group participated in a standard rehabilitation program, but only members of the experimental group additionally underwent MTP. Therapeutic intervention was given to the subjects for 4 wks after pretest, and posttest was conducted 1 day after the end of intervention. The experimental procedure is illustrated in Figure 1. Before intervention, we explained the objective, effects, and rules of mirror therapy based on the St. Gallen Protocol.13 With a patient in a sitting position on a stool, a mirror was positioned perpendicular to the patient’s midline. All jewelry was removed from arms, and the affected hand was put into a mirror box, whereas the unaffected hand was placed on the front of the reflective surface. The uninvolved limb of the subject is put in front of the mirror so that it can make a visual image by reflecting itself. By doing this, the patient visualizes illusioned limb instead of actual limb. The therapist told the patient to focus only on what is on the mirror. MTP was conducted for 25 mins twice a day, 5 days a week, for 4 wks. The movements fell into ten categories: observing the reflected hand, lifting both arms in front of the body with elbows extended, moving both arms from side to side with elbows extended, flexing and extending the elbows, pronation of the hand on a table, wrist extension, wrist internal/external flexion, clenching and opening the fist, right hand holding fingers of the left hand and vice versa, and tapping on the table. For the first 5 mins of the sessions, the subjects performed the ten movements to get used to the program and then repeated all ten movements 30 times for approximately 20 mins. Intervention was performed by the subjects themselves under supervision of a guardian, and performance was confirmed by an observer on the checklist attached behind the mirror box. The mirror box used had an acrylic mirror (30 cm \_ 30 cm \_ 3 mm) and blackboards. Velcro was used to control the inclination of the mirror surface. The box was designed to allow it to be folded and easily carried (Fig. 2AYB). Standard rehabilitation comprised therapeutic exercise, occupational therapy, and functional electrical stimulation, and all 26 subjects participated. Therapeutic exercise targeted lower-limb muscle strength and gait and was performed for 30 mins twice a day, five times a week, for 4 wks. For the first 30-min session of therapeutic exercise, Bobath Neuro Developmental Treatment was performed. Occupational therapy, an upper-limb training program for activities of daily living, was performed for 30 mins a day, five times a week, for 4 wks. Functional electrical stimulation was applied to both upper and lower limbs simultaneously for 15 mins a day, five times a week, for 4 wks. Outcome was determined using measures of upper-limb motor recovery and motor function. Upper-limb motor recovery was measured using the Fugl-Meyer Assessment (FMA) method and Brunnstrom stages. FMA was used to assess motor recovery of upper-limb items,20 which comprised 18 items dealing with shoulder/elbow/forearm, 5 items dealing with wrist, 7 items dealing with hand, and 3 items

dealing with coordination. Brunnstrom stages qualitatively assess motor recovery of hemiplegic arms and hands after stoke. The Manual Function Test (Sakai Rehabilitation Instruments, Japan) was used to assess upper-limb motor function. This instrument is commonly used to measure upper-limb motor function and movement ability in stroke patients during the initial stage of rehabilitation. Upper-limb

assessment comprised four assessment items for shoulders and four for hands. Affected shoulder functions were assessed in flexion, extension, abduction, and adduction, and hand function was assessed by assessing grasping, picking up, and pinching abilities. As for the finger manipulation items, patients moved cubes and performed a standardized method of counting pins.

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## Lin et al. Effects of modified constraint-induced movement therapy on reach-to-grasp movements and functional performance after chronics stroke: A randomized controlled study. 2007.

TREATMENT GROUP 1. The intervention was provided at three participating hospitals under the supervision of three separate occupational therapists. These three therapists were trained in the administration of the modified constraint-induced movement therapy protocol by the investigators and completed a written competency test before subject treatment. During the treatment period, structured daily treatment notes were made and reviewed by the investigators to ensure the standardization of treatment. During the three-week period, treatment for patients in the modified constraint-induced movement therapy group consisted of two main elements: (1) restriction of movement of the unaffected hand by placement in a mitt for 6 hours per day and (2) intensive training of the affected arm for 2 hours per weekday. Hours of mitten wearing per day were recorded by the patients and confirmed by the caregivers under the supervision

of the treating therapist. Typical practice activities were picking up marbles, flipping cards, stacking blocks, combing hair, writing and other activities similar to those performed in daily life. The level of challenge was adapted based on patient ability and improvement during the training.

CONTROL GROUP 1. The traditional rehabilitation was designed to control for the duration and intensity of patient–therapist interaction and therapeutic activities (5 days/week for 2 hours/day for three consecutive weeks). Therapy in the traditional rehabilitation group involved strength, balance, and fine motor dexterity training, functional task practice when possible, and stretching/weight bearing by the affected arm.

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## Lin et al. The Effects of Bilateral Arm Training on Motor Control and Functional Performance in Chronic Stroke: A Randomized Controlled Study. NNR. 2010.

CONTROL GROUP: CI (control treatment) for 2 hours on weekdays for 3 weeks. The intervention was provided at 3 participating hospitals under the supervision of 3 occupational therapists. With equivalent intensity and duration, participants in the control group also received the treatment program for 2 hours per day, 5 days a week, for 3 weeks. This group received standard occupational therapy treatment that also focused on UE training and included neurodevelopmental techniques, trunk–arm control (ie, practice UE tasks during standing), weight bearing by the affected arm, fine motor tasks practice, and practice on compensatory strategies for daily activities.

TREATMENT GROUP: They received either a BAT program concentrating on both

upper extremities moving simultaneously in functional tasks by symmetric patterns. For 2 hours on weekdays for 3 weeks. The intervention was provided at 3 participating hospitals under the supervision of 3 occupational therapists. The BAT group concentrated on both the affected and unaffected UEs moving simultaneously in functional tasks with symmetric patterns for 2 hours per day, 5 days a week, for 3 weeks. The subjects had one-on-one supervision as they practiced on a variety of functional were instructed to lift 2 cups, stack 2 checkers, pick up 2 small dried beans with a diameter of 0.5 to 1 cm, fold 2 towels, turn 2 large screws, manipulate 2 coins simultaneously by each hand, or use both hands to hold a sprinkler can to water plants.

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## Lincoln et al. Randomized, Controlled Trial to Evaluate Increased Intensity of Physiotherapy Treatment of Arm Function After Stroke. STROKE. 1999.

CONTROL GROUP: They were randomly allocated to routine physiotherapy, additional

treatment by a qualified physiotherapist, or additional treatment by a physiotherapy assistant. Outcome was assessed after 5 weeks of treatment and at 3 and 6 months after stroke on measures of arm function and of independence in activities of daily living. The routine-physiotherapy (RPT) group received standard physiotherapy as is given at the City Hospital. This therapy follows predominantly a Bobath approach, and most patients receive treatment each weekday for '30 to 45 minutes. RPT patients received no additional treatment by the research physiotherapist.

TREATMENT GROUP 1: They were randomly allocated to routine physiotherapy, additional

treatment by a qualified physiotherapist, or additional treatment by a physiotherapy assistant. Outcome was assessed after 5 weeks of treatment and at 3 and 6 months after stroke on measures of arm function and of independence in activities of daily living. The qualified-physiotherapist (QPT) group received standard physiotherapy and in addition were treated for '2 hours per week by a senior research physiotherapist. This additional treatment consisted of facilitation, specific neuromuscular techniques, and functional rehabilitation, broadly based on the Bobath approach. Patients were encouraged and taught to practice correct movements. When appropriate, instruction was given in motor and functional tasks to be practiced between therapy sessions. The treatment of QPT patients incorporated aspects that are usually administered only by an experienced therapist. These included ongoing assessment and specialized advice at each treatment session, specific facilitatory and

inhibitory techniques, and prescription of suitable self-practice activities. Patients in the QPT and APT groups received the same amount of additional treatment, ie, 10 hours in total; the difference between them was in the experience and training of the therapist. Patients were treated for 5 weeks. If they were discharged to home during these 5 weeks, treatment continued in the patient’s home or on an outpatient basis.

TREATMENT GROUP 2: They were randomly allocated to routine physiotherapy, additional

treatment by a qualified physiotherapist, or additional treatment by a physiotherapy assistant. Outcome was assessed after 5 weeks of treatment and at 3 and 6 months after stroke on measures of arm function and of independence in activities of daily living. activities. The assistant-physiotherapist (APT) group received standard physiotherapy but in addition were treated for '2 hours per week by a physiotherapy assistant. Depending on the patients’ impairments, this treatment consisted of instruction in correct positioning and care of the arm; passive, assisted, and active movements; and practice of functional activities. Patients in this group were initially assessed for '1 hour by the research physiotherapist. This therapist then super vised the assistant’s treatment of each patient weekly to update and adjust the treatment program appropriately. The training and assessment of the assistant have been described in detail elsewhere.26 In brief, the assistant received practical and theoretical teaching at the start of the study, equivalent to 31⁄2 full days of training and evaluation, as well as on-the-job training throughout the course of the study. The physiotherapist compiled a manual of treatment activities to be carried out by the assistant.44 Activities from this manual were selected to form the treatment program for APT patients. More detailed description of the treatment approach in both APT and RPT groups will be the subject of a future publication. Patients in the QPT and APT groups received the same amount of additional treatment, ie, 10 hours in total; the difference between them was in the experience and training of the therapist. Patients were treated for 5 weeks. If they were discharged to home during these 5 weeks, treatment continued in the patient’s home or on an outpatient basis.

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## Lo et al. Robot-Assisted Therapy for Long-Term Upper-Limb Impairment after Stroke. NEJM. 2010.

CONTROL GROUP: Therapy consisted of 36 1-hour sessions over a period of 12 weeks. The usual-care group received customary care available to all patients (i.e., medical management, clinic visits as needed, and in some cases rehabilitation services), which was not dictated by the protocol. Patients in the usual-care group were offered their choice of robot-assisted therapy or intensive comparison therapy after their final study visit.

TREATMENT GROUP1 (intensive Robot assisted therapy): Therapy consisted of 36 1-hour sessions over a period of 12 weeks. Robotassisted therapy was administered for a maximum of 36 sessions over a period of 12 weeks (up to 14 weeks to allow for missed sessions). The robotic system consisted of four modules: a shoulder–elbow unit for horizontal movements; an antigravity unit for vertical movements; a wrist unit for flexion–extension, abduction–adduction, and pronation–supination movements; and a grasphand unit for closing and opening movements. The 12 weeks of training consisted of four training blocks and were supervised by a therapist. In the first 3-week block, a planar shoulder-andelbow training robotic device was used. In the second 3-week block, an antigravity shoulder and grasp-hand device was used. In the third 3-week block, the wrist robot was used. In the final block, all three devices were used to integrate proximal (shoulder) to distal (wrist and hand) training (see video). Modules were used separately and in combination to perform high-intensity, repetitive, task oriented

movements (1024 per session on average), directed by video screens. Training targeted isolated proximal, distal, and integrated movements of the upper limb. The robot provided assistance if patients were unable to initiate or complete a movement independently.

TREATMENT GROUP2 (intensive usual care): Therapy consisted of 36 1-hour sessions over a period of 12 weeks. Intensive comparison therapy consisted of a structured protocol using conventional rehabilitative techniques, such as assisted stretching, shoulder-stabilization activities, arm exercises, and functional reaching tasks. This therapy matched robot-assisted therapy in schedule and in the form and intensity of movements.4,6 The same research personnel delivered both robot-assisted therapy.

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## Logan et al. A randomized controlled trial of enhanced Social Service occupational therapy for stroke patients. CR. 1997.

CONTROL GROUP: For patients in both groups the first date they were seen after referral the number and time of treatment sessions provided, the equipment and adaptations provided and the date of discharge from therapy were recorded. Patient-related activity was also monitored; this included telephone calls, letters written, forms completed.

TREAMTMENT GROUP: The enhanced service group were seen and treated by a single research occupational therapist (PAL). It was expected that the case load would be such that she could see patients sooner than possible by the routine service. She had equal access to aids and budgets for adaptations and she was able to check that equipment provided was appropriate. In the routine service all patients were prioritized by the senior occupational therapist and only the urgent cases were seen immediately whereas others were placed on a waiting list. For patients in both groups the first date they were seen after referral the number and time of treatment sessions provided, the equipment and adaptations provided and the date of discharge from therapy were recorded. Patient-related activity was also monitored; this included telephone calls, letters written, forms completed.

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## Luft et al. Treadmill exercise activates subcortical neural networks and improves walking after stroke: A randomized controlled trial. 2008.

TREATMENT GROUP 1. The T-EX training goal was three 40-minute exercise sessions per week at an aerobic intensity of 60% of heart rate reserve. Duration and intensity started low (10 to 20 minutes, 40% to 50% heart rate reserve) and increased approximately 5 minutes and 5% heart rate reserve every 2 weeks as tolerated. To reach intensity targets, treadmill velocity and incline were increased by 0.05 m/s and 1% increments, respectively.

CONTROL GROUP 1. Subjects randomized to CON performed 13 supervised traditional stretching movements on a raised mat table with a therapist’s assistance as previously described.7 Each movement was performed actively if possible or passively with a therapist’s assistance. Movements included quadriceps, calf, hip and hamstring stretch, low back rotation and stretch, chest stretch, bridging, shoulder shrug, abduction, and flexion, heel slides and short arc of quadriceps. The duration of each CON session and the number of sessions were equal to the T-EX sessions.

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## Lum et al. Robot-Assisted Movement Training Compared With Conventional Therapy Techniques for the Rehabilitation of Upper-Limb Motor Function After Stroke. APMR. 2002.

CONTROL GROUP: Over a 2-month period, both groups received twenty four 1-hour treatment sessions held in the same treatment area and supervised by a single occupational therapist. Thus the 2 groups received equal intensity and duration of treatment. In each treatment session, robot group subjects received 50 minutes of robot-assisted movement, whereas control group subjects received 50 minutes of conventional treatment that targeted proximal upper-limb function that was based on neurodevelopmental therapy24 (NDT). All subjects received 5 minutes of tone normalization and limb positioning at the beginning and end of each session. Subjects were not informed of the explicit goals of the clinical trial, only that the effectiveness of 2 treatments was being tested. A typical control group session involved approximately 10 minutes of establishing a physical postural base of support coupled with assessing and facilitating the alignment of the shoulder. Approximately 35 minutes were devoted to graded application of the arm’s use in functional leisure and self-care tasks. Emphasis was placed on the reeducation of muscles using a sensorimotor approach to control motor output. Subjects needed to show ability to independently perform basic mass functional movements before progressing to more isolated advanced functional patterns. Progression within each movement was facilitated by increasing the number of repetitions, weight of item being handled, height at which tasks were done, and so on. The last 10 minutes were used for practice of the highest level task that was completed, with review, and additional assessment of the shoulder. Control subjects received exposure to the robot for 5 minutes within each session. The robot provided a moving target and subjects attempted to track the target with their hand or to stack cones on topof the robot end effector as it moved. Therapy was provided by an NDT-certified therapist with 9 years of experience in treating neurologically injured patients. Consultations regarding the subjects were held with another equally experienced therapist as needed.

TREATMENT GROUP: Over a 2-month period, both groups received twenty four 1-hour treatment sessions held in the same treatment area and supervised by a single occupational therapist. Thus the 2 groups received equal intensity and duration of treatment. In each treatment session, robot group subjects received 50 minutes of robot-assisted movement, whereas control group subjects received 50 minutes of conventional treatment that targeted proximal upper-limb function that was based on neurodevelopmental therapy24 (NDT). All subjects received 5 minutes of tone normalization and limb positioning at the beginning and end of each session. Subjects were not informed of the explicit goals of the clinical trial, only that the effectiveness of 2 treatments was being tested. In the robot group, emphasis was placed on targeted reaching movements that started close to the body and ended further away. Therefore, elbow extension was a component of all of these movements. Four point-to-point reaching directions were trained: forward medial (shoulder flexion, adduction), directly forward (shoulder flexion), forward lateral (shoulder flexion, abduction, external rotation), and directly lateral (abduction, external rotation). For each of these 4 directions, targets could be located at tabletop, shoulder, or eye level. These 12 targeted reaching movements formed a core set of movements. Subjects practiced some or all of these movements in each session (the eye level movements were usually only used for mildly impaired subjects). Each movement progressed from the easiest exercise modes (passive and bimanual) to the most challenging (active constrained). During active-constrained movements, feedback of the fraction of the movement completed or the time to complete 3 repetitions was used to track and motivate performance. Time permitting, tracing of circles and polygons and isolated elbow extension movements were practiced, all assisted by the robot. Movements were kept well within each subject’s passive ROM. All subjects spent approximately 12 minutes in bimanual mode and 5 minutes in passive mode. A total of 20 minutes were spent in the active-assisted and active-constrained modes, with the ratio varying depending on the level of the subject. Lower-level subjects spent as much as 7 to 8 minutes in active-assisted mode, while higher-level subjects skipped directly to active-constrained mode.

# M Authors

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## Macko et al. Treadmill Exercise Rehabilitation Improves Ambulatory Function and Cardiovascular Fitness in Patients With Chronic Stroke : A Randomized, Controlled Trial. .S. 2005.

TREATMENT GROUP: T-AEX training target was 3 40-minute sessions per week at target aerobic intensity of 60% to 70% heart rate reserve (HRR).12,18 Training started at low intensity (40% to 50% HRR) for 10 to 20 minutes and increased approximately 5 minutes every 2 weeks as tolerated. Aerobic intensity was similarly progressed by 5% HRR every 2 weeks.

CONTROL GROUP: R CONTROL provided matched duration exposure to staff implementing common components of conventional therapy. Subjects performed 13 supervised stretching movements lasting 35 minutes2 and 5-minute low-intensity treadmill walking at 30 to 40% HRR, approximating the aerobic stimulus of conventional rehabilitation.23 Hence, both groups were scheduled to receive 72 training sessions, equaling 48 hours of training across 6 months.

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## Masiero et al. Robotic-Assisted Rehabilitation of the Upper Limb After Acute Stroke. AMPR. 2007.

CONTROL GROUP: Patients of both groups received the same dose and length per day of standard poststroke multidisciplinary rehabilitation. Patients were randomly assigned to 2 groups. The control group (n\_18) was exposed to the robotic device, 30 minutes a week, twice a week, but the exercises were performed with the unimpaired upper limb. The patients of both groups admitted to the trial received the same dose and length per day of standard rehabilitative treatment (based on the Bobath concept) and poststroke occupational therapy by the same blinded interdisciplinary clinical team. The control group received similar initial exposure to the robot (30min/wk twice) except that the exercises were performed with the unimpaired upper limb. The same therapist supervised the NeReBot training for all the patients; a different therapist performed standard rehabilitation. At the start of each session, the trained researcher (therapist) sought to identify the optimal path and rest positions for each patient in the robot plane, related to individual stage of recovery, in order to fully exploit the patient’s residual motor skills and provide spatial stimulation. A trained research assistant provided a standardized set of instructions and was always in attendance to indicate positions and useful trajectories of movement for the upper limb and, if necessary, to intervene in emergency situations. The robot assisted and guided the patient’s forearm and hand through a repetitive pattern set by the rehabilitation team based on degree of patient impairment. All treatment sessions consisted of a sequence of motor tasks followed by a short resting phase. Patients performed 5 to 7 exercise cycles lasting 3 minutes each, followed by a 1-minute resting period (total time for each session, \_20\_30min). Patients underwent robot training treatment twice a day, 5 days a week, for at least 5 weeks. The exercise protocols focused on shoulder and elbow movement patterns and included alternative flexion and extension and pronation and supination and adduction and abduction movements (\_20 repetitions per cycle). The movements were performed slowly to avoid abnormal muscle activity that might cause pain or injury of the paretic muscle. The forearm together with the wrist and hand were placed in a neutral position in the orthosis. At the start of each therapy session the clinician examined arm impairment to investigate motor function recovery and pain or other complications. Before directing each movement during therapy, the patient was instructed to remain passive while the robot moved the limb in the programmed trajectory. The patient was then instructed to voluntarily (actively) contribute to movement by pushing or pulling according to the goals’ movements. During the robot therapy session, a trained research assistant verbally encouraged the patient to increase effort. In the first week the patient was usually supine (in bed) and the daily exercises included passive repetitions along simple trajectories (eg, arm elevation). Subsequently the patient sat on a chair or in a wheelchair fitted with seat belts to limit torso movements and prevent falling. The exercise package with the impaired limb was more complex at this stage (eg, it included circular motion). Motion speed was also increased according to patient improvements. Treatment was completed in the same rehabilitation center for all recruited subjects during hospitalization and no patient underwent rehabilitative treatment elsewhere during follow-up.

TREATMENT GROUP: Patients of both groups received the same dose and length per day of standard poststroke multidisciplinary rehabilitation. Patients were randomly assigned to 2 groups. The experimental group (n\_17) received additional early sensorimotor robotic training, 4 hours a week for 5 weeks. The patients of both groups admitted to the trial received the same dose and length per day of standard rehabilitative treatment (based on the Bobath concept) and poststroke occupational therapy by the same blinded interdisciplinary clinical team. The 17 experimental group patients received additional early sensorimotor robotic training by NeReBot, in 25 daily sessions (starting \_1wk poststroke) divided into 2 sessions a day, 4 hours a week for 5 weeks. The same therapist supervised the NeReBot training for all the patients; a different therapist performed standard rehabilitation. At the start of each session, the trained researcher (therapist) sought to identify the optimal path and rest positions for each patient in the robot plane, related to individual stage of recovery, in order to fully exploit the patient’s residual motor skills and provide spatial stimulation. A trained research assistant provided a standardized set of instructions and was always in attendance to indicate positions and useful trajectories of movement for the upper limb and, if necessary, to intervene in emergency situations. The robot assisted and guided the patient’s forearm and hand through a repetitive pattern set by the rehabilitation team based on degree of patient impairment. All treatment sessions consisted of a sequence of motor tasks followed by a short resting phase. Patients performed 5 to 7 exercise cycles lasting 3 minutes each, followed by a 1-minute resting period (total time for each session, \_20\_30min). Patients underwent robot training treatment twice a day, 5 days a week, for at least 5 weeks. The exercise protocols focused on shoulder and elbow movement patterns and included alternative flexion and extension and pronation and supination and adduction and abduction movements (\_20 repetitions per cycle). The movements were performed slowly to avoid abnormal muscle activity that might cause pain or injury of the paretic muscle. The forearm together with the wrist and hand were placed in a neutral position in the orthosis. At the start of each therapy session the clinician examined arm impairment to investigate motor function recovery and pain or other complications. Before directing each movement during therapy, the patient was instructed to remain passive while the robot moved the limb in the programmed trajectory. The patient was then instructed to voluntarily (actively) contribute to movement by pushing or pulling according to the goals’ movements. During the robot therapy session, a trained research assistant verbally encouraged the patient to increase effort. In the first week the patient was usually supine (in bed) and the daily exercises included passive repetitions along simple trajectories (eg, arm elevation). Subsequently the patient sat on a chair or in a wheelchair fitted with seat belts to limit torso movements and prevent falling. The exercise package with the impaired limb was more complex at this stage (eg, it included circular motion). Motion speed was also increased according to patient improvements. Treatment was completed in the same rehabilitation center for all recruited subjects during hospitalization and no patient underwent rehabilitative treatment elsewhere during follow-up.

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## Masiero et al. Randomized Trial of a Robotic Assistive Device for the Upper Extremity During Early Inpatient Stroke Rehabilitation. NNR. 2014.

CONTROL GROUP: All participants received a total daily rehabilitation

treatment for 120 minutes, 5 days per week for 5 weeks. The control group received standard therapy for the upper limb. patients of both groups received an equal dose of rehabilitation treatment. the control group (CG) received only conventional treatment (for 100% of exercise time). Patients of both groups received a total daily rehabilitation treatment time of 120 minutes, for 5 days a week and for 5 weeks (in total, 3000 minutes per subject). CG patients performed conventional functional rehabilitation 80 minutes a day (partly based on the Bobath technique and including proprioceptive exercises, functional reeducation, gait training, occupational therapy, and passive and active assisted mobilization of the hand and wrist, but without specifically exercising the upper paretic arm), whereas the upper paretic arm was actively exercised for 40 more minutes with the assistance of a therapist. Treatment was delivered in an exercise room in the same rehabilitation center for all the subjects during hospitalization.

TREATMENT GROUP: All participants received a total daily rehabilitation treatment for 120 minutes, 5 days per week for 5 weeks. The experimental group received standard therapy (65% of exercise time) associated with robotic training (35% of exercise time). patients of both groups received an equal dose of rehabilitation treatment. The EG received conventional therapy (for 65% of exercise time) and substitutive robotic treatment (for 35% of exercise time). Patients of both groups received a total daily rehabilitation treatment time of 120 minutes, for 5 days a week and for 5 weeks (in total, 3000 minutes per subject). For the EG, conventional treatment of the upper paretic arm was substituted by NeReBot training for 40 minutes a day (divided into two 20-minute sessions). NeReBot is a 3-degrees-of-freedom robotic device for upper extremities that can be easily used in the acute and post– acute stroke phase thanks to its portability and to the possibility of being used at bedside.29,30,33 The robot is based on directdrive wire actuation: 3 actuated nylon cables are used to sustain and move the patient’s forearm, which is fastened on a splint (Figure 2). In this way, a traditional rehabilitation therapy of the upper limb is simulated with imperceptible differences in patient’s sensorimotor experience. NeReBot allows to train the patient on 3-dimensional movements of the arm (flexion and extension, pronation and supination, adduction and abduction, circumduction), not only while sitting but also in the supine position (Figure 2). In this study, NeReBot training was administered under the supervision of a physiotherapist, who defined the exercises (flexion and extension, adduction and abduction, pronation and supination, circumduction) according to the protocol, adapted robot parameters to the patient’s progress and, in agreement with the rehabilitation team, defined the treatment schedule weekly. Each robotic session lasted 20 minutes, and consisted of robotic training interrupted by a 30- to 60-second resting period every 3 to 4 minutes. Patients actively contributed to exercises in all sessions, and were verbally encouraged by the therapist to do so.33 The same therapist supervised the NeReBot training for all EG patients, whereas a different therapist delivered standard rehabilitation to all patients. Treatment was delivered in an exercise room in the same rehabilitation center for all the subjects during hospitalization.

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## McClellan et al. A six-week, resource-efficient mobility program after discharge from rehabilitation improves standing in people affected by stroke: Placebo-controlled, randomised trial. AJS. 2004.

CONTROL GROUP: The control group participated in a six-week, home-based program of upper-limb exercises (i.e. ‘sham’ mobility exercises). The exercises prescribed for the *control* group were aimed at improving the function of the affected upper limb (Carr and Shepherd 1987). As with the experimental group, intervention was standardised by prescribing the first five exercises that the subject could not perform successfully from a list of 39 predetermined exercises that were arranged loosely hierarchically. Exercises were initially prescribed that involved only the movement of one joint such as elbow extension and were progressed until subjects were performing complex tasks such as shuffling a deck of cards. Each subject attended local physiotherapy outpatient department for the initial prescription of exercises by one of the investigators (RM). The exercises were recorded on videotape to reinforce correct and therefore effective practice. The videotape recording consisted of each exercise being demonstrated by the therapist, followed by three attempts by the subject with feedback from the therapist. Strategies to enhance safety such as modification of the environment (e.g. performing exercises next to a wall) and assistance from carers (e.g. standing on the affected side) were also included in the recording. Subjects in each group were instructed to practise each exercise twice a day in front of the videotape. They were telephoned at the end of Week 1 to encourage compliance, and returned to their local physiotherapy outpatient department to have their exercises reviewed and progressed at Weeks 2 and 4. Subjects were required to keep a record of practice during the six weeks of intervention.

TREATMENT GROUP: The experimental group participated in a six-week, home-based mobility program. The exercises prescribed for the *experimental* group were aimed at improving mobility in standing andwalking (Carr and Shepherd 1987, Berg et al 1989).Intervention was standardised by prescribing the first fiveexercises that the subject could not perform successfully froma list of 23 predetermined exercises. The exercises werearranged loosely hierarchically, based on their challenge tobalance. Initially exercises were prescribed that involvedstanding with a wide base of support with little perturbation.Exercises were progressed by systematically decreasing thebase of support and increasing the perturbations until subjectswere performing exercises such as stepping backwards onand off a step. . Each subject attended local physiotherapy outpatient department for the initial prescription of exercises by one of the investigators (RM). The exercises were recorded on videotape to reinforce correct and therefore effective practice. The videotape recording consisted of each exercise being demonstrated by the therapist, followed by three attempts by the subject with feedback from the therapist. Strategies to enhance safety such as modification of the environment (e.g. performing exercises next to a wall) and assistance from carers (e.g. standing on the affected side) were also included in the recording. Subjects in each group were instructed to practise each exercise twice a day in front of the videotape. They were telephoned at the end of Week 1 to encourage compliance, and returned to their local physiotherapy outpatient department to have their exercises reviewed and progressed at Weeks 2 and 4. Subjects were required to keep a record of practice during the six weeks of intervention.

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## Michielsen et al. Motor Recovery and Cortical Reorganization After Mirror Therapy in Chronic Stroke Patients : A Phase II Randomized Controlled Trial. NNR. 2011.

CONTROL GROUP: All patients participated in a 6-week training program. Both mirror and control groups performed bimanual exercises, with the difficulty of the exercises depending on the patients’individual levels of functioning. Exercises were not only based on the Brunnstrom phases of motor recovery but also consisted of functional exercises such as moving objects. The control group had a direct view of both hands. Patients practiced at the rehabilitation center once a week under the supervision of a physiotherapist and were instructed to practice 5 times a week, 1 hour per day, at home. Home practice materials consisted of an instruction booklet with photographs and a digital video disk with film fragments of the exercises to be performed. Regular telephone calls were made by the physiotherapist to assure that patients complied with their exercise regimens. Furthermore, patients were instructed to keep detailed accounts of their practice schedules and experiences. These diaries were inspected by the physiotherapist during each training session in the rehabilitation center.

TREATMENT GROUP: All patients participated in a 6-week training program. Both mirror and control groups performed bimanual exercises, with the difficulty of the exercises depending on the patients individual levels of functioning. Exercises were not only based on the Brunnstrom phases of motor recovery but also consisted of functional exercises such as moving objects. the mirror group practiced with the affected hand positioned behind the mirror while they looked at the reflection of the unaffected hand in the mirror. To ensure that patients focused at the mirror reflection of their unaffected hand instead of their moving unaffected hand itself, a cover was placed over their unaffected hand (Figure 1). Patients practiced at the rehabilitation center once a week under the supervision of a physiotherapist and were instructed to practice 5 times a week, 1 hour per day, at home. Home practice materials consisted of an instruction booklet with photographs and a digital video disk with film fragments of the exercises to be performed. Regular telephone calls were made by the physiotherapist to assure that patients complied with their exercise regimens. Furthermore, patients were instructed to keep detailed accounts of their practice schedules and experiences. These diaries were inspected by the physiotherapist during each training session in the rehabilitation center.

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## Mirelman et al. Effects of Training With a Robot-Virtual Reality System Compared With a Robot Alone on the Gait of Individuals After Stroke. STROKE. 2009.

CONTROL GROUP: Subjects trained on the Rutgers Ankle Rehabilitation System, a 6-degree of freedom Stewart platform force-feedback system that allows individuals to exercise the lower extremity by navigating through a virtual environment that is displayed on a desktop computer. The development and testing of the device was reported elsewhere.17,22,23 Training was performed 3 times per week for 4 weeks for \_1 hour each visit. Subjects trained in a seated position facing a computer monitor. The lower extremity was positioned with 90 deg of hip and knee flexion (Figure 1). Subjects moved the ankle into dorsiflexion, plantar flexion, inversion, eversion, and a combination of these movements. Force, speed, and excursion baseline performance were measured by the robot at the beginning of each session and were used as a reference for the exercise protocol. Exercises performed by each group were comparable and consisted of warm-up, endurance, speed, strengthening and coordination exercises, and emphasized the direction of movement and timing of segmental motion. Training intensity and progression of the protocol, designed based on previous studies17,19,24 were adjusted for individual subjects based on their observed performance (relative to accuracy) and reported fatigue. The same physical therapist assisted the training of both groups.

TREATMENT GROUP: Subjects trained on the Rutgers Ankle Rehabilitation System, a 6-degree of freedom Stewart platform force-feedback system that allows individuals to exercise the lower extremity by navigating through a virtual environment that is displayed on a desktop computer. The development and testing of the device was reported elsewhere.17,22,23 Training was performed 3 times per week for 4 weeks for \_1 hour each visit. Subjects trained in a seated position facing a computer monitor. The lower extremity was positioned with 90 deg of hip and knee flexion (Figure 1). Subjects moved the ankle into dorsiflexion, plantar flexion, inversion, eversion, and a combination of these movements. Force, speed, and excursion baseline performance were measured by the robot at the beginning of each session and were used as a reference for the exercise protocol. Exercises performed by each group were comparable and consisted of warm-up, endurance, speed, strengthening and coordination exercises, and emphasized the direction of movement and timing of segmental motion. Training intensity and progression of the protocol, designed based on previous studies17,19,24 were adjusted for individual subjects based on their observed performance (relative to accuracy) and reported fatigue. The same physical therapist assisted the training of both groups. Subjects in the robot VR group executed the exercises by using the foot movements to navigate a plane or a boat through a virtual environment that contained a series of targets. The position and timing of the targets were manipulated to insure training included discrete and combined ankle movements. Subjects who trained with the robot device alone received the same exercises as the robot VR group but without the virtual environment. The computer screen was occluded to block visual and auditory feedback. High-level haptic feedback synchronized with the simulation was turned off; however, low-level force feedback was provided by the robot.22 Subjects in the robot alone group were instructed by a therapist on what direction to move their foot and were paced by a metronome cueing them to complete a comparable number of repetitions with the robot VR group.

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## Moore et al. 2010. Locomotor Training Improves Daily Stepping Activity and Gait Efficiency in Individuals Poststroke Who Have Reached a ''Plateau'' in Recovery. STROKE. 2010.

CONTROL GROUP: The delayed LT group was also assessed 4 weeks before and after termination from clinical PT (A1 and A2), but did not receive LT or any other interventions for 4 weeks after termination of clinical PT (ie, delay period). After this 4 week delay, subjects were reassessed before (A3) and after (A4) 4 weeks of intensive LT as described above. The study design is illustrated in Figure 1.

TREATMENT GROUP: The immediate LT group was provided 4 weeks of intensive LT after discharge from clinical PT, which consisted of high intensity stepping practice on a motorized treadmill while wearing an overhead harness attached to a safety system. LT was performed at the same frequency as PT (2 to 5 days/wk) at the highest tolerable speed,6,7 with velocity increased in 0.5-kmph increments until subjects’ heart rate reached 80% to 85% of age-predicted maximum or until the subjects’ Rating of Perceived Exertion increased to 17 on the Borg scale.17 Up to 40% partial body weight support using a counterweight system attached to the safety harness was provided for those subjects who walked \_0.2 m/s overground,6 and was reduced in 10% increments as tolerated. Subjects held onto the handrail for balance only, and therapists did not provide manual assistance to improve intralimb kinematics, but rather focused on increasing intensity and amount of stepping practice as tolerated. After completion of LT, subjects were reassessed (assessment 3: A3), and again after a delay of 4 weeks after completion of LT (assessment 4: A4).

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## Moreland et al. Progressive Resistance Strengthening Exercises After Stroke: A Single-Blind Randomized Controlled Trial. APMR. 2003.

CONTROL GROUP: Both groups received conventional physical therapy programs. In addition, the experimental group performed 9 lower-extremity progressive resistance exercises 3 times a week for the duration of their stay, whereas the control group did the same exercises and for the same duration but without resistance. The control group exercises were the same as for the experimental group (see appendix 1), including the frequency and number of repetitions, except that no external resistance was applied with weights. All exercises by both groups were documented. Verbal and manual guidance was given if needed to correct the quality of movement. Any muscle soreness from a previous session was documented, and the patient did not resume exercising until the soreness had abated. The stroke programs provided multidisciplinary treatment. All patients received conventional physical therapy: techniques to facilitate and inhibit impaired movements, balance retraining, motor control exercises, stroke mat classes, gait training, and gross motor skills training. Two centers used a predominantly neurodevelopmental therapy approach, and the others used an eclectic approach. Therapists were instructed not to use weights or other resistance equipment during conventional therapy.

TREATMENT GROUP: Both groups received conventional physical therapy programs. In addition, the experimental group performed 9 lower-extremity progressive resistance exercises 3 times a week for the duration of their stay, whereas the control group did the same exercises and for the same duration but without resistance. Progressive resistance exercises were performed with weights at the waist or on the lower extremities. Given the specificity of strength training,32 the exercises were designed to be performed in functional patterns of movements, with the exception of the ankle exercises. We used an ankle exerciser to which variable weights could be applied in each direction of movement with the patient sitting. Thirty-minute exercise sessions took place 3 times a week and were supervised by kinesiologists and therapy assistants. The treatment group exercise program details are given in appendix 1. All exercises by both groups were documented. Verbal and manual guidance was given if needed to correct the quality of movement. Any muscle soreness from a previous session was documented, and the patient did not resume exercising until the soreness had abated. The stroke programs provided multidisciplinary treatment. All patients received conventional physical therapy: techniques to facilitate and inhibit impaired movements, balance retraining, motor control exercises, stroke mat classes, gait training, and gross motor skills training. Two centers used a predominantly neurodevelopmental therapy approach, and the others used an eclectic approach. Therapists were instructed not to use weights or other resistance equipment during conventional therapy.

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## Morone et al. Who May Benefit From Robotic-Assisted Gait Training? : A Randomized Clinical Trial in Patients With Subacute Stroke. NNR. 2011.

CONTROL GROUP 1: All patients underwent 2 therapy sessions per day, 5 days per week for 3 months. the CG received only conventional gait training. After 1 week of admission, the CG patients performed 2 daily physiotherapy sessions. One of them was dedicated to walking training, consisting of 20 sessions of 40-minute therapy (5 times per week),25 instead of a second session of standard physiotherapy. In light of the patient’s ability, the walking therapy was focused on trunk stabilization, weight transfer to the paretic leg, and walking between parallel bars or on the ground. If necessary, the patient was helped by 1 or 2 therapists and walking aids. The standard physiotherapy, shared by both groups, was focused on the facilitation of movements on the paretic side and upper-limb exercises, and improving balance, standing, sitting, and transferring.

CONTROL GROUP 2: All patients underwent 2 therapy sessions per day, 5 days per week for 3 months. the CG received only conventional gait training. After 1 week of admission, the CG patients performed 2 daily physiotherapy sessions. One of them was dedicated to walking training, consisting of 20 sessions of 40-minute therapy (5 times per week), 25 instead of a second session of standard physiotherapy. In light of the patient’s ability, the walking therapy was focused on trunk stabilization, weight transfer to the paretic leg, and walking between parallel bars or on the ground. If necessary, the patient was helped by 1 or 2 therapists and walking aids. The standard physiotherapy, shared by both groups, was focused on the facilitation of movements on the paretic side and upper-limb exercises, and improving balance, standing, sitting, and transferring.

TREATMENT GROUP 1: All patients underwent 2 therapy sessions per day, 5 days per week for 3 months. Those in the RG underwent 20 sessions of robotic-assisted gait training in the first 4 weeks of inpatient therapy using controlled endpoint trajectories and abbreviated conventional therapy. CGLM, and CGHM. All groups had our standard rehabilitation treatment (nearly 3 h/d for 5 d/wk). In particular, 2 daily physiotherapy sessions were performed by all groups. After 1 week postadmission, RG participants performed 20 robotic sessions (5 times per week for 4 weeks) instead of a second session of standard physiotherapy; this session lasted 40 minutes, 20 of which were active GT therapy (the remaining 20 minutes were allocated for the patient’s preparation, parameter setting, and rest breaks as needed). The duration of robotic treatment was 4 weeks, in accordance with previous studies.16-18. During all RG sessions, 1 physiotherapist manually assisted knee flexion and extension and verbally encouraged the patients to perform the task with correct posture, when necessary. However, 2 therapists were necessary to settle severely affected patients in the harness. Each RG session began after setting the parameters, based on motor ability and the patient’s comfort. Step lengths ranged from 38 to 44 cm. The walking speed was selected to be around 1 to 1.5 km/h at the first GT session and was increased as soon as possible in accordance with comfortable gait for each patient.23 BWS was 0% to 50% of body weight. The BWS was measured while the patient was harnessed, after supporting straps were stretched, and after the nonparetic leg was extended and aligned to the paretic leg; hands were positioned on the handrail solely for balance. The BWS was selected and adjusted during therapy in line with 3 principles: a progressive decrease in BWS during rehabilitation, patient comfort, and the patient’s ability to extend his hip and sufficiently bear weight on the paretic leg.24 During the GT session, a rest period was possible, if required by patients. The standard physiotherapy, shared by both groups, was focused on the facilitation of movements on the paretic side and upper-limb exercises, and improving balance, standing, sitting, and transferring.

TREATMENT GROUP 2: All patients underwent 2 therapy sessions per day, 5 days per week for 3 months. Those in the RG underwent 20 sessions of robotic-assisted gait training in the first 4 weeks of inpatient therapy using controlled endpoint trajectories and abbreviated conventional therapy. . CGLM, and CGHM. All groups had our standard rehabilitation treatment (nearly 3 h/d for 5 d/wk). In particular, 2 daily physiotherapy sessions were performed by all groups. After 1 week postadmission, RG participants performed 20 robotic sessions (5 times per week for 4 weeks) instead of a second session of standard physiotherapy; this session lasted 40 minutes, 20 of which were active GT therapy (the remaining 20 minutes were allocated for the patient’s preparation, parameter setting, and rest breaks as needed). The duration of robotic treatment was 4 weeks, in accordance with previous studies.16-18. During all RG sessions, 1 physiotherapist manually assisted knee flexion and extension and verbally encouraged the patients to perform the task with correct posture, when necessary. However, 2 therapists were necessary to settle severely affected patients in the harness. Each RG session began after setting the parameters, based on motor ability and the patient’s comfort. Step lengths ranged from 38 to 44 cm. The walking speed was selected to be around 1 to 1.5 km/h at the first GT session and was increased as soon as possible in accordance with comfortable gait for each patient.23 BWS was 0% to 50% of body weight. The BWS was measured while the patient was harnessed, after supporting straps were stretched, and after the nonparetic leg was extended and aligned to the paretic leg; hands were positioned on the handrail solely for balance. The BWS was selected and adjusted during therapy in line with 3 principles: a progressive decrease in BWS during rehabilitation, patient comfort, and the patient’s ability to extend his hip and sufficiently bear weight on the paretic leg.24 During the GT session, a rest period was possible, if required by patients. The standard physiotherapy, shared by both groups, was focused on the facilitation of movements on the paretic side and upper-limb exercises, and improving balance, standing, sitting, and transferring.

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## Morone et al. The Efficacy of Balance Training with Video Game-Based Therapy in Subacute Stroke Patients: A Randomized Controlled Trial. HINDAWI. 2014.

CONTROL GROUP 1: Fifty adult stroke patients participated to the study 25 subjects were assigned to usual balance therapy. Both groups were also treated with conventional physical therapy (40 min 2 times/day). 14]. Patients enrolled in the control group added to standard physiotherapy 20 minutes of balance therapy 3 times/week for 4 weeks. In light of the patient’s ability, the balance exercises were focused on trunk stabilization, weight transfer to the paretic leg, and exercise with Freeman board for balance and proprioception. The rehabilitative protocol for both the Wii and the control groups was in add-on to the standard physiotherapy focused on the facilitation of movements on the paretic side and upperlimb exercises and improving balance, standing, and transferring.

TREATMENT GROUP 1: Fifty adult stroke patients participated to the study: 25

subjects were randomly assigned to balance training with Wii Fit. . Both groups were also treated with conventional physical therapy (40 min 2 times/day). Patients enrolled in the Wii group performed 12 sessions of 20 minutes each of balance training performed with Wii Fit, 3 times a week for four weeks, in addon to a standard physiotherapy. During the intervention, three games were carried out in order to train balance, coordination, and endurance under the supervision of a physiotherapist: hula hoop, bubble blower, and sky slalom [2, 8, 14]. . The rehabilitative protocol for both the Wii and the control groups was in add-on to the standard physiotherapy focused on the facilitation of movements on the paretic side and upperlimb exercises and improving balance, standing, and transferring.

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## Morris et al. A Comparison of Bilateral and Unilateral Upper-Limb Task Training in Early Poststroke Rehabilitation: A Randomized Controlled Trial. APRM. 2008.

CONTROL GROUP 1: Participants in the unilateral training group followed the same program as the bilateral training group but used the paretic upper limb only. The intervention and control sessions occurred away from normal therapy areas so that regular therapists were unaware of group allocation. . Training lasted 20 minutes a session 5 weekdays a week over 6 weeks in addition to usual therapy. Participants performed as many trials as possible in each session to a maximum of 30 trials of each task, a total of 120 trials per session. The duration and intensity of training reflected other bilateral training studies5- 7 and was pragmatic, given the acute stage of recovery and ongoing usual therapy. Also reflecting the pragmatic nature of the study, participants discharged home before the end of the intervention period continued training at home twice a week through supervised visits of 30 minutes in duration from the same therapists, in line with the usual discharge and follow-up procedures. Equipment and task protocols were standardized and portable.

The program incorporated 4 core tasks typically found difficult by stroke patients; 3 had been used previously in bilateral training studies.5,6 Participants were asked (1) to move a doweling peg 2cm in diameter by 4cm in height from tabletop to attach to the underside of a shelf placed at eye level; (2) to move a 7-cm3 block from the table onto a shelf at shoulder height; (3) to grasp an empty glass, take to the mouth, and return to starting position; and (4) to point to targets raised 30cm from the table and positioned at midline, 40cm to the right, and 40cm to the left of midline. The fourth task was included because pointing is an important upper-limb function involving proximal and distal control,

for which task constraints could be progressed by using targets of varying size. Participants were assigned to a core protocol if they were able to complete the 4 core tasks at the first training session or to a modified protocol when the core tasks could not be completed. The modified protocol involved tabletop activities incorporating components of the core tasks, including reaching, forearm pronation and supination, wrist extension, and grasp. Training sessions were organized to enhance skill acquisition and retention through block practice in the cognitive stage of learning progressing to random practice in the associative stage of learning.29 Progressive, standardized graded variations of the core and modified tasks, with specific motor or functionalgoals and incorporating a range of everyday objects of differing shapes and sizes, were piloted and developed to provide a variation of reaching distances, accuracy, dexterity, and strength requirements. The aim was to encourage active participation matched to the degree of the impairment. Participants allocated to the modified protocol who had very little or no active movement were facilitated in their attempts to achieve goals with assistance from the therapists who withdrew physical assistance as soon as the participant showed active involvement. Goals for these participants, within the modified protocol, involved simple wrist and hand movement and reaching to points marked on the tabletop. Progression for all participants occurred when a participant was successful in 75% of the randomly scheduled trials. To facilitate self-evaluation of performance and maintain participant engagement, knowledge of results was provided after 5 trials using systematic feedback from therapists on goal achievement and movement pattern.30 Two senior stroke rehabilitation physiotherapists each with 15 years of experience conducted the intervention.

TREATMENT GROUP: Participants allocated to bilateral training practiced identical tasks with each arm simultaneously. Training lasted 20 minutes a session 5 weekdays a week over 6 weeks in addition to usual therapy. Participants performed as many trials as possible in each session to a maximum of 30 trials of each task, a total of 120 trials per session. The duration and intensity of training reflected other bilateral training studies5- 7 and was pragmatic, given the acute stage of recovery and ongoing usual therapy. Also reflecting the pragmatic nature of the study, participants discharged home before the end of the intervention period continued training at home twice a week through supervised visits of 30 minutes in duration from the same therapists, in line with the usual discharge and follow-up procedures. Equipment and task protocols were standardized and portable. The program incorporated 4 core tasks typically found difficult by stroke patients; 3 had been used previously in bilateral training studies.5,6 Participants were asked (1) to move a doweling peg 2cm in diameter by 4cm in height from tabletop to attach to the underside of a shelf placed at eye level; (2) to move a 7-cm3 block from the table onto a shelf at shoulder height; (3) to grasp an empty glass, take to the mouth, and return to starting position; and (4) to point to targets raised 30cm from the table and positioned at midline, 40cm to the right, and 40cm to the left of midline. The fourth task was included because pointing is an important upper-limb function involving proximal and distal control, for which task constraints could be progressed by using targets of varying size. Participants were assigned to a core protocol if they were able to complete the 4 core tasks at the first training session or to a modified protocol when the core tasks could not be completed. The modified protocol involved tabletop activities incorporating components of the core tasks, including reaching, forearm pronation and supination, wrist extension, and grasp. Training sessions were organized to enhance skill acquisition and retention through block practice in the cognitive stage of learning progressing to random practice in the associative stage of learning.29 Progressive, standardized graded variations of the core and modified tasks, with specific motor or functionalgoals and incorporating a range of everyday objects of differing shapes and sizes, were piloted and developed to provide a variation of reaching distances, accuracy, dexterity, and strength requirements. The aim was to encourage active participation matched to the degree of the impairment. Participants allocated to the modified protocol who had very little or no active movement were facilitated in their attempts to achieve goals with assistance from the therapists who withdrew physical assistance as soon as the participant showed active involvement. Goals for these participants, within the modified protocol, involved simple wrist and hand movement and reaching to points marked on the tabletop. Progression for all participants occurred when a participant was successful in 75% of the randomly scheduled trials. To facilitate self-evaluation of performance and maintain participant engagement, knowledge of results was provided after 5 trials using systematic feedback from therapists on goal achievement and movement pattern.30 Two senior stroke rehabilitation physiotherapists each with 15 years of experience conducted the intervention.

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## Mudge et al. Circuit-Based Rehabilitation Improves Gait Endurance but Not Usual Walking Activity in Chronic Stroke: A Randomized Controlled Trial. AMPR. 2009.

CONTROL GROUP: The control group received a comparable duration of group social and educational classes. Participants in the control group attended eight 90-minute sessions over 4 weeks in groups of up to 8. The control group was run by an occupational therapist and consisted of 4 social and 4 educational sessions. The content of the sessions is outlined in appendix 2. The duration of the control group sessions was designed to match the duration of the intervention sessions in order to control for possible effects of dosage. Matching for duration and not number of sessions was a pragmatic choice based on resources, allowing 1 intervention session a weekday to be scheduled over the 4-week intervention period. Both the control and exercise group sessions took place in a private rehabilitation clinic.

TREATMENT GROUP: The exercise group had 12 sessions of clinic based rehabilitation delivered in a circuit class designed to improve walking. investigator after the second baseline assessment. Participants allocated to the exercise group participated in 12 group circuit exercise sessions 3 times a week for 4 weeks. The groups contained up to 9 participants and were led by 1 of the investigators (S.M.) assisted by 2 physiotherapy students. There were 15 stations in the circuit, which were graded to each participant’s ability and progressed as tolerated. Each station contained either a task-oriented gait or standing balance activity, or strengthening of a lower extremity muscle in a way designed to improve gait. Details of the content of each station and examples of progressions are provided in appendix 1. The total exercise time was 30 minutes, although sessions lasted between 50 to 60 minutes, including stretching. Participants spent 2 minutes at each station of the circuit, with time allowed to move between stations and receive instructions for the next station. Details about exercise intensity and/or repetitions performed at each station were recorded for each participant.

# N Authors

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## Ng et al. Transcutaneous Electrical Nerve Stimulation Combined With Task-Related Training Improves Lower Limb Functions in Subjects With Chronic Stroke. STROKE. 2007.

CONTROL GROUP: Subjects were required to perform the home program daily 5 days a week for 4 weeks. During this period, they attended 8 instruction sessions in our laboratory to ensure that they could follow the home program properly and for the physiotherapist to progress the exercise level as needed. Daily log books were entered by all subjects. To ensure treatment compliance, the physiotherapist made regular telephone reminders and checked clients’ daily log books in every instruction session. The control group received no treatment.

TREATMENT GROUP 1: Subjects were required to perform the home program daily 5 days a week for 4 weeks. During this period, they attended 8 instruction in our laboratory to ensure that they could follow the home program properly and for the physiotherapist to progress the exercise level as needed. Daily log books were entered by all subjects. To ensure treatment compliance, the physiotherapist made regular telephone reminders and checked clients’ daily log books in every instruction session. TRT included 4 weightbearing and stepping exercises using wooden blocks of 2.5 or 5 cm in height: (1) loading exercise on the affected leg; (2) stepping up exercise with the affected leg; (3) stepping down exercise with the unaffected leg; (4) heel lifts from a dorsiflexed position in standing and 2 functional training; (5) standing up from a chair, walking a short distance, and returning to the chair; and (6) walking with rhythmic auditory cues generated by a metronome. Standardized progression was made by the physiotherapist by using higher wooden blocks when subjects could perform the weightbearing exercises 20 times without compensatory movement and by increasing the number of repetitions completed within 10 minutes. Walking was progressed by increasing its speed.

TREATMENT GROUP 2: Subjects were required to perform the home program daily 5 days a week for 4 weeks. During this period, they attended 8 instruction in our laboratory to ensure that they could follow the home program properly and for the physiotherapist to progress the exercise level as needed. Daily log books were entered by all subjects. To ensure treatment compliance, the physiotherapist made regular telephone reminders and checked clients’ daily log books in every instruction session. The TENS\_TRT group received 60 minutes of TENS followed by 60 minutes of TRT modified from Carr and Shepherd.9 TRT included 4 weightbearing and stepping exercises using wooden blocks of 2.5 or 5 cm in height: (1) loading exercise on the affected leg; (2) stepping up exercise with the affected leg; (3) stepping down exercise with the unaffected leg; (4) heel lifts from a dorsiflexed position in standing and 2 functional training; (5) standing up from a chair, walking a short distance, and returning to the chair; and (6) walking with rhythmic auditory cues generated by a metronome. Standardized progression was made by the physiotherapist by using higher wooden blocks when subjects could perform the weightbearing exercises 20 times without compensatory movement and by increasing the number of repetitions completed within 10 minutes. Walking was progressed by increasing its speed.

TREATMENT GROUP 3: Subjects were required to perform the home program daily 5 days a week for 4 weeks. During this period, they attended 8 instruction in our laboratory to ensure that they could follow the home program properly and for the physiotherapist to progress the exercise level as needed. Daily log books were entered by all subjects. To ensure treatment compliance, the physiotherapist made regular telephone reminders and checked clients’ daily log books in every instruction session The PLBO\_TRT group received 60 minutes of PLBO-TENS from identical-looking TENS devices with the electrical circuit disconnected inside followed by 60 minutes of TRT as described subsequently. TRT included 4 weightbearing and stepping exercises using wooden blocks of 2.5 or 5 cm in height: (1) loading exercise on the affected leg; (2) stepping up exercise with the affected leg; (3) stepping down exercise with the unaffected leg; (4) heel lifts from a dorsiflexed position in standing and 2 functional training; (5) standing up from a chair, walking a short distance, and returning to the chair; and (6) walking with rhythmic auditory cues generated by a metronome. Standardized progression was made by the physiotherapist by using higher wooden blocks when subjects could perform the weightbearing exercises 20 times without compensatory movement and by increasing the number of repetitions completed within 10 minutes. Walking was progressed by increasing its speed.

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## Ng et al. A Pilot Study of Randomized Clinical Controlled Trial of Gait Training in Subacute Stroke Patients With Partial Body-Weight Support Electromechanical Gait Trainer and Functional Electrical Stimulation. STROKE. 2008.

CONTROL GROUP 1: All subjects in all groups underwent one gait training session of 20 minutes duration per weekday for the 4 weeks under supervision of a physical therapist. In addition to the assigned group treatment, each subject also received his or her own regular hospital-prescribed 40 minutes of physical therapy and a 1.5-hour multidisciplinary treatment session every weekday throughout the 4-week intervention period. The CT group received conventional physical-therapy gait training begun with individual assessment in order to plan specific physiotherapy treatment to maximize potential recovery for each patient after stroke. A physiotherapy session usually begins with stretching exercises to restore flexibility to tight muscles in the affected side of trunk, arms and legs based on the principles of proprioceptive neuromuscular facilitation and Bobath concepts.20,21 The principle of the Bobath treatment is to train up the key proximal segments then distal segments in order to improve the subject’s posture and movement.20 Cardiovascular exercises for both arms and legs are used to build endurance and improve circulation. Specific strengthening exercises are also planned for weakened arm, leg and trunk muscles. Activities for daily living such as changing positions from sitting to standing, getting out of bed are also parts of the routine rehabilitation training. The CT subjects were to undergo the overground walking gait training with or without a walking aid or orthoses and with manual assistance from the physical therapist, depending on the individual subject’s abilities. The duration of the overground walking gait training for each CT subject was the same as that for each GT and GT-FES subject on the electromechanical gait trainer for their respective gait-training interventions. Each gait-training session was conducted by the subject’s own hospital physical therapist who was blinded to the group assignments.

TREATMENT GROUP 1: All subjects in all groups underwent one gait training session of 20 minutes duration per weekday for the 4 weeks under supervision of a physical therapist. In addition to the assigned group treatment, each subject also received his or her own regular hospital-prescribed 40 minutes of physical therapy and a 1.5-hour multidisciplinary treatment session every weekday throughout the 4-week intervention period. Subjects in the GT group trained on the electromechanical gait trainer with their body weight partially supported by a harness attached by ropes to a gear system, according to the subject’s ability in lifting the paretic foot during the swing phase.10 Walking was simulated by propulsion of the footplates, which aided the movement of the feet and legs in a symmetric manner with a gait cycle ratio of 60% to 40% between the stance and swing phases. The target training velocity was relatively slow (0.20 m/s to 0.60 m/s) to avoid overexertion of the subject.13 There was partial support of body weight, which was reduced as soon as the subject could support his or her full body weight. The clinical criterion for the reduction was that the subject showed the ability to move his or her hips and was able to support his or her own body weight sufficiently on the affected lower limb and straighten their legs during the single-leg stance phase. Weight support would be gradually decreased by 5 kg in each session if the subjects had the above clinical criterion. Gait speed would be gradually increased by 0.1 m/s in next session if the subjects completed the last training session without discomfort. The subject’s physical therapist gave assistance during the gait training to help with the subject’s knee extension as well as verbal cueing for head and trunk extension and erection and midline awareness. Each gait-training session was of 20 minutes duration with an optional rest break (of 1 to 3 minutes) after the first 10 minutes.

TREATMENT GROUP 2: All subjects in all groups underwent one gait training session of 20 minutes duration per weekday for the 4 weeks under supervision of a physical therapist. In addition to the assigned group treatment, each subject also received his or her own regular hospital-prescribed 40 minutes of physical therapy and a 1.5-hour multidisciplinary treatment session every weekday throughout the 4-week intervention period. Subjects in the GT-FES group underwent the same ambulatory training on the gait trainer as the GT group but also received FES simultaneously. Each GT-FES subject received standardized electrical stimulation modalities, including waveform and pulse width with fixed values (rectangular pulse with pulse width of 400 \_s with rising edge and falling edge ramp set as 0.3 seconds). The stimulation intensity was adjusted by the supervising physical therapist according to how successful the correct limb movement was elicited and to the subject’s comfort threshold. Two connection wires linked the gait trainer control box and the 2 singlechannel FES stimulators (model R01–0093; Jockey Club Rehabilitation Engineering Centre, The Hong Kong Polytechnic University, Hong Kong, China), which were set to synchronize the gait phase and the stimulation timing for the quadriceps and the common peroneal nerve, respectively. The subject’s quadriceps in the paretic side were stimulated in the stance phase to facilitate weight acceptance, and his or her common peroneal nerve in the paretic side was stimulated during the swing phase to elicit ankle dorsiflexion and knee flexion. This training procedure had been used previously in a case study.22

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## Nilssen et al. Walking training of patients with hemiparesis at an early stage after stroke: a comparison of walking training on a treadmill with body weight support and walking training on the ground. CLIN REHAB. 2001.

CONTROL GROUP: The treatment group received walking training on a treadmill with BWS for 30 minutes, 5 days a week. The control group received walking training according to the Motor Relearning Programme (MRP) on the ground for 30 minutes 5 days a week, not including treadmill training. During the time in the rehabilitation department (about two months), all patients in the study also received professional stroke rehabilitation besides the walking training in the two groups.

TREATMENT GROUP: The treatment group received walking training on a treadmill with BWS for 30 minutes, 5 days a week. During the time in the rehabilitation department (about two months), all patients in the study also received professional stroke rehabilitation besides the walking training in the two groups.

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## Noh et al. The effect of aquatic therapy on postural balance and muscle strength in stroke survivors – a randomized controlled pilot trial. CR 2008.

CONTROL GROUP: The conventional therapy group performed gym exercises. In both groups, the interventions occurred for 1 hour, three times per week, for eight weeks. The conventional therapy group was assigned to an eight-week gym exercise programme (1-hour session, three days/week). Participants in the conventional therapy group performed general conditioning exercises, including a warm-up (e.g. calf and hamstring stretches, shoulder and hand passive range of motion exercises, 10 minutes), lower extremity strengthening (e.g. bicycle, leg extensor), upper-extremity strengthening (e.g. upper body ergometer) and gait training (e.g. marching with 0.5-kg ankle weights for 10 minutes) for the same amount of time as the aquatic therapy group spent in the pool. Exercises in this programme were designed with graded increments to meet the capabilities of each subject and were supervised by a physical therapist.

TREATMENT GROUP: The aquatic therapy group participated in a programme consisting of Ai Chi and Halliwick methods, which focused on balance and weight-bearing exercises. In both groups, the interventions occurred for 1 hour, three times per week, for eight weeks. The aquatic therapy group participated in intensive aquatic therapy for eight weeks (1-hour session, three days/week) in a therapeutic pool (Netherland, EWAC; water temperature 34\_C; water depth 115 cm). The main objective of the aquatic therapy programme, based on the Halliwick and Ai Chi methods, was to improve balance function associated with postural control in stroke patients. Two participants were treated by one therapist at each session. Two therapists trained in the Halliwick and Ai Chi methods performed the aquatic therapy by turns. Aquatic therapy consisted of 10 minutes of light warm-up in the water (marching in place, forward and backward walking), 20 minutes of the Halliwick method, 20 minutes of rounding and balancing according to the Ai Chi method, and 10 minutes of a light cool-down (forward and backward walking). All those participating in the aquatic therapy were habituated to the water environment through warm-up periods at each session. The basic movements of the Halliwick method for balance restoration are sagittal rotation control (bending from left to right or transferring weight while in an upright position), transverse rotation control (around the transverse axis with the subject moving from standing to supine and returning to a standing position), and combined rotation control (a combination of transverse sagittal and longitudinal rotations). The Ai Chi method focused on weight bearing on the more affected side. The Ai Chi movements consisted of rounding (forward and backward horizontally, extending both arms while flexing and extending one leg at the same time) and balancing (flexing and extending both arms while alternatively flexing and extending one leg with the other leg bearing weight). To enhance balance control, support provided by the therapist’s hands and legs was gradually decreased.

# O Authors

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## Olawale et al. Exercise training improves walking function in an African group of stroke survivors: a randomized controlled trial. CLIN REHAB. 2011.

CONTROL GROUP 1: All subjects received individual outpatient conventional physiotherapy rehabilitation for 12 weeks. Those in Group C (control) (n¼20) received conventional physiotherapy rehabilitation only. Subjects in Group C had 12 weeks of conventional physiotherapy treatment only. Three treatment/training sessions were conducted each week. On each day of treatment/training, subjects observed a pre-exercise rest period of 10 minutes during which heart rate and blood pressure measurements were made. Subjects in Group C went through a one-hour session of conventional physiotherapy only.

TREATMENT GROUP 1: All subjects received individual outpatient conventional physiotherapy rehabilitation for 12 weeks. In addition, subjects in Group A (n¼20) received treadmill walking exercise training (TWET). Subjects in Group A had 12 weeks of conventional physiotherapy treatment and treadmill walking exercise training (TWET). Three treatment/training sessions were conducted each week. On each day of treatment/training, subjects observed a pre-exercise rest period of 10 minutes during which heart rate and blood pressure measurements were made. subjects in Group A went through a one-hour session of conventional physiotherapy including 25 minutes of treadmill walking exercise training. The treadmill walking exercise training involved walking on a treadmill at a pre-determined natural safe walking speed. In each case, exercise would be terminated any time the subject reported symptoms of exertional intolerance, i.e. outside the target zone on Borg’s rate of perceived exertion (RPE) scale.17–18 The conventional physiotherapy rehabilitation consisted of active and passive range of motion (ROM) exercises, strength training and balance training, as applicable.

TREATMENT GROUP 2: All subjects received individual outpatient conventional physiotherapy rehabilitation for 12 weeks. those in Group B (n¼20) received overground walking exercise training (OWET). while those in Group B had 12 weeks of conventional physiotherapy treatment and overground walking exercise training (OWET). Three treatment/training sessions were conducted each week. On each day of treatment/training, subjects observed a pre-exercise rest period of 10 minutes during which heart rate and blood pressure measurements were made. those in Group B went through a one-hour session of conventional physiotherapy including 25 minutes of overground walking exercise training. The overground walking exercise training involved walking overground at a natural safe speed (i.e. walking at own pace in order to cover as much ground as possible within the training period) on a 15x10 metre walk course marked out on the flat floor of a remedial gymnasium. In each case, exercise would be terminated any time the subject reported symptoms of exertional intolerance, i.e. outside the target zone on Borg’s rate of perceived exertion (RPE) scale.17–18 The conventional physiotherapy rehabilitation consisted of active and passive range of motion (ROM) exercises, strength training and balance training, as applicable.

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## Onley et al. A Randomized Controlled Trial of Supervised Versus Unsupervised Exercise Programs for Ambulatory Stroke Survivors. S. 2006.

TREATMENT GROUP 1: Intervention consisted of supervised exercise sessions conducted in 1.5-hour sessions 3 days per week for 10 weeks (supervised) and 3 days per week for the first week followed by a home program for 9 weeks (unsupervised). Subjects joined the class of 3 or 4 participants as they were admitted. Each supervised session included the following: (1) a 5- to 10-minute warm-up consisting of leisurely walking, mild stretching, and range of motion exercises of lower limbs; (2) aerobic exercise consisting of a graded walking program and/or cycling, depending on subject preference and capability; (3) strength training; and (4) a cool-down period consisting of 5 to 10 minutes of leisurely walking and muscular relaxation exercises. Subjects were taught how to take their pulse and to maintain exercise within target range (between 50% and 70% of age-adjusted maximum and adjusted for \_-blockers) and how to conduct their exercises and progress in them. With rests as indicated by the subjects, the program took subjects \_1.5 hours to complete. Aerobic conditioning used procedures modified from those recommended for healthy elderly adults.13 During the first 5 weeks of the program, walking intensity was increased from 50% to 70% aerobic working capacity, and walking duration per session was increased from 10 to 20 minutes. Exercise intensity and duration were kept constant between 50% and 70% of maximum and 20 minutes, respectively, during the second 5 weeks of the program. A Polar Heart Rate Monitor was worn, and perception of effort was monitored with the use of Borg’s 15-point (scale of 6 to 20) psychometric scale.14 Strength training concentrated on hip flexors, extensors, and abductors; knee extensors and flexors; and ankle dorsiflexors and plantar flexors with particular attention to muscle groups with obvious deficits. Theraband (Hygenic Corporation), simple weights, and functional exercises were used. Programs were tailored to each subject’s needs and were adjusted weekly as indicated for supervised subjects. Subjects in the unsupervised group were given written and verbal instructions on advancing in their exercises.

TREATMENT GROUP 2: Intervention consisted of supervised exercise sessions conducted in 1.5-hour sessions 3 days per week for 10 weeks (supervised) and 3 days per week for the first week followed by a home program for 9 weeks (unsupervised). Subjects joined the class of 3 or 4 participants as they were admitted. Each supervised session included the following: (1) a 5- to 10-minute warm-up consisting of leisurely walking, mild stretching, and range of motion exercises of lower limbs; (2) aerobic exercise consisting of a graded walking program and/or cycling, depending on subject preference and capability; (3) strength training; and (4) a cool-down period consisting of 5 to 10 minutes of leisurely walking and muscular relaxation exercises. Subjects were taught how to take their pulse and to maintain exercise within target range (between 50% and 70% of age-adjusted maximum and adjusted for \_-blockers) and how to conduct their exercises and progress in them. With rests as indicated by the subjects, the program took subjects \_1.5 hours to complete. Aerobic conditioning used procedures modified from those recommended for healthy elderly adults.13 During the first 5 weeks of the program, walking intensity was increased from 50% to 70% aerobic working capacity, and walking duration per session was increased from 10 to 20 minutes. Exercise intensity and duration were kept constant between 50% and 70% of maximum and 20 minutes, respectively, during the second 5 weeks of the program. A Polar Heart Rate Monitor was worn, and perception of effort was monitored with the use of Borg’s 15-point (scale of 6 to 20) psychometric scale.14 Strength training concentrated on hip flexors, extensors, and abductors; knee extensors and flexors; and ankle dorsiflexors and plantar flexors with particular attention to muscle groups with obvious deficits. Theraband (Hygenic Corporation), simple weights, and functional exercises were used. Programs were tailored to each subject’s needs and were adjusted weekly as indicated for supervised subjects. Subjects in the unsupervised group were given written and verbal instructions on advancing in their exercises.

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## Ouellete et al. High-Intensity Resistance Training Improves Muscle Strength, Self-Reported Function, and Disability in Long-Term Stroke Survivors. STROKE. 2004.

CONTROL GROUP: The control intervention consisted of bilateral range of motion (ROM) and upper body flexibility exercises performed 3 times per week.

TREATMENT GROUP: Subjects performed seated bilateral leg press (LP), unilateral paretic and nonparetic limb knee extension (KE), unilateral ankle dorsiflexion (DF), and plantarflexion (PF) 3 times per week for 12 weeks. The LP and KE were performed using pneumatic resistance training equipment (Keiser Sports Health Equipment Inc) and the PF and DF were performed using a modified weight stack-pulley system (Therapy Systems). Four warm-up repetitions at 25% of the 1-repetition maximum (1RM) were performed followed by 3 sets (8 to 10 repetitions per set) at 70% of the 1RM. Training intensity was adjusted biweekly by reassessing the 1RM.

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## Outermans et al. Effects of a high-intensity task-oriented training on gait performance early after stroke: a pilot study. CR. 2010.

CONTROL GROUP: All participants engaged in usual individual physiotherapy for half an hour each day. Information about intensity and content of the therapy beyond the trial were documented in a patient’s record. Therapists were instructed not to depart from their usual care during the trial. This was monitored using the available documentation. The focus in the low-intensity physiotherapygroup was on improving motor control of the hemiparetic leg and balance. In contrast to the high-intensity training-group there were no components of physical fitness training such as strengthening exercises or cardiorespiratory training, indicating that the training was set at a low-intensity profile aimed at learning gait-related activities. The participants in the low-intensity physiotherapy-group went through a 45-minute programme of group exercises, three times a week for four weeks, thus matching therapy time to the high-intensity training-group. The low-intensity physiotherapy-programme was also based on a 10 workstations circuit. All stations were practised for 2.5 minutes, followed by a 1-minute gap to transfer to the next station. Afterwards the participants joined in games, like passing through a ball, for 10 minutes. Progression, according to the observations and estimation of the therapists in charge, was achieved by enhancing motor control challenge, not in enhancing the number of repetitions like the high-intensity training-group.

TREATMENT GROUP: The high-intensity task-oriented trainingprogramme incorporated 10 standardized workstations, focused on improving walking competency, similar to the study by Dean et al.19 Participants in the high-intensity training-group performed 45 minutes of circuit class training, held at the rehabilitation clinic three times a week for four weeks. All stations were practiced for 2.5 minutes, followed by a 1-minute transfer to the next station. Afterwards the participants joined in walking relays and races for 10 minutes. The high-intensity training-programme focused on improving postural control and gait-related activities such as stair walking, turning, making transfers, walking quickly and walking for specified distances. In line with the recommendations of the American Heart Association,22 cardiorespiratory workload started at 40–50% of heart rate reserve. Progressionwas attained by increasing the workload to a maximum of 70–80% of heart rate reserve,25 and increasing the number of repetitions, both according to the observations and estimation of the therapists in charge and the patients perceived exertion. A 6–20 Borg Scale was used to rate subjects’ perceived exertion.2

# P Authors

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## Page et al. Efficacy of Modified Constraint-Induced Movement Therapy in Chronic Stroke: A Single-Blinded Randomized Controlled Trial. APMR. 2004.

CONTROL GROUP 1: Six patients received no therapy (control). Patients assigned to the control condition received no therapy during the 10-week period. After 10 weeks, all patients returned to the laboratory, where they were again administered the FMA, ARA, and MAL by an examiner who was blinded in that he was unaware of the patients’ randomized grouping.

TREATMENT GROUP 1: Four patients received regular therapy with similar contact time to mCIMT. Patients in traditional rehabilitation received 1⁄2-hour, consecutive PT and OT sessions, 3d/wk for 10 weeks. Approximately 80% of each PT and OT session (\_25min) focused on proprioceptive neuromuscular facilitation (PNF) techniques, with emphasis on functional tasks when possible, as well as stretching of the more affected limb and particularly in the more affected shoulder. Approximately 20% of traditional rehabilitation therapy (\_5min) focused on compensatory techniques using the less affected side (eg, performing functional tasks with the less affected arm, assisting the more affected arm during reaching tasks). The duration, frequency, and type of therapy provided to traditional rehabilitation subjects were consistent with that generally provided to stroke patients at this motor level in our clinics. Moreover, studies have not shown PNF is more effective than other therapies.36 Therefore, this was an appropriate approximation of traditional rehabilitation.

TREATMENT GROUP 2: Seven patients participated in structured therapy sessions emphasizing more affected arm use in valued activities, 3 times a week for 10 weeks. Their less affected arms were also restrained 5d/wk for 5 hours (mCIMT). As in previous studies,25,26 mCIMT subjects participated in consecutive, 1⁄2-hour sessions of physical therapy (PT) and occupational therapy (OT) 3 times a week for 10 weeks. Approximately 20 to 25 minutes of OT concentrated on more affected limb use in functional tasks largely chosen by patients and their treating therapists, with some time (\_5min) spent on strengthening and/or compensatory techniques using the less affected arm as needed. During OT, shaping techniques (see Page et al25,26 for a description) were used with 2 to 3 upperlimb activities chosen by the patients (eg, writing, using a fork and spoon, brushing teeth, combing hair). PT sessions largely concentrated on lower-limb activities (eg, dynamic stand and balance activities, gait training), but some time in each PT session was spent on upper-limb stretching to facilitate ADLs. During the same 10-week period, the less affected upper limbs of subjects in the mCIMT group were restrained every weekday for 5 hours that were identified as a time of frequent arm use. Their arms were restrained with a cotton hemislingb; hands were placed in mesh, polystyrene-filled mitts with Velcro straps around the wrist.b Because patients were restricted at home, logs were kept to document device use time, as well as activities performed during restraint hours.

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## Page et al. Modified constraint-induced therapy in chronic stroke: Results of a single-blinded randomized controlled trial. 2008.

TREATMENT GROUP 1. mCIT group. As in previous studies, 17–23 the mCIT intervention, begun 1 week after the second pretesting session, consisted of 2 components. The first component consisted of half-hour, one-on-one sessions of more affected arm therapy occurring 3 days per week during a 10-week period. This component included shaping techniques (see Page and colleagues19–22 for a description) in which operant conditioning was applied in such a way that subjects received positive verbal encouragement to more fully perform selected motor skills with their more affected arm. Shaping was applied with 2 or 3 upper-limb activities (eg, writing, using a fork) chosen by the subjects with help from their therapist. In the second component of the mCIT intervention, during the same 10-week period, subjects’ less affected arms were restrained every weekday for 5 hours identified as a time of frequent arm use, as identified by the subjects with assistance from the therapist. Their arms were restrained using a cotton hemi-sling, while their hands were placed in mesh, polystyrene-filled mitts with Velcro straps\* around the wrist. Although no difficulties with adherence to training have been documented in mCIT studies, each subject in the mCIT group and his or her caregiver met prior to the beginning of the first therapy session with the assigned therapist and the principal investigator (SJP), and a behavioral contract was discussed, reviewed, and signed.

CONTROL GROUP 1. TR and control groups. Subjects who were randomly assigned to the group that received the TR intervention, begun 1 week after the second pretesting session, received half-hour, more affected arm therapy sessions 3 days per week for 10 weeks. Approximately 80% of each session (about 25 minutes) focused on proprioceptive neuromuscular facilitation (PNF) techniques,33 with emphasis on functional tasks whenever possible, as well as stretching of the more affected limb, particularly in the more affected shoulder (ie, extension, adduction, and internal rotation of shoulder with elbow extended and with finger and wrist flexion). The therapists focused, as needed, on compensatory techniques using the less affected side (eg, performing functional tasks with the less affected arm, assisting the more affected arm during reaching tasks) for the remaining 5 minutes. The duration, frequency, and content of therapy provided to subjects in the TR group were consistent with typical therapy provided to patients with stroke at this motor level in our clinics, as indicated by the treating therapists. Moreover, studies have not shown PNF to be more effective than other motor therapies for patients with stroke.34 This regimen, therefore, was chosen.

CONTROL GROUP 2. Subjects assigned to the control group received no therapy during a 10-week period. As noted previously, many subjects more than 3 months poststroke who exhibit distal motor function are discharged from therapy and living in the community, making this a realistic reference condition.

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## Page et al. Modified Constraint-Induced Therapy in Acute Stroke: A Randomized Controlled Pilot Study. NNR. 2005.

CONTROL GROUP: *Five other patients received ½ sessions of traditional motor rehabilitation for the affected arm, which included affected limb manual dexterity exercises and stretching, as well as compensatory strategies with the unaffected limb. The TR regimens occurred 3 d/week for 10 weeks.* Three d/week for 10 weeks, members of the TR group received standard therapy for their affected limbs, administered by therapists in the inpatient unit of the hospital. These 1/2-h treatment sessions included stretching of the affected limb, weight bearing with the affected limb, manual dexterity exercises (e.g., grasp release, stacking cones), and teaching of ADLs with the less affected side.

TREATMENT GROUP: *Five patients were administered mCIT, consisting of structured therapy emphasizing more affected arm use in valued activities 3 d/week for 10 weeks and less affected arm restraint 5 d/week for 5 h.* Each patient assigned to mCIT participated in individualized, 1/2-h therapy sessions, 3 times/week for 10 weeks, all administered by the same therapist. Approximately 25 min of therapy concentrated on more affected limb use in 3 agreedupon ADLs chosen by patients and the treating therapist, including writing, picking up a hairbrush and combing hair, typing on a computer, and picking up a cup and drinking from it. Approximately 5 min of therapy was spent on more affected limb range of motion as needed. Shaping techniques (see Page and colleagues for a description9,17-22) were used with the 3 chosen ADLs. During the same 10-weeks, mCIT patients’ unaffected hands and wrists were restrained every weekday for 5 h identified as a time of frequent arm use. The hands and wrists were restrained using polystyrene-filled mitts with velcro straps around the wrist (Sammons Preston, Bolingbrook, IL). Because patients’ affected limbs were restricted while they were at home, logs were administered to document device use time, as well as activities performed during restraint hours.

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## Pandian et al. Comparison of Brunnstrom movement therapy and motor relearning program in rehabilitation of post-stroke hemiparetic hand: A randomized trial. JBMT. 2012.

TREATMENT GROUP 1: Group A received Brunnstrom hand manipulation (BHM). BHM is the hand treatment protocol of the Brunnstrom movement therapy, which uses synergies and reflexes to develop voluntary motor control. Group A subjects received Brunnstrom hand manipulation (BHM) along with conventional occupational therapy for the upper (excluding the hand) and lower extremities. The detailed BHM protocol is provided in appendix-1. The major goal of the BHM was the acquisition of mass grasp and mass release of objects. Once the goal was achieved, more prehensile activities were focused. Reflexive, passive, synergistic and active movements were used sequentially to enhance the hand recovery.

TREATMENT GROUP 2: . Group B received the Motor Relearning Program (MRP) based hand protocol. MRP is the practice of specific motor skills, which results in the ability to perform a task. Group B received motor relearning program (MRP) for hand along with conventional occupational therapy for upper (excluding the hand) and lower extremities. The MRP protocol used in the study is given in Appendix 2. A fourstep sequence of the protocol was followed to improve the upper-extremity functional skill: analysis of a task, practice of a missing component of the task and practice of the entire task. Five strategies were also used for providing MRP training to the subjects; verbal instruction, visual demonstration, manual guidance, feedback and practice of the task.

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## Pang et al. A Community-Based Fitness and Mobility Exercise Program for Older Adults with Chronic Stroke: A Randomized, Controlled Trial. J Am Ger Soc. 2005.

CONTROL GROUP: The control group underwent a seated upper extremity program. The control group underwent a seated upper extremity program (Appendix 2). The intervention and control groups underwent an exercise program for 19 weeks (1-hour sessions, three sessions per week) in the same multipurpose room of a community hall. The participants occupied the community space only during the exercise sessions. The two groups exercised at different times of the day. In each session, a physical therapist, an occupational therapist, and an exercise instructor supervised nine to 12 participants. Hip protectors (SAFEHIP, Tutex, Denmark) were provided to those in the intervention group, and they were instructed to wear them in each session. No aerobic exercises, leg strengthening, or balance training were given.

TREATMENT GROUP: Participants were randomized into intervention group (n532) or control group (n531). The (FAME) program designed to improve cardiorespiratory fitness, mobility, leg muscle strength, balance, and hip bone mineral density (BMD) (1-hour sessions, three sessions/ week, for 19 weeks). Interventions The intervention and control groups underwent an exercise program for 19 weeks (1-hour sessions, three sessions per week) in the same multipurpose room of a community hall. The participants occupied the community space only during the exercise sessions. The two groups exercised at different times of the day. In each session, a physical therapist, an occupational therapist, and an exercise instructor supervised nine to 12 participants. Hip protectors (SAFEHIP, Tutex, Denmark) were provided to those in the intervention group, and they were instructed to wear them in each session. The FAME program was provided to the intervention group (Appendix 1). To determine cardiorespiratory training intensity, maximum heart rate achieved at the end of the cycle ergometer test was used to calculate the heart rate reserve (HRR).28 As the trial progressed, exercise intensity and duration were increased as tolerated (Appendix 1), as adapted from the guidelines recommended by the American College of Sports Medicine.28 During aerobic exercise training, participants wore a heart rate monitor (Polar A3, Polar Electro Inc., Woodbury, NY) and were instructed to exercise within the set target heart rate zone. The average heart rate attained, the duration over which the target heart rate was sustained, and the specific exercises completed in each session were recorded.

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## Pang et al. A Community-Based Upper-Extremity Group Exercise Program Improves Motor Function and Performance of Functional Activities in Chronic Stroke: A Randomized Controlled Trial. APMR. 2006.

TREATMENT GROUP 1: Participants in both the arm and leg groups underwent an exercise program for 19 weeks (1-h sessions, 3 sessions/wk). A physical therapist, an occupational therapist, and an exercise

instructor supervised each exercise session consisting of 9 to 12 participants. The exercise programs took place in a community hall. In the arm group, the participants underwent an exercise program designed to improve upper-extremity function. The overall aim was to prevent learned nonuse and to improve functional abilities of the paretic upper extremity through self directed exercises. The participants were required to rotate through 3 exercise stations (fig 1). In station 3, electric stimulation

of the wrist extensors was provided to those with less than 20° of active wrist extension (n10), by using an electric muscle stimulatorb (frequency, 100Hz; pulse duration, 150s; on time, 10s; off time, 10s; ramp, 1s; treatment time, 1015min). Each exercise session had a brief (5min) warm-up and cool-down period in which the participants performed upper-extremity stretches and active or self-assisted range of motion exercises. The specific exercises performed in each session were recorded in a log book provided for each participant. The participants were expected to be more self-directed as the trial progressed, by following the exercise protocol recorded in the log book. Any adverse symptoms (ie, excessive fatigue, pain, injuries) were reported to the therapists.

Station 1: Shoulder exercises

1. Theraband exercises.

Movements: flexion, abduction,

extension, external rotation

(progressed by increasing the

resistance of theraband and

increasing repetitions from 2 sets of

10 to 3 sets of 15).

Station 2: Range of motion, weightbearing

activities, and elbow/wrist

exercises

1. Passive or self-assisted range of

motion for joints with no or minimal

active movement.

2. UE weight-bearing activities (eg

pushing down on a physio ball, pushups

on the armrest of chair).

3. Dumbbell/wrist cuff weight exercises.

Movements: elbow/wrist flexion,

extension (progressed by increasing

the weight and increasing repetitions

from 2 sets of 10 to 3 sets of 15).

Station 3: Hand activities and functional training

1. Hand muscle strengthening:

Exercises using putty, grippers (movements: pinch,

grip, finger extension) (progressed by increasing the

resistance of the putty and grippers and increasing

repetitions from 2 sets of 10 to 3 sets of 15).

2. Functional activities: playing cards, picking up

objects of various sizes and shapes, reaching tasks,

fine motor tasks.

3. Electric stimulation to wrist extensors (only for

those with less than 20° of active wrist extension).

Fig 1. Exercise training protocol:

arm group. Participants in

the arm group were required

to rotate through 3 exercise

stations to work on different

upper-extremity (UE) tasks.

TREATMENT GROUP 2: Participants in both the arm and leg groups underwent an exercise program for 19 weeks (1-h sessions, 3 sessions/wk). A physical therapist, an occupational therapist, and an exercise

instructor supervised each exercise session consisting of 9 to 12 participants. The exercise programs took place in a community hall. The leg exercise group participated in a lower-extremity exercise program (fig 2). No upper-extremity exercises were performed in this group.

Station 1: Cardiorespiratory fitness and

mobility

1. Brisk walking.

2. Sit-to-stand: progressed by reducing the

height of chair.

3. Alternate stepping onto low risers:

progressed by increasing the height of

the stepper and/or reducing arm

support.

Duration: started at 10min, with increment

of 5min every week, up to 30min of

continuous exercise.

Intensity: started at 40%–50% Heart rate

reserve (HRR), with increment of 10%

HRR every 4 weeks, up to 70%–80% HRR,

as tolerated.

Station 2: Mobility and balance

1. Walking in different directions

2. Tandem walking

3. Walking through an obstacle

course

4. Sudden stops and turns during

walking

5. Walking on difference surfaces

(carpet, foam)

6. Standing on a balance disk or

wobble board

7. Standing with 1 foot in front of the

other

8. Kicking ball with either foot

Progressed by reducing arm support

and increasing speed of movement

Station 3: Lower-extremity muscle strength

1. Partial squats: progressed by increasing movement magnitude

2. Toe rises: progressed from bilateral rises to unilateral rises on either

leg

Progressed by increasing the number of repetitions (from 2 sets of 10 to 3

sets of 15) and by reducing arm support. Fig 2. Exercise training protocol:

leg group. Participants in

the leg group underwent a leg

exercise program.

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## Park et al. Effectiveness of community-based ambulation training for walking function of post-stroke hemiparesis: a randomized controlled pilot trial. CR. 2011.

CONTROL GROUP: All subjects received a routine physical therapy.

TREATMENT GROUP: All subjects received a routine physical therapy. The subjects in the experimental group also received community-based ambulation training, which was performed for an hour, once a day, three times a week for a four-week period. For the 10-m walk test, the subjects were instructed to walk as fast as possible on a 12-m indoor walkway. Walking aids and/or foot orthoses were used, if required. To avoid the effects of acceleration and deceleration, measurements were obtained for the middle 10-m stretch of the walkway.2 The time taken for walking at a self-adopted maximum speed was measured using a stopwatch (AST, KK-5898, USA). The 10-m walk test has high test–retest reliability in patients

with stroke (intraclass coefficient (ICC)¼0.87).13 The 6-minute walk test is a useful assessment tool for exercise tolerance in deconditioned individuals 14 and is reported to have high test–retest reliability with regard to measuring the distance travelled by individuals with neurological deficits (ICC¼0.94).15 The subjects were instructed to walk repeatedly along a 20-m walkway for 6 minutes, with or without a walking aid.16 Rest periods were allowed at the subjects’ request. The assessor did not encourage the subjects. The maximum distance walked in 6 minutes was recorded. The community walk test was performed on a walking route that involved crossing the street, stepping up and down the ramp/kerb, and stepping over some street obstacles. The walking path for testing was newly established to avoid the learning effect with respect to training routes that may have been used for subjects from the experimental group during community ambulation training aimed to evaluate walking function in an actual community situation. In accordance with suggestions made with respect to community ambulation in a study performed by Lerner-Frankiel et al.,17 the subjects were instructed to walk at a comfortable pace for 300-m in a community near our hospital. The time taken to walk 300-m was measured and multiplied by a factor corresponding to the level of walking aid used (no aid, \_1; ankle foot orthosis, \_2; mono cane, \_3; quadruped cane, \_4; ankle foot orthosis and mono cane, \_5; and ankle foot orthosis and quadruped cane, \_6).

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## Park et al. A Comparison of the Effects of Overground Gait Training and Treadmill Gait Training According to Stroke Patients’ Gait Velocity. J Phys Ther Sci. 2013.

TREATMENT GROUP 1 overground gait training: The OGT group and the TCT group received gait training for 30 min twice a day, before noon and after noon for five days, 10 times in total. The OGT group walked in a treatment room where a 30-m track was installed, under the supervision of a therapist who walked behind them, and the TGT group walked at a comfortable speed on a treadmill

(Kobe-950, Kobe, Korea) fallowing the method presented by Langhammer and Stanghelle15). The treadmill speed started at the lowest velocity and was increased within 1 min in line with each patient’s gait level. Measurement was made prior to the training and after 4 weeks of training.

The same procedures were followed for both the fast group and the slow group.

TREATMENT GROUP 2 treadmill gait training: The OGT group and the TCT group received gait training for 30 min twice a day, before noon and after noon for five days, 10 times in total. the TGT group walked at a comfortable speed on a treadmill (Kobe-950, Kobe, Korea) fallowing the method presented by Langhammer and Stanghelle15). The treadmill speed started at the lowest velocity and was increased within 1 min in line with each patient’s gait level. Measurement was made prior to the training and after 4 weeks of training.

The same procedures were followed for both the fast group and the slow group.

TREATMENT GROUP 3 overground gait training (less impaired group): The OGT group and the TCT group received gait training for 30 min twice a day, before noon and after noon for five days, 10 times in total. The OGT group walked in a treatment room where a 30-m track was installed, under the supervision of a therapist who walked behind them, The treadmill speed started at the lowest velocity and was increased within 1 min in line with each patient’s gait level. Measurement was made prior to the training and after 4 weeks of training. The same procedures were followed for both the fast group and the slow group.

TREATMENT GROUP 4 treadmill gait training (less impaired group): The OGT group and the TCT group received gait training for 30 min twice a day, before noon and after noon for five days, 10 times in total. the TGT group walked at a comfortable speed on a treadmill (Kobe-950, Kobe, Korea) fallowing the method presented by Langhammer and Stanghelle15). The treadmill speed started at the lowest velocity and was increased within 1 min in line with each patient’s gait level. Measurement was made prior to the training and after 4 weeks of training.

The same procedures were followed for both the fast group and the slow group.

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## Parker et al. A multicentre randomized controlled trial of leisure therapy and conventional occupational therapy after stroke. CR. 2001.

CONTROL GROUP 1: Participants allocated to the two treatment groups received occupational therapy interventions at home for up to six months after recruitment. The protocol specified a minimum of 10 sessions lasting not less than 30 minutes each. Participants allocated to the control group received no occupational therapy treatment within the trial. All participants were eligible for any existing rehabilitation services provided in their area, such as day hospital visits.

TREATMENT GROUP 1: Participants allocated to the two treatment groups received occupational therapy interventions at home for up to six months after recruitment. The protocol specified a minimum of 10 sessions lasting not less than 30 minutes each. For the leisure group, goals were set in terms of leisure activity and so interventions included practising the leisure tasks as well as any ADL tasks necessary to achieve the leisure objective. The treating therapist used a standard form to record brief details of date and duration of sessions. All participants were eligible for any existing rehabilitation services provided in their area, such as day hospital visits.

TRETMENT GROUP 2: Participants allocated to the two treatment groups received occupational therapy interventions at home for up to six months after recruitment. The protocol specified a minimum of 10 sessions lasting not less than 30 minutes each. The treatment goals set in the ADL group were in terms of improving independence in self-care tasks and therefore treatment involved practicing these tasks (such as preparing a meal or walking outdoors). All participants were eligible for any existing rehabilitation services provided in their area, such as day hospital visits.

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## Parry et al. Effect of severity of arm impairment on response to additional physiotherapy early after stroke. CR. 1999.

CONTROL GROUP 1: Ten hours additional physiotherapy were given over a five-week period A control ‘routine physiotherapy’ group received no additional physiotherapy.

TREATMENT GROUP 1: Ten hours additional physiotherapy were given over a five-week period. . One intervention group received additional treatment from a qualified experienced physiotherapist. The additional physiotherapy in both intervention groups aimed to follow the approach of usual British practice, thus providing ‘more of the same’ rather than a different approach to treatment.

TREATMENT GROUP 2: Ten hours additional physiotherapy were given over a five-week period. a further group were treated by an assistant who was trained and supervised by the same physiotherapist. The additional physiotherapy in both intervention groups aimed to follow the approach of usual British practice, thus providing ‘more of the same’ rather than a different approach to treatment.

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## Partridge et al. Is dosage of physiotherapy a critical factor in deciding patterns of recovery from stroke: a pragmatic randomized controlled trial. PRO. 2000.

CONTROL GROUP 1: The control group received 30 minutes’ treatment per day (that previously available in the unit). After subjects signed their informed consent forms, assessments were undertaken by the treating physiotherapist then after six weeks and six months, by the research associate.

TERATMENT GROUP 1: the intervention group received 60 minutes’ treatment per day. After subjects signed their informed consent forms, assessments were undertaken by the treating physiotherapist then after six weeks and six months, by the research associate.

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## Patten et al. Concurrent neuromechanical and functional gains following upper-extremity power training post-stroke. J NEO ENG REHAB. 2013.

CONTROL GROUP 1: design. All participants received both functional task practice (FTP) and HYBRID (combined FTP and power training) in random order. 26]. All participants received both the control (FTP) and experimental (HYBRID) interventions, randomized to treatment order (Figure 1). Treatment Order A was operationally defined as FTP followed by HYBRID. Treatment was delivered in two 4-week blocks of twelve sessions each, interspersed with a 4-week washout period. Thus, each participant received a total of 24 sessions of one-on-one treatment with a physical therapist over a 12- week period. All participants were treated by the same physical therapist. Blinded evaluators conducted clinical and neuromechanical assessments at: baseline, following each block of therapy, following the washout period, and again at 6-months post-intervention.

TREATMENT GROUP 1: design. All participants received both functional task practice (FTP) and HYBRID (combined FTP and power training) in random order. All participants received both the control (FTP) and experimental (HYBRID) interventions, randomized to treatment order (Figure 1). Treatment Order B as HYBRID followed by FTP. . Treatment was delivered in two 4-week blocks of twelve sessions each, interspersed with a 4-week washout period. Thus, each participant received a total of 24 sessions of one-on-one treatment with a physical therapist over a 12- week period. All participants were treated by the same physical therapist. Blinded evaluators conducted clinical and neuromechanical assessments at: baseline, following each block of therapy, following the washout period, and again at 6-months post-intervention.

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## Peurala et al. The Effectiveness of Body Weight–Supported Gait Training and Floor Walking in Patients With Chronic Stroke. AMPR. 2005.

CONTROL GROUP 1: All patients practiced gait for 15 sessions during 3 weeks (each session, 20min), and they received additional physiotherapy 55 minutes daily. The objective of the 3-week inpatient rehabilitation for our patients with chronic stroke was to improve their walking independence at home. Each patient practiced for 20 minutes walking either (1) in the electromechanical gait trainer (Gait Trainera) (fig 1) with FES (GTstim group), (2) in the gait trainer without stimulation (GT group), or (3) overground (WALK group). The duration of the walking exercise in each group was 20 minutes. Each patient also received other physiotherapy (PT) for 55 minutes daily every workday for 3 weeks. The PT sessions and the walking exercises were based on individually set goals but were always aimed at improving gait. The WALK group practiced walking overground or over uneven terrain with their individual walking aids. In the WALK group, the training progression was carried out by increasing the speed with the aim of decreasing reliance on walking aids or different surfaces for walking.

TREATMENT GROUP 1: All patients practiced gait for 15 sessions during 3 weeks (each session, 20min), and they received additional physiotherapy 55 minutes daily. The objective of the 3-week inpatient rehabilitation for our patients with chronic stroke was to improve their walking independence at home. Each patient practiced for 20 minutes walking either (1) in the electromechanical gait trainer (Gait Trainera) (fig 1) with FES (GTstim group), (2) in the gait trainer without stimulation (GT group), or (3) overground (WALK group). The duration of the walking exercise in each group was 20 minutes. Each patient also received other physiotherapy (PT) for 55 minutes daily every workday for 3 weeks. The PT sessions and the walking exercises were based on individually set goals but were always aimed at improving gait. In the gait trainer (GTstim, GT), a patient is supported with a harness and his/her feet are placed on motor-driven footplates. The speed of the gait trainer can be selected from 0 to 2km/h, which determines the number of steps during each session. The amount of the body weight supported by the harness is chosen according to each patient’s needs. In the GTstim and GT groups, the training progression was carried out by increasing the speed and aiming to support less than 20% of the body weight.16,17 The GTstim group received FES with surface electrodesb for the 2 individually selected muscles that were weakest on each patient’s paretic lower extremity. The frequency of the stimulation was 25Hz, with a pulse width of 0.3ms. The onset of stimulation was electrically synchronized to the gait pattern. The duration of the stimulation at each muscle was set with the help of an oscilloscopec for the individually functionally beneficial phase of the gait cycle. The duration of the stimulation decreased while the gait speed increased. The stimulation was delivered at an appropriate phase of the gait cycle, depending on the muscle to be stimulated. The synchronization trigger was delivered by the motor, which controlled the movement of the footplate propulsion.

TREATMENT GROUP 2: All patients practiced gait for 15 sessions during 3 weeks (each session, 20min), and they received additional physiotherapy 55 minutes daily. The objective of the 3-week inpatient rehabilitation for our patients with chronic stroke was to improve their walking independence at home. Each patient practiced for 20 minutes walking either (1) in the electromechanical gait trainer (Gait Trainera) (fig 1) with FES (GTstim group), (2) in the gait trainer without stimulation (GT group), or (3) overground (WALK group). The duration of the walking exercise in each group was 20 minutes. Each patient also received other physiotherapy (PT) for 55 minutes daily every workday for 3 weeks. The PT sessions and the walking exercises were based on individually set goals but were always aimed at improving gait. In the gait trainer (GTstim, GT), a patient is supported with a harness and his/her feet are placed on motor-driven footplates. The speed of the gait trainer can be selected from 0 to 2km/h, which determines the number of steps during each session. The amount of the body weight supported by the harness is chosen according to each patient’s needs. In the GTstim and GT groups, the training progression was carried out by increasing the speed and aiming to support less than 20% of the body weight.16,17 The GTstim group received FES with surface electrodesb for the 2 individually selected muscles that were weakest on each patient’s paretic lower extremity. The frequency of the stimulation was 25Hz, with a pulse width of 0.3ms. The onset of stimulation was electrically synchronized to the gait pattern.

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## Piron et al. Reinforced Feedback in Virtual Environment Facilitates the Arm Motor Recovery in Patients after a Recent Stroke. VIRTUAL REHAB. 2007.

CONTROL GROUP 1: For both groups the therapy lasted from 5 to 7 weeks, 1 hour daily for five days a week. thirteen patients (Control Group) received an equal amount of a conventional rehabilitation (CR) therapy focused to the upper limb.

TREATMENT GROUP 1: Twenty-five subjects (RFVE Group) received Reinforced Feedback in Virtual Environment (RFVE) therapy for the arm. For both groups the therapy lasted from 5 to 7 weeks, 1 hour daily for five days a week. During RFVE therapy, the subject was seated in front of the wall screen grasping a real object, and the physical objects, such as an envelope and a mailbox, a hammer and a nail, a glass and a carafe, respectively. Virtual handling object matched the real object held by the subject. While performing virtual tasks, such as putting the envelope in the mailbox, hitting the nail, or pouring the glass in the carafe, which is applied the magnetic receiver. the subject moves the real envelope, hammer, or glass and see on the screen the trajectory of the corresponding virtual object toward the virtual mailbox, nail, or carafe (fig. 1). only their own movement but also the correct trajectory that they had to execute, prerecorded by the physical therapist. This setting allowed subjects to easily perceive motion RFVE Group errors and adjust them during the task. Once subjects completed adequately the required task, the system provided a rewarding signal. The physical therapist can increase or decrease the complexity of the exercise by modifying the Clinical parameters position of the target object or the pathway to reach it. For instance, the motor procedure required posting the changed with the virtual position of the mailbox in the workspace (close or far) and/or with the orientation of the mailbox slot (vertical, diagonal, or horizontal). This strategy allowed patients to take advantage of executing a large variety of goal oriented movements tailored to their individual motor deficits. Both groups underwent a CR program for lower limb and balance impairments, aphasia or others cognitive deficits.

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## Piron et al. EFFECTS OF INTENSIVE THERAPY USING GAIT TRAINER OR FLOOR WALKING EXERCISES EARLY AFTER STROKE. J REHAB MED. 2009.

CONTROL GROUP 1: The objective of our 3-week in-patient rehabilitation for acute patients was to enhance their motor abilities and help them regain their walking independence as soon as possible. For 3 weeks each patient a maximum of 1 h/day to obtain 20 min actual walking either in the electromechanical gait trainer (Gait Trainer, Reha-Stim, Berlin, Germany) or over ground. Each patient also received additional gaitoriented physiotherapy for 55 min daily. The patients in the CT group were most often transferred to a health centre after the first set of measurements. Thereafter, they visited the hospital on testing days. While in the health centre, the patients normally had 1 or 2 physiotherapy sessions daily, but not at the same intensity as in the GT and WALK groups. The content of physiotherapy in the CT group was determined according to individually set goals.

TREATMENT GROUP 1: The objective of our 3-week in-patient rehabilitation for acute patients was to enhance their motor abilities and help them regain their walking independence as soon as possible. For 3 weeks each patient a maximum of 1 h/day to obtain 20 min actual walking either in the electromechanical gait trainer (Gait Trainer, Reha-Stim, Berlin, Germany) or over ground. Each patient also received additional gaitoriented physiotherapy for 55 min daily. In the GT, the patient was supported with a harness and his or her feet were placed on motor-driven footplates. The amount of body weight support (BWS) provided by the harness was chosen according to the patient's individual needs. The percentage of BWS was recorded (kg). In the WALK group, the patients practiced walking over ground with 1 or 2 physiotherapists, using their individual walking aids. The training in the GT and WALK groups was progressed by increasing the speed and decreasing the amount of BWS or manual guidance and reliance on walking aids (for more details see (16)).

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## Piron et al. Motor Learning Principles for Rehabilitation: A Pilot Randomized Controlled Study in Poststroke Patients. NNR. 2010.

CONTROL GROUP 1: This prospective, single-blinded, randomized controlled trial compared reinforced feedback in a virtual environment (RFVE; n = 27) with a control intervention (n = 20) of progressive therapy for the affected upper extremity. Both treatments were provided for 4 weeks, 5 days per week, with 1-hour treatment sessions daily. The CT program was based on Bobath principles. The subjects were asked to perform specific exercises with the upper limb with progressive complexity. First, the patients were asked to control isolated motions without postural control; subsequently, postural control was included; and finally, complex motion with postural control was practiced. For example, patients were asked to touch different targets arranged on a horizontal plane in front of them to manipulate different objects, to follow trajectories displayed on a plane, or to recognize different arm positions. All the RFVE treatment sessions were automatically recorded by dedicated software, whereas CT sessions were reported in detail each week by the physical therapist. The treatment protocol consisted of 1 hour of RFVE or CT therapy daily, 5 days per week, for 4 weeks.

TREATMENT GROUP 1: This prospective, single-blinded, randomized controlled trial compared reinforced feedback in a virtual environment (RFVE; n = 27) with a control intervention (n = 20) of progressive therapy for the affected upper extremity. Both treatments were provided for 4 weeks, 5 days per week, with 1-hour treatment sessions daily. Throughout the duration of the trial, 2 groups of 7 physical therapists were involved with the experimental RFVE treatment and conventional physical therapy. For RFVE, the subject was asked to perform different kinds of motor tasks while the movement of the entire biomechanical arm system’s end section (end-effector) was simultaneously represented in a virtual scenario by means of motion-tracking equipment. The equipment included a computer workstation connected to a 3D motion-tracking system (Polhemus 3Space FasTrak, Colchester, VT) and a high-resolution LCD projector displaying the virtual scenarios on a large wall screen. The electromagnetic 3D motion-tracking sensor was positioned on a manipulatable object (eg, rubber ball, polystyrene cube) held by the subject or was alternatively attached to a glove worn by the patient in cases of severe grasping deficits. The physical therapist could create numerous virtual motor tasks for the arm through the use of flexible software developed at the Massachusetts Institute of Technology (Cambridge, MA), which elaborated the motion data coming from the endeffector receiver. The software permitted the alignment of the virtual scene with the patients’ positions, applying a rigid body transformation to the entire scenario, and the synchronization of the teacher animation with patient movement.15 The RFVE therapist selected the characteristics and complexity of the motor tasks to suit each patient’s arm deficit. In the virtual scenario, the therapist determined the starting position and the target of each task, such as target orientation or the addition of other virtual objects, to increase the complexity of the task. A simple reaching movement could accomplish some tasks, whereas others required more complicated movements. During the RFVE therapy, patients were asked to perform motor tasks according to constraints specified beforehand by the therapist. Subjects were given information about their arm movements during the performance of motor skills

(ie, knowledge of performance [KP]) by the movement of the virtual representation of the end-effector. The therapist’s movement and trajectory was displayed in the background of the virtual scene to facilitate the subject’s perception and adjustment to motion errors (learning by imitation).16 Moreover, knowledge of results (KR) regarding motor task correctness was supplied to patients in the form of standardized scores and by displaying arm trajectory morphology on the screen. Initially, the above-mentioned KP and KR were provided at a frequency of more than 90%, but this was gradually decreased as performance improved. In all the trials, the subject, seated in front of the wall screen where the scene was represented, had to move from a starting position at knee level to a target positioned 75 cm in front of the ipsilateral shoulder and approximately 60 cm above the starting position in the same sagittal plane (Figure 1). The different orientations of the target (eg, horizontal, vertical, and diagonal on the subject’s frontal plane) determined the complexity of the movement in terms of involving the activation of different muscles.

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## Platz et al. Impairment-oriented training or Bobath therapy for severe arm paresis after stroke: a single-blind, multicentre randomized controlled trial. CR. 2005.

CONTROL GROUP 1: (A) no augmented exercise therapy time: During the four-week interval between pre- and posttest, all patients received the usual standard rehabilitation therapy The treatment made use of different therapeutic concepts and addressed various issues such as activities of daily living, arm activities, stance and gait, speech and cognition.

TREATMENT GROUP 1: (B) augmented exercise therapy time as Bobath therapy: During the four-week interval between pre- and posttest, all patients received the usual standard rehabilitation therapy The treatment made use of different therapeutic concepts and addressed various issues such as activities of daily living, arm activities, stance and gait, speech and cognition. For the Bobath approach, a study manual served the experienced physiotherapists as the basis for the study treatment. Its design had been supervised by a senior Bobath instructor. The emphasis has been on control of muscle tone and recruitment of arm activity in functional situations with various positions (i.e., lying, sitting, standing, walking, both with and without objects and during unilateral or bilateral tasks).

TREATMENT GROUP 2: (C) augmented exercise therapy time as Arm BASIS training: During the four-week interval between pre- and posttest, all patients received the usual standard rehabilitation therapy The treatment made use of different therapeutic concepts and addressed various issues such as activities of daily living, arm activities, stance and gait, speech and cognition. For the Bobath approach, a study manual served the experienced physiotherapists as the basis for the study treatment. Its design had been supervised by a senior Bobath instructor. The emphasis has been on control of muscle tone and recruitment of arm activity in functional situations with various positions (i.e., lying, sitting, standing, walking, both with and without objects and during unilateral or bilateral tasks). The Arm BASIS training is a systematic repetitive training technique for hemiparetic patients.9"'

During each training session, all degrees of freedom of the arm are repetitively trained across the full range of motion. The patient is encouraged to perform selective dynamic movements across the range of motion in individual planes of individual arm joints. The training is first without active postural stabilization of the limb to promote dynamic control. The therapist substitutes for any incapacity of the patient to perform movements actively and provides feedback about any movement success (in terms of selective dynamic motion) or failure. Once selective dynamic motion across the full range of motion of single joints has been re-established, the interplay between postural stabilization and dynamic control is trained, and finally multijoint co-ordination. The training comprises three consecutive stages: 1) selective innervation for isolated motions without postural control,

2) selective innervation for isolated motions with

postural control,

3) selective innervation for complex motions

with postural control.

At each stage the various degrees of freedom of the arm are systematically and repetitively trained. At stage 1 single-joint movements are trained with concentric contractions, but not against gravity. The aim of stage 1 is to restore (fast and forceful as well as nonsegmented) dynamic motion control across the full range of motion for individual joints without postural control. Single joint motions are also trained in stage 2 of the Arm BASIS training.

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## Platz et al. Best Conventional Therapy Versus Modular Impairment-Oriented Training for Arm Paresis After Stroke: NNR. 2009.

CONTROL GROUP 1: *Inflatable splint arm therapy.* A standardized set of 5 different hand/arm pressure splints of various sizes was used. Hand and/or arm of the paretic arm were positioned in an antispastic position. A manual described the usage of the inflatable splints and suggested a sequence of applications that varied from day to day to enhance patient compliance.

CONTROL GROUP 2: *Conventional treatment.* During conventional treatment experienced occupational therapists and/or physiotherapists provided individualized arm rehabilitation therapy on a one-toone basis. Based on their past therapeutic experience and individual patient characteristics they were free to select whatever they regarded the best possible physical therapy regimen. The term *best* refers to the fact that therapeutic choices were individually taken in every patient’s best interest; it does not imply that evidenced-based guidelines had been used. Study therapists were not restricted in terms of the type of therapeutic approach they choose; devices such as arm therapy robots or functional electrical stimulation could, however, not be used

TREATMENT GROUP: *Impairment-oriented training.* The Arm BASIS training15-17 addresses the lack of selective movements in severe arm paresis. For each single degree of freedom of the arm and hand, selective movements (dynamic control with a high degree of reciprocal inhibition and as little co-contraction as possible) are systematically restored by a repetitive training of isolated motions across the full range of motion in that segment. During the first phase the therapist takes over the weight of the arm (no postural control should be carried out by the patient) and assists the movement as far as the patient cannot move on her or his own. Once the full active range of motion is achieved, the combination of dynamic and postural control is relearnt for this isolated motion; only then will prespecified multijoint movements and coordination be trained. The Arm Ability training15,16 trains different abilities such as speed, aiming, dexterity, tracking, and steadiness. The selection of training tasks covers these different sensorimotor control affordances and is thereby comprehensive in terms of their relevance for motor performance in many different circumstances as encountered during daily life. In addition, variation of task difficulty is implemented in each type of training task to enhance motor learning. Work load is individually standardized in line with the baseline motor capacities of each patient. During the training, patients are continuously encouraged to try to fulfill their workload in even shorter time but without compromise for the individual tasks’ accuracy demands. This progress (knowledge of result) is intermittently shown to the patient for each type of task during training sessions using diagrams on a PC screen (Arm Ability software). Because the IOT was not established in the participating rehabilitation centers, study personnel had to be trained in the lead study center before patient recruitment commenced.

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## Pohl et al. Speed-Dependent Treadmill Training in Ambulatory Hemiparetic Stroke Patients. STROKE. 2002.

CONTROL GROUP 1: Physiotherapeutic gait therapy based on the latest description of the principles of the proprioceptive neuromuscular facilitation (PNF) and Bobath concepts15,16 was performed by experienced and skilled therapists with additional qualification in the PNF and Bobath techniques.

TREATMENT GROUP 1: The goal of STT was to achieve an increase in walking speed with each training session. All patients wore an unweighted safety belt. The patients were assisted during the treadmill training by a physical therapist, but the therapist gave no assistance in the actual performance of the movements. Because of the high belt speeds, the therapist was unable to provide any direct facilitation of the walking cycle. The maximum overground walking speed (V0max) was determined before the first training session. This speed was then halved and used for a 5-minute warm-up on the treadmill. After the warm-up, the first speed-dependent training phase (Vt1) began. During a period of 1 to 2 minutes, the belt speed was increased, in communication with the patient, to the highest speed at which the patient could walk safely and without stumbling. This maximum-achieved belt speed (Vt1) was held for 10 seconds, followed by a recovery period during which the patient’s pulse was allowed to return to its resting level. If the patient maintained the speed and felt safe during the 10 seconds at Vt1, the speed would then be increased by 10% during the next attempt. This speed (Vt2) was again held for 10 seconds, followed by another recovery period. If the patient, during any phase, was unable to maintain the speed, felt unsafe, or stumbled on the belt, the speed was reduced by 10% in the next phase (V0max\_10%, Vt1\_10%, Vt2\_10%, . . .). Each time the patient successfully completed 10 seconds of walking at the set speed, the speed was increased during the next phase by 10%. Over the course of each training session, the speed was increased at least by a factor of 3 and at most by a factor of 5 (Vt1 to Vt5). The total walking distance varied from session to session. At the next training session, the treadmill would be set (after a short warm-up) to the last-achieved maximum speed from the previous session. The treadmills were run at 0% incline.

TREATMENT GROUP 2: For the LTT group, the training speed was increased by no more than 5% of the maximum initial walking speed each week (20% over 4 weeks). The total walking distance was also allowed to vary in this group. During training, the therapist directly assisted the patients in executing the walking cycle. The treadmills were run at 0% incline.

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## Pohl et al. Repetitive locomotor training and physiotherapy improve walking and basic activities of daily living after stroke: a single-blind, randomized multicenter trial (DEutsche GAngtrainerStudie, DEGAS). CR. 2007.

CONTROL GROUP 1: Intervention: Group A received 20 min locomotor training and 25 min physiotherapy. Group A patients received 20 min of repetitive locomotor therapy on the gait trainer, immediately followed by 25 min of one-on-one physiotherapy every week day for four weeks (i.e. 20 45-min sessions). Additional time for preparation was not to exceed a total of 15 min in both groups, limiting the total patient\_therapist contact time to 60 min daily. The remaining comprehensive rehabilitation programme, including group but no additional individual physiotherapy sessions, was the same for both groups. The physiotherapy in both groups concentrated exclusively on the restoration of stance and gait, comprising at least 60% of the net therapy time. Initially two therapists assisted the patient’s gait on the floor and on the stairs; with further improvement less and less help was required. A data sheet asked the therapists to tick off the specific content and time needed. Occupational therapy was implemented for upper limb rehabilitation

TREATMENT GROUP 1: group B had 45 min physiotherapy every week day for four weeks. Group B patients received 20 45-min sessions of physiotherapy in the same period. The gait training machine consisted of two footplates whose driven movements simulated stance and swing; the movements of the centre of by ropes attached to the harness (Figure 1). During the locomotor training, patients wore a harness, were initially transferred onto the machine with the help of a lifter, and later stepped into it. They practised up to 20 min, with the option of a break in between, and were then reseated into the wheelchair. The step length was 48 cm, the cadence was individually adjusted to a comfortable training velocity ranging from 1.4 to 1.8 km/h. The initial weight support ranged from 10% to 20% body weight, being reduced as rapidly as possible. Initially one therapist sat in front of the patient assisting the paretic knee control, but with further improvement patients practised independently in the gait trainer. The physiotherapy in both groups concentrated exclusively on the restoration of stance and gait, comprising at least 60% of the net therapy time. Initially two therapists assisted the patient’s gait on the floor and on the stairs; with further improvement less and less help was required. A data sheet asked the therapists to tick off the specific content and time needed. Occupational therapy was implemented for upper limb rehabilitation.

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## Pomeroy et al. The SWIFT Cast trial protocol: a randomized controlled evaluation of the efficacy of an ankle–foot cast on walking recovery early after stroke and the neural–biomechanical correlates of response. IJS. 2011.

CONTROL GROUP 1: All participants will receive CPT deemed appropriate for their presentation by the clinical physiotherapists using a standardized treatment schedule to record therapy given (24). The clinical physiotherapists providing CPT will be trained to use the treatment schedule and will document content and amount of treatment provided each day as in our earlier trial (25). Participants allocated to the control group will receive CPT. A SWIFT Cast will not be provided.

TREATMENT GROUP 1: All participants will receive CPT deemed appropriate for their presentation by the clinical physiotherapists using a standardized treatment schedule to record therapy given (24). The clinical physiotherapists providing CPT will be trained to use the treatment schedule and will document content and amount of treatment provided each day as in our earlier trial (25). Participants allocated to the experimental group will receive a SWIFT Cast in addition to CPT. Research therapists will make the SWIFT Cast on the first day of the intervention phase and fit it on the subsequent day. Training of therapists will take place before any participants are recruited and will be ongoing throughout the trial to maintain consistency in procedure. A SWIFT Cast is a lightweight (100–200 g), semirigid cast extending from the metatarsal heads to the head of the fibula. It positions the paretic foot in relation to the shank so that plantarflexion and/or excessive pronation/supination of the foot is minimized during walking and so that the ground reaction force vector assumes the normal direction: for example, passing behind the knee in the loading phase. It is made from Soft Cast and Scotch (3M PLC, Loughborough, UK). The SWIFT Cast will be made with a participant in a sitting position that allows the hips, knees, and ankles to be at 90 degrees. A research therapist will apply the materials required while maintaining the paretic ankle and foot in the plantigrade position, avoiding either pronation or supination at the subtalar joint and so that the tibia is in five to 10 degrees of tibilal inclination from the vertical. An assistant may be required to help maintain the correct position during casting. Two stockinet layers are applied to the lower leg, fromthe knee joint line to approximately 2·5 cm beyond the level of the toes. Bony prominences (ankle malleoli) are covered with self adhering microfoam to the outer layer of stockinet. A cutting spacer is then inserted between the two layers running on top of the fourth and fifth metatarsal bones and laterally along the shank (Fig. 2a).A roll of soft cast bandage is applied below the head of the fibula, with half-layered overlaps as it is wrapped around the lower leg.A figure of eight wrap is used around the ankle and continued until the toes are covered. A six-layer Scotch back slab is then applied from the level of the head of the fibula to the end of toes (Fig. 2b). Another soft-cast bandage is applied, in the same fashion as the first. A wet crepe bandage is applied, covering the whole SWIFT Cast. The SWIFT Cast is then molded to maintain arch support and align the ankle. The SWIFT Cast is left to dry for five–minutes, maintaining this alignment with assistance if required, and is cut off along the cutting spacer. The front section of the cast is then cut out along a line just anterior to the head of the fibula, just anterior to the lateral malleolus and just medial to the fifth metatarsal joint (Fig. 2c). The medial cut is made so that the SWIFT Cast is as symmetrical as possible. The SWIFT Cast is left to set for 24 h before Leukotape (BFN Medical Ltd., Hull, UK) is used to cover all edges andVelcro straps are applied just above the ankle and just below the knee. The participant will then put on the completed SWIFT Cast together with a strong plaster shoe (Darco Multifit Surgical Trauma Shoe rounded toe, Markell Shoe Co., Yonkers, NY, USA) (Fig. 2d). The research therapist then observes the participant standing while wearing the SWIFT Cast. If the tibia is not in 5 to 10 degrees of inclination from the vertical, a wedge will be placed under the heel in the plaster shoe to tilt the tibia slightly forwards (tuning). Any increased leg length asymmetry asymmetry due to wearing the SWIFT Cast will be corrected using an insole in the shoe on the nonparetic foot. During CPT sessions, the SWIFT Cast will be worn for retraining of walking as deemed clinically appropriate by the treating physiotherapist. As gait improves, there will be periods of walking retraining without wearing the SWIFT Cast. Outside of CPT sessions, the participants will be requested to wear the SWIFT Cast for the whole of their waking day initially. As gait improves the Research Therapist will adjust use of the SWIFT Cast as clinically appropriate. Each participant will keep a diary to record the number of hours that the SWIFT Cast is worn each day and to make free comments about its use. Each time the SWIFT Cast is applied/ removed, the lower limb will be assessed for skin integrity (adverse event monitoring later section). If a participant is discharged from an inpatient care setting during the six-week intervention period then, he or she will continue wearing the SWIFT Cast in his or her home as long as the participant is visited regularly to ensure that skin integrity is monitored. If an individual regains the ability to walk independently with a normal gait pattern during the six-week intervention period, then use of the SWIFT Cast will be discontinued as it will not be clinically indicated. Discontinuation of a SWIFT Cast might also occur due to adverse events (see later section). If an individual discontinues using a SWIFT Cast before the end of the six-week intervention phase, then the time period for which it was worn will be recorded.

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## Popovic et al. Clinical evaluation of Functional Electrical Therapy in acute hemiplegic subjects. JRRD. 2003.

CONTROL GROUP 1: The subjects from the control LFG and HFG receivedconventional physiotherapy. Thirty minutes of superviseddaily exercise with the paretic arm and hand were addedthat included the same tasks as the FET groups, yet withouta neural prosthesis. Control group hemiplegic subjects were offered FET after the 26 weeks long study if they were interested.

CONTROL GROUP 2: The subjects from the control LFG and HFG receivedconventional physiotherapy. Control group hemiplegic subjects were offered FET after the 26 weeks long study if they were interested. Thirty minutes of superviseddaily exercise with the paretic arm and hand were addedthat included the same tasks as the FET groups, yet withouta neural prosthesis.

TREATMENT GROUP 1: *FET Groups:* FET is an exercise program that comprises voluntary arm movements and opening, closing, holding, and releasing of objects that are assisted by a neural prosthesis (electrical stimulation). FET consisted of a 30 min everyday exercise for 3 consecutive weeks in addition to conventional therapyThe subjects from the FET groups, in addition to conventionaltherapy, performed 30 min long exercise with theparetic arm and hand every day during 3 consecutiveweeks. The conventional therapy was a comprehensivetreatment introduced by Bobath [23]. This exercise was assisted with a neural prosthesis that controlled the opening, grasping, and releasing functions by mimicking natural movement. Four channels of electrical stimulation were applied via self-adhesive surface electrodes positioned over the following muscle groups: finger flexors (*m. flexor* *digitorum profundus* and *m. flexor digitorum superficialis*), finger extensors (*m. extensor digitorum communis*), thumb extensor (*m. extensor longus pollicis*), and the thenarmuscle muscle group (*m. pollicis abductor* and *m. opponens*). The positions of electrodes were carefully determined to maximize selectivity of stimulation by the experienced physical therapist. The typical stimulation parameters were frequency 50 Hz, pulse duration *T* = 200 , and stimulation intensity *I* = 20 mA – 45 mA. The timing and intensity of stimulation were programmed to mimic as closely as possible the normal prehension, grasp, and release typical for a normal hand. During FET sessions, the hemiplegic subjects were instructed to try to functionally use a toothbrush, comb, telephone receiver, pen, small food, 0.33 L can, 0.33 L bottle, 1 L container, CD (compact disc) for computer, and 0.25 L coffee mug; yet, they were not limited to these objects. The objects were selected so the subjects would be forced to practice palmar, lateral, and precision grasps. Functional use consisted of reaching, grasping, manipulating, and using an object; returning the object to the original post; and releasing the object. The hemiplegic subjects were instructed to trigger the opening synergy with their nonparetic hand at the appropriate time during the reaching phase and to trigger the release function once they accomplished effectively the task or established that they were not able to fulfill the task. During the 3 weeks of FET, the hemiplegic subjects started with easier tasks and included more difficult tasks upon their increased abilities. In most cases, the simplest tasks were the use of the can, telephone receiver, and similar round, middle-sized objects. The overall goal during a single session was to perform as many tasks as possible with the paretic arm. A trained physical therapist assisted the subjects while they were trying to reach, grasp, and functionally use objects with their paretic hand and arm. The assistance comprised ensuring the hemiplegic subjects held the object in the adequate orientation and position, if required, and even more important, instructing them as to when and how to maximize the use of the externally controlled hand. FET sessions were sometimes performed without supervision after a subject learned how to position the stimulation electrodes correctly and how to appropriately train his or her paretic arm and hand. FET sessions were performed 7 days a week within the rehabilitation institution since the study subjects were inpatients. The subjects occasionally missed FET sessions but never more then 2 days in a row.

TREATMENT GROUP 2: *FET Groups:* FET is an exercise program that comprises voluntary arm movements and opening, closing, holding, and releasing of objects that are assisted by a neural prosthesis (electrical stimulation). FET consisted of a 30 min everyday exercise for 3 consecutive weeks in addition to conventional therapy.The subjects from the FET groups, in addition to conventionaltherapy, performed 30 min long exercise with theparetic arm and hand every day during 3 consecutiveweeks. The conventional therapy was a comprehensivetreatment introduced by Bobath [23]. This exercise was assisted with a neural prosthesis that controlled the opening, grasping, and releasing functions by mimicking natural movement. Four channels of electrical stimulation were applied via self-adhesive surface electrodes positioned over the following muscle groups: finger flexors (*m. flexor* *digitorum profundus* and *m. flexor digitorum superficialis*), finger extensors (*m. extensor digitorum communis*), thumb extensor (*m. extensor longus pollicis*), and the thenarmuscle group (*m. pollicis abductor* and *m. opponens*). The positions of electrodes were carefully determined to maximize selectivity of stimulation by the experienced physical therapist. The typical stimulation parameters were frequency 50 Hz, pulse duration *T* = 200 , and stimulation intensity *I* = 20 mA – 45 mA. The timing and intensity of stimulation were programmed to mimic as closely as possible the normal prehension, grasp, and release typical for a normal hand. During FET sessions, the hemiplegic subjects were instructed to try to functionally use a toothbrush, comb, telephone receiver, pen, small food, 0.33 L can, 0.33 L bottle, 1 L container, CD (compact disc) for computer, and 0.25 L coffee mug; yet, they were not limited to these objects. The objects were selected so the subjects would be forced to practice palmar, lateral, and precision grasps. Functional use consisted of reaching, grasping, manipulating, and using an object; returning the object to the original post; and releasing the object. The hemiplegic subjects were instructed to trigger the opening synergy with their nonparetic hand at the appropriate time during the reaching phase and to trigger the release function once they accomplished effectively the task or established that they were not able to fulfill the task. During the 3 weeks of FET, the hemiplegic subjects started with easier tasks and included more difficult tasks upon their increased abilities. In most cases, the simplest tasks were the use of the can, telephone receiver, and similar round, middle-sized objects. The overall goal during a single session was to perform as many tasks as possible with the paretic arm. A trained physical therapist assisted the subjects while they were trying to reach, grasp, and functionally use objects with their paretic hand and arm. The assistance comprised ensuring the hemiplegic subjects held the object in the adequate orientation and position, if required, and even more important, instructing them as to when and how to maximize the use of the externally controlled hand. FET sessions were sometimes performed without supervision after a subject learned how to position the stimulation electrodes correctly and how to appropriately train his or her paretic arm and hand. FET sessions were performed 7 days a week within the rehabilitation institution since the study subjects were inpatients. The subjects occasionally missed FET sessions but never more then 2 days in a row.

# R Authors

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## Rabadi et al. A pilot study of activity-based therapy in the arm motor recovery post stroke: a randomized controlled trial. CR. 2008.

CONTROL GROUP 1: All patients received standard, inpatient, post-stroke rehabilitation training for 3 hours a day, plus 12 additional 40-minute sessions of the activity-based therapy. The ‘standard’ occupational therapy at this institution comprised positioning and safe-handling of the paretic arm, passive and active range of movements, and techniques incorporating motor learning, neurodevelopment and proprioceptive neuromuscular facilitative approaches. Twelve additional sessions of 40 minutes/day, five days/ week was provided, consisting of arm ergometer, robot or occupational therapy alone based on randomization. The control occupational therapy (OT) group received 40 minutes of group therapy led by a certified occupational therapist assigned to the designated stroke unit who has also completed competency in group therapy protocol. Therapy was carried out with the patient seated and followed a set protocol (self-range of motion exercises focusing on patient-directed movements at the affected shoulder, elbow and hand when able). Patients were also encouraged to use their unaffected arm in actively assisting the paretic arm movement. The paretic arm in the occupational group therapy was moved an average of 16 to 18 times per minute (to-and-fro movements) either by the patient themselves supporting or assisting the paretic arm or helped by the therapist conducting the group therapy (a total of 640 to-and-fro movements in a 40-minute session).

TREATMENT GROUP 1: All patients received standard, inpatient, post-stroke rehabilitation training for 3 hours a day, plus 12 additional 40-minute sessions of the activity-based therapy. The ‘standard’ occupational therapy at this institution comprised positioning and safe-handling of the paretic arm, passive and active range of movements, and techniques incorporating motor learning, neurodevelopment and proprioceptive neuromuscular facilitative approaches. Twelve additional sessions of 40 minutes/day, five days/ week was provided, consisting of arm ergometer, robot or occupational therapy alone based on randomization. Arm ergometry and robotic therapies were carried out under the supervision of skilled clinicians who were not part of the multidisciplinary stroke team. This therapy consists of goal-directed, robot-assisted arm movement, and a customized interactive computer-generated video programme provides visual feedback to the patient about the speed and accuracy of reaching the target.18 The limb movement is initially passive in patients with a paralysed arm, but as voluntary movement returns the interactive robot assists the patient to initiate, to guide and to complete the motor activity required for point-to-point movements. Patients participated in two 20-minute programmes with a 5-minute break during each session. The patient’s hand and wrist are held in a rigid support affixed to the robot arm; therapy consists of flexion, extension and rotational movement at the elbow and shoulder joints.

TREATMENT GROUP 2: : All patients received standard, inpatient, post-stroke rehabilitation training for 3 hours a day, plus 12 additional 40-minute sessions of the activity-based therapy. The ‘standard’ occupational therapy at this institution comprised positioning and safe-handling of the paretic arm, passive and active range of movements, and techniques incorporating motor learning, neurodevelopment and proprioceptive neuromuscular facilitative approaches. Twelve additional sessions of 40 minutes/day, five days/ week was provided, consisting of arm ergometer, robot or occupational therapy alone based on randomization. Arm ergometry and robotic therapies were carried out under the supervision of skilled clinicians who were not part of the multidisciplinary stroke team. The subject exercised for 20 minutes of continuous cycling at 0 resistance, had a 5-minute rest, and then cycled again for another 20 minutes. The unaffected arm helped move the paretic arm. The exercise was stopped if the patient reported fatigue or discomfort in the affected arm. Heart Rate, blood pressure and oxygen saturation measurements were continuously monitored for adverse cardiovascular reaction during the exercise period. The intensity (patient’s participatory effort in the exercise programme) to which the paretic arm in this activity-based programme was subjected was a count of the number of movements completed at 1 minute and over the 40 minute session. These movements were on average 55–60 to-andfro cycling movements per minute (2200 total movements in a 40-minute session).

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## Ribeiro et al. Effects of treadmill training with partial body weight support and the proprioceptive neuromuscular facilitation method on hemiparetic gait: a randomized controlled study. EUR J REHAB MED. 2013.

TREATMENT GROUP 1: Twelve intervention sessions, divided into three weekly 30-minute sessions, were held over four consecutive weeks. 20 During this period, participants were not engaged in any other type of gait-related training or that could interfere with interventions. The PNF group was stimulated using basic PNF procedures and facilitation patterns. Manual contact, stretching and maximum resistance during preparatory activities for gait and gait activities themselves were focused on. 14, 21 Sessions were initiated with the waist dissociation movement by scapular and pelvic patterns, in lateral decubitus. The anterior elevation/posterior depression and anterior depression/ posterior elevation diagonals were requested from patients. For scapular waist dissociation, manual contact was on the paretic shoulder; for pelvic dissociation, with hands positioned on the iliac crest, on the paretic side. Next, participants, initially seated, were encouraged to get up, while therapists placed their hands on the iliac crests (sit and rise). Patients then sat up, with therapists positioning their hands on the posterior portion of the iliac crests, resisting and supporting torso and hip flexion. With the patient standing, weight was transferred in the anteroposterior and laterolateral direction, in which the therapist controlled and resisted pelvic movement during weight transfer from one lower limb to another. For antero- posterior transfer, therapists placed their hands on the iliac crests bilaterally; for laterolateral transfer, on only one iliac crest laterally. Similar positioning was applied during frontal and lateral gait. This activity was executed on parallel bars for greater patient safety, where at least 10 repetitions were performed, each one equivalent to five steps (frontal or lateral) on the bars (Table I). Stretching reflex was performed in the same direction as the required movement, applied immediately before its execution, in order to facilitate contraction of adacent muscles. In points of manual contact, movement was initially guided/controlled (only for demonstration) and after was resisted by the therapist.21 Three trained therapists applied the intervention in this group (one per individual), who gave verbal encouragement and instructions in relation to posture and correct exercise execution. At each session, resistance to movement was raised and once the patient developed greater strength levels in that activity (measured subectively by the therapist), the number of repetitions was increased. Heart rate and blood pressure were monitored in both groups before and after each session, using a digital sphygmomanometer (Visomat Comfort III). In the week before the start of interventions and in the week following the end of interventions, subjects were submitted to clinical and kinematic evaluations by outcome raters blinded to the type of intervention performed.

TREATMENT GROUP 2: Twelve intervention sessions, divided into three weekly 30-minute sessions, were held over four consecutive weeks. 20 During this period, participants were not engaged in any other type of gait-related training or that could interfere with interventions. Gait Trainer (Gait Trainer System 2 Biodex Medical Systems, NY) was used in the TPBWS group. This system is composed of a harness attached to a weight bearing mechanism (unweighing system) coupled to an electric treadmill, with walking area measuring 160x51 cm and a front bar with heart monitoring sensors. Subjects were instructed to hold the front bar for stability, and were initially aided by two therapists, who monitored posture, gave instructions on body alignment and helped control lower limbs when necessary. Assistance such as displacement of paretic lower limb, knee control and maintaining the hip and trunk erect was provided according to individual demands. When a therapist was sufficient to meet these individual demands, the patient would be accompanied by only one therapist. The therapist should offer the least possible manual assistance, so that patients develop gait patterns more symmetrical as possible, without compensation. When this was achieved, manual assistance was removed. However, verbal correction and incentives were free. The first session initiated with 30% weight bearing support. 22 This support was reduced with increased tolerance to the exercise, where subjects could sustain the greater load in the lower paretic limb without help from the physical therapist, and move it adequately forward during the stance and swing phases of gait. A “comfortable” treadmill speed was selected. This was defined as maximum speed without muscle compensations or fatigue and increased at each session, according to subject feedback. In other words, subjects were instructed to keep their trunk and limbs aligned and properly transfer load to the lower paretic limb; if they were unable to do so after an increase in velocity, it was decreased to the previous value. 22 After support and speed were adjusted, individuals walked on the treadmill for 20 minutes (not counting pauses for exceeding maximum heart rate or fatigue). Heart rate and blood pressure were monitored in both groups before and after each session, using a digital sphygmomanometer (Visomat Comfort III). In the week before the start of interventions and in the week following the end of interventions, subjects were submitted to clinical and kinematic evaluations by outcome raters blinded to the type of intervention performed.

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## Riccio et al. Mental practice is effective in upper limb recovery after stroke: a randomized single-blind cross-over study. EUR J REHAB MED. 2010.

TREATMENT GROUP 1: Patients in group A underwent the conventional neuro-rehabilitation protocol (therapeutic exercise and occupational therapy) for three weeks (3 hours a day, 5 days a week) and in the following 3 weeks, they received an additional 60 minutes of MP training. All patients were evaluated at baseline (T0), at 3 weeks (T1) and at 6 weeks (T2) with the Motricity Index (MI) and the Arm Functional Test (AFT). Patients in group A underwent the conventional neuro-rehabilitation protocol (therapeutic exercise and occupational therapy) for three weeks (three hours a day, five days a week) and in the following three weeks, they received an additional 60 minutes of MP training. In this training, the patient was led to a comfortable, quite room, twice a day, where s/he could lie down and perform relaxing exercises before listening to an audio CD on which s/he was asked to imagine in detail some simple activities involving the upper limbs. The activities were those included in the Arm Functional Test (AFT) 16 (Table I). The protocol was approved by the Institute Ethics Committee.

CONTROL GROUP 1: Patients in group B, instead, underwent, in the first 3 weeks, the rehabilitation program plus MP training and in the following 3 weeks, only the conventional neurorehabilitation program. All patients were evaluated at baseline (T0), at 3 weeks (T1) and at 6 weeks (T2) with the Motricity Index (MI) and the Arm Functional Test (AFT). Patients in group B, instead, underwent the rehabilitation program plus MP training in the first three weeks and in the following three weeks the conventional neuro rehabilitation program alone (Figure 1). The protocol was approved by the Institute Ethics Committee.

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## Richards et al. The Role of Technology in Task-Oriented Training in Persons with Subacute Stroke: A Randomized Controlled Trial. NNR. 2004.

TREATMENT GROUP 1: *those in the control (CTL) group did not while engaging in PT 1 h per day, 5 days per week for 2 months. .* All patients received speech and occupational therapy as indicated. Only PT treatments were controlled. The intensity (1 h per day, 5 days per week) and duration (2 months when possible) were similar in both groups, but the content and approach differed. In both rehabilitation units, a team of 3 to 5 experienced physical therapists provided the treatments. Therapists were randomly assigned to treat patients in one of the groups exclusively to limit contamination. To further reduce contamination, participants in the EXP group were treated in a separate area out of view of the participants in the CTL group. Treatment of the upper extremity was similar in both groups. The patients in the EXP group received therapy similar to that described for the CTL group. In addition, patients received specialized locomotor training. This approach, including progressive steps, has been described in detail.18 Briefly, it consists of intensive training using a tilt table, if needed to hold the patient upright; the use of a limb-load monitor to induce weight bearing on the affected side; reciprocal stepping on a Kinetron isokinetic device; and treadmill walking with full weight bearing. The goal was to promote gait re-learning through locomotor activities that were adapted to the individual level of motor recovery.

CONTROL GROUP 1: *Participants in the experimental (EXP) group used a treadmill, a Kinetron isokinetic exerciser, and a limb-load monitor.* All patients received speech and occupational therapy as indicated. Only PT treatments were controlled. The intensity (1 h per day, 5 days per week) and duration (2 months when possible) were similar in both groups, but the content and approach differed. In both rehabilitation units, a team of 3 to 5 experienced physical therapists provided the treatments. Therapists were randomly assigned to treat patients in one of the groups exclusively to limit contamination. To further reduce contamination, participants in the EXP group were treated in a separate area out of view of the participants in the CTL group. Treatment of the upper extremity was similar in both groups. The participants in the CTL group received conventional PT. At study initiation, the conventional approach used by the therapists who participated in the study was an amalgamation of several methods. Thus, elements of the traditional neurodevelopmental approach9 were incorporated with a motor learning, task-oriented approach.15 Influences from undergraduate students, postgraduate courses, and visiting lecturers led to increased use of the task-oriented approach over the course of the study. Locomotion in the CTL group was initiated as soon as possible with external support. Other locomotor activities such as stair-climbing, walking on inclined planes, and various transfers were gradually added to permit training in a variety of gait-related tasks. Participants in the CTL group did not, however, practice walking on a treadmill, or use an isokinetic device, or a limb-load monitor.

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## Richards et al. Task-Specific Physical Therapy for Optimization of Gait Recovery in Acute Stroke Patients. AMPR. 1993.

CONTROL GROUP 1: All patients received conventional hospital care. The study did not alter usual medical or paramedical procedures. In particular, occupational therapy was provided to all patients according to hospital practice. Physical therapy, however, was specifically organized and delivered in terms of timing, content, and approach. For one control group. PT started early and was as intensive as for the experimental group but contained more traditional approaches to care based on older neurophysical techniques and practice.

CONTROL GROUP 2: All patients received conventional hospital care. The study did not alter usual medical or paramedical procedures. In particular, occupational therapy was provided to all patients according to hospital practice. Physical therapy, however, was specifically organized and delivered in terms of timing, content, and approach. The second control group received therapy as it had been organized and delivered in the institution previously. This started later in the hospital stay, was not intense and was composed of similar techniques as provided to the other control group

TREATMENT GROUP 1: All patients received conventional hospital care. The study did not alter usual medical or paramedical procedures. In particular, occupational therapy was provided to all patients according to hospital practice. Physical therapy, however, was specifically organized and delivered in terms of timing, content, and approach. The experimental group started as early as possible after admission to the study and was provided with an intensive and focused approach to therapy that incorporated use of the tilt table and a limb-load monitor, resisted exercises with a Kinetron” isokinetic device, and a treadmill. The goal was to promote gait relearning through locomotor activities that were adapted to the individual level of motor recovery.

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## Rogers et al. Does an early increased-intensity interdisciplinary upper limb therapy programme following acute stroke improve outcome? CR. 2003.

CONTROL GROUP 1: The control group received stroke unit care. *Interdisciplinary treatment programme* consisting of joint therapy sessions which integrated our current stroke unit physiotherapy (Bobath based)26 and occupational therapy practice combining a ‘normal movement’ approach within meaningful activity and task analysis.27 The physiotherapist and occupational therapist worked together during each session.

TREATMENT GROUP 2: The intervention group received stroke unit care plus enhanced upper limb rehabilitation provided jointly by a physiotherapist and occupational therapist, commencing within 10 days of stroke, and available up to 30 minutes/day, five days/week for six weeks. *Enhanced upper limb therapy time* commencing within 10 days of stroke. Participants received 30 minutes of rehabilitation jointly from the study physiotherapist and occupational therapist, five days a week for up to six weeks, in addition to their other rehabilitation needs. Participants discharged from hospital during the intervention period received enhanced therapy either as outpatients or in their own home. Patients who regained arm function within the intervention period were discharged from the enhanced therapy programme if they were able to score full marks on the ARAT.

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## Rydwik et al. The effect of exercise of the affected foot in stroke patients - a randomized controlled pilot trial. 2006.

TREATMENT GROUP 1. Stimulo (Farzaneh Chidopory, Sweden) is a portable device developed to maintain or increase range of motion in the ankle by passive and active dorsal extension and plantar flexion, carried out with the subject lying face up. The device changes from dorsal extension to plantar flexion automatically when maximum range of motion is reached (Figure 1). The intervention was standardized concerning warming up (passive workout, 5 min), followed by a period of 1520 min with active and passive workout individualized by muscle strength in the ankle and finally a cooling down period (passive work-out, 5 min). The subjects were instructed to hold for 10 s in maximum range of motion positions. The active workout was progressed during the intervention period by increased length of the active work period and decrease of the passive work period. The subjects received individual intervention with the Stimulo by a chiropodist for 30 min three times a week for six weeks (18 training sessions). Further information about the intervention programme can be obtained from the corresponding author. After completing intervention, the subjects filled in a questionnaire concerning opinions of the intervention and their self-reported evaluation of the effect(s) of the programme.

CONTROL GROUP 1. The control group was assessed at baseline and after six weeks (first follow-up) without intervention.

# S Authors

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## Sackley et al. Single blind randomized controlled trial of visual feedback after stroke: effects on stance symmetry and function. VISUAL FEEDBACK. 1997.

CONTROL GROUP 1: The assessment with the Nottingham Balance Platform (NBP), was undertaken without any postural correction. At the first and last session the mean of three measures of 30 seconds of stance symmetry and sway were used. Single measurements were also made at the start and end of each treatment session. The patients did not receive any postural feedback during the tests, nor were they made aware of the results. Group A received training from a physiotherapist using the feedback programme of the NBP. Treatment was given for an hour, three times a week for four weeks. Independent assessments were undertaken at 0, 4 and 12 weeks. The Rivermead Motor Function Assessment and the Nottingham 10 Point ADL Scale were completed at each assessment and measures of stance symmetry and sway at the first two. Patients in Group A and B received 12 treatment sessions, over four weeks, each of approximately one hour’s duration, dependent on the patient’s tolerance and medical status. The treatment and control group underwent the first and third stages and these are outlined here (for a detailed description see Sackley *er* dZ3) only the second stage differed and that is described separately for each group. Each stage lasted approximately 20 minutes. This included activities such as practising symmetrical weight bearing while sitting, leaning forward and lifting the pelvis and trunk mobilizations. The ‘Placebo Programme’ is used which displays two static yellow columns each half filled with red. The display does not move when there is a change in weight distribution (Figure *6).* The patients practise similar activities to the treatment group, but without the visual feedback of at least one physiotherapist. Therefore the targeting and balancing the columns exercises are performed using the subjective impressions of the patient and therapist. Immediately after the feedback or control session the therapist practised goal orientated tasks, such as walking to the bathroom or climbing stairs. The tasks incorporated the movements learned in the session with the NBP into every day activities.

TREATMENT GROUP 1: Group A received training from a physiotherapist using the feedback programme of the NBP. Treatment was given for an hour, three times a week for four weeks. Group B received the same training from a physiotherapist, but using the placebo programme. This was of the same frequency and duration as Group A. Independent assessments were undertaken at 0, 4 and 12 weeks. The Rivermead Motor Function Assessment and the Nottingham 10 Point ADL Scale were completed at each assessment and measures of stance symmetry and sway at the first two. Patients in Group A and B received 12 treatment sessions, over four weeks, each of approximately one hour’s duration, dependent on the patient’s tolerance and medical status. The treatment and control group underwent the first and third stages and these are outlined here (for a detailed description see Sackley *er* dZ3) only the second stage differed and that is described separately for each group. Each stage lasted approximately 20 minutes. This included activities such as practising symmetrical weight bearing while sitting, leaning forward and lifting the pelvis and trunk mobilizations. Feedback signals displaying weight distribution and weight shift activity were continuously presented to the patient in the form of two vertical red columns. Each column moved upwards with an increase in weight on the corresponding foot. When the columns were within *5 YO* of each other a red triangle appeared confirming that stance symmetry had been achieved. The importance of visual input in maintaining a stable standing posture has been shown in healthy adultsz4 26 and stroke patients.27 The patients practised a number of activities on the NBP with the constant supervision of at least one physiotherapist. This included: Sitting to stand, Standing, balancing the columns (Figure 3) ; and More complicated activities such as targeting, reaching, stride standing and stepping (Figures 4 and *5).* Immediately after the feedback or control session the therapist practised goal orientated tasks, such as walking to the bathroom or climbing stairs. The tasks incorporated the movements learned in the session with the NBP into every day activities.

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## Saeys et al. Randomized Controlled Trial of Truncal Exercises Early After Stroke to Improve Balance and Mobility. NNR. 2013.

CONTROL GROUP 1: The control group received 16 hours of sham treatment. Both groups received multidisciplinary conventional physical and occupational therapy as provided by the rehabilitation staff, mainly focused on neurodevelopmental treatments. This treatment concept is a problem-solving approach in which the trunk is an essential component.7,23 In clinical practice, activities of the trunk are integrated in postural control and task-directed movement. In addition to conventional therapy, patients received training to improve truncal function (experimental group) or exercises for the upper limb (control group). Both groups received 16 hours of additional training over 8 weeks (30 minutes, 4 times a week). This amount of additional therapy is based on a meta-analysis about augmented exercises training to improve ADLs or gait.24 Patients of the control group received passive mobilization of the upper limb and transcutaneous electrical nerve stimulation of the hemiplegic shoulder while supine. A small group of trained therapists delivered the same protocol in order to reduce variability in treatment. All therapists were randomly assigned to a patient.

TREATMENT GROUP 1: In addition to conventional therapy, the experimental group received 16 hours of truncal exercises. Both groups received multidisciplinary conventional physical and occupational therapy as provided by the rehabilitation staff, mainly focused on neurodevelopmental treatments. This treatment concept is a problem-solving approach in which the trunk is an essential component.7,23 In clinical practice, activities of the trunk are integrated in postural control and task-directed movement. In addition to conventional therapy, patients received training to improve truncal function (experimental group) or exercises for the upper limb (control group). Both groups received 16 hours of additional training over 8 weeks (30 minutes, 4 times a week). This amount of additional therapy is based on a meta-analysis about augmented exercises training to improve ADLs or gait.24 The additional training for the experimental group focused on trunk muscle strength, coordination, and selective movements of the trunk (Table 1).A small group of trained therapists delivered the same protocol in order to reduce variability in treatment. All therapists were randomly assigned to a patient. The conventional therapist for that patient was blinded for the experimental intervention. Progression was based on the patients’ level of performance.

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## Salbach et al. A task-orientated intervention enhances walking distance and speed in the first year post stroke: a randomized controlled trial. CR. 2004.

TREATMENT GROUP 1: The experimental intervention comprised 10 functional tasks designed to strengthen the lower extremities and enhance walking balance, speed and distance. Subjects in both groups attended sessions three times a week for six weeks. Subjects in both groups participated in 18 sessions of task-orientated training, given three times a week for six weeks in a rehabilitation or hospital setting. The mobility intervention, inspired by Dean et al.,16 was a standardized programme, supervised by a physical or occupational therapist, of 10 walking-related tasks designed to strengthen the lower extremities and enhance walking balance, speed and distance in a progressive manner (Appendix). Subjects were challenged to maximize their performance and rested when necessary. The study therapist recorded the duration and level of difficulty achieved by a subject in each task on individualized log sheets every session. The log sheets were used as a reference to show subjects that they were improving. It was recommended to each subject to carry over the walking component of this programme at home.

CONTROL GROUP 1: The control intervention involved the practice of upper extremity activities. Subjects in both groups attended sessions three times a week for six weeks. The control group performed functional, UE tasks, such as manipulating cards, using a keyboard and writing. Tasks were done while sitting to minimize the load on the lower extremities and subjects were recommended to practice these tasks at home. In addition, any other activities, formal or informal, that subjects participated in was recorded.

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## Saposnik et al. Effectiveness of Virtual Reality Using Wii Gaming Technology in Stroke Rehabilitation A Pilot Randomized Clinical Trial and Proof of Principle. STROKE. 2010.

CONTROL GROUP 1: All participants received standard rehabilitation therapy for stroke, which accounts for an average of 1 hour of physiotherapy and another hour of occupational therapy per day on tolerance. RT sessions included leisure activities such as playing cards, stamping a seal while playing bingo, or playing Jenga. Adherence to 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. Additional details of the protocol have been published previously.21

TREATMENT GROUP 1: All participants received standard rehabilitation therapy for stroke, which accounts for an average of 1 hour of physiotherapy and another hour of occupational therapy per day on tolerance. Nintendo introduced a new style of VR (2006) by using a wireless controller that interacts with the player through a motion detection system and avatar (computer user’s representation of himself or herself or alter ego) technology. The controllers use embedded 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. A 2-point infrared light sensor, mounted on top of a television, captures and reproduces on the screen the movement from the controller as performed by participants. 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, thus facilitating training and task improvement. (Additional details are described online at <http://www.nintendo.com/wii/what>.) As described, several distinctive features favored the selection VRWii over other VR systems, including novel and widely available

3D technology using gaming simulations, affordability, clinical applicability using simple graphics with real-time feedback with the possibility to reduce speed, making it usable for patients with cognitive impairments after stroke, and provision of direct multimodal sensory feedback (vision, touch, and auditory) with the avatar, thus allowing adjustments while performing and self-observing the execution of diverse tasks. The software used in EVREST was the publicly available sports (ie, Wii Sports) and Cooking Mamma packages, accounting for 30 minutes each in the VRWii group.

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## Schmid et al. Poststroke Balance Improves With Yoga. A Pilot Study. 2012

CONTROL GROUP 1: Those randomized to group yoga or yoga-plus completed biweekly

hour-long sessions over 8 weeks (16 sessions). There were 5 “waves” of yoga groups, and each wave included up to 10 people. Waves 1 to 4 included only veterans, whereas wave 5 included veterans and nonveterans to allow the inclusion of women and the mixing of veterans and nonveterans. The yoga-based rehabilitation intervention was developed and taught by a registered yoga therapist with input from the rehabilitation research team. A standardized protocol was developed with modified postures, breathing, and meditation in sitting, standing, and supine positions. Postures were chosen based on our previous experience with stroke and evidence supporting improved balance via a focus on hip and ankle flexibility and strength. 35 All sessions included focused deep relaxation/meditation (Table 1). Over the 8-week period, yoga sessions were increased in intensity and difficulty to allow for early success and progressive improvement. Mat tables, bolsters, blankets, and yoga straps were used as needed to facilitate yoga postures. A standardized safety protocol was in place for high blood pressure or emergency events. Those randomized to the control group completed baseline and 8-week assessments without any intervention or contact during the study time. Consistent with chronic stroke usual care, no one in the control group received stroke-related rehabilitation.

TREATMENT GROUP 1: Those randomized to group yoga or yoga-plus completed biweekly

hour-long sessions over 8 weeks (16 sessions). There were 5 “waves” of yoga groups, and each wave included up to 10 people. Waves 1 to 4 included only veterans, whereas wave 5 included veterans and nonveterans to allow the inclusion of women and the mixing of veterans and nonveterans. The yoga-based rehabilitation intervention was developed and taught by a registered yoga therapist with input from the rehabilitation research team. A standardized protocol was developed with modified postures, breathing, and meditation in sitting, standing, and supine positions. Postures were chosen based on our previous experience with stroke and evidence supporting improved balance via a focus on hip and ankle flexibility and strength. 35 All sessions included focused deep relaxation/meditation (Table 1). Over the 8-week period, yoga sessions were increased in intensity and difficulty to allow for early success and progressive improvement. Mat tables, bolsters, blankets, and yoga straps were used as needed to facilitate yoga postures. Stroke survivors randomized to the yoga-plus group completed the same 16 sessions of group yoga, but also received a device with a relaxation audio recording. The device was preloaded with the 20-minute relaxation recording developed by the registered yoga therapist. Participants randomized to this group were asked to listen to the recording 3 times each week and to track their use of the device.

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Schauer et al. Musical motor feedback (MMF) in walking hemiparetic stroke patients: randomized trials of gait improvement. 2003.

CONTROL GROUP 1: The control group participated in a 20-minute training session each day, which consisted of a warming up and common exercises led by a therapist, such as slow walking with support of parallel bars and handrails, stepping sideways and backwards, etc. In both groups during each therapy session the In both groups during each therapy session the patients were verbally encouraged by therapists to walk at their usual speed, retaining the limited extension of the knee, complete weight shifting and in sufcient foot rollover. In addition, both groups received neurodevelopmental therapy

(NDT) for 45 minutes per day, according to the regular schedule of the rehabilitation unit.

TREATMENT GROUP 1: The test group practised walking with the musical motor feedback (MMF) ve days per week, 20 minutes each day, a total of 15 sessions. The MMF device consists of sensor insoles that detect the ground contact of the heels, and a portable music player compatible with the MIDI

(musical instrument digital interface) standard. The music was played at an adjustable speed, which was estimated from the time interval between two consecutive heel-strikes. The required time period to play a quarter meter was stretched or compressed instantly to coincide with the patient’s present step duration. The portable MMF device was xed to the patient’s belt and thin wires led to the insoles. The music was presented via plugged headphones. In both groups during each therapy session the In both groups during each therapy session the patients were verbally encouraged by therapists to walk at their usual speed, retaining the limited extension of the knee, complete weight shifting and in sufcient foot rollover. In addition, both groups received neurodevelopmental therapy

(NDT) for 45 minutes per day, according to the regular schedule of the rehabilitation unit.

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## Schwartz et al. Original Research The Effectiveness of Locomotor Therapy Using Robotic Assisted Gait Training in Subacute Stroke Patients: A Randomized Controlled Trial. 2009.

CONTROL GROUP 1: All patients in both the RAGT and control groups received regular physiotherapy for 30 minutes each work day 5 times a week for 6 weeks. The patients in the RAGT group were scheduled for 30 minutes of one robotic training per work-day, 3 times a week for 6 weeks, whereas the control patients were treated with additional regular physiotherapy for gait training for 30 minutes (overall 60 min of regular physiotherapy) 3 times a week. Focus on this training was gait rehabilitation, ie, on the patients’ exercised trunk stability and symmetry, step initiation, and weight support on the paretic leg. In every session, the patient walked some steps with the help of therapists. Hence, both groups received an overall equal amount of net physiotherapy of 4 hours per week of gait training. All patients received an additional half hour of training per day of upper limb strengthening, static balance training in sitting position, range of motion, and stretching exercises.

TREATMENT GROUP 1. The study group was treated with the robotic-driven gait orthosis, the Lokomat, which includes a treadmill, a body weight support system, and two lightweight robotic actuators that attach to the subject’s legs. The overall time of the Lokomat treatment, including the getting in and getting out time, was 1 hour, whereas the net robotic gait training was 30 minutes. The speed of the treadmill can be adjusted from 0 km/h to approximately 3 km/h. During the treatments, the velocity of the treadmill was set to the maximum speed tolerated by the patients. At the beginning of the treatment, patients required intensive support of their body weight to stand on the treadmill without their knees buckling. There- fore, at the beginning of the treatment, approximately 50% of each subject’s body weight needed to be supported by the harness system. During the following walking sessions, the body weight support was reduced in approximately 10% increments per session as tolerated without substantial knee buckling or toe drag. All patients in both the RAGT and control groups received regular physiotherapy for 30 minutes each work day 5 times a week for 6 weeks. The patients in the RAGT group were scheduled for 30 minutes of one robotic training per work-day, 3 times a week for 6 weeks, whereas the control patients were treated with additional regular physiotherapy for gait training for 30 minutes (overall 60 min of regular physiotherapy) 3 times a week. Focus on this training was gait rehabilitation, ie, on the patients’ exercised trunk stability and symmetry, step initiation, and weight support on the paretic leg. In every session, the patient walked some steps with the help of therapists. Hence, both groups received an overall equal amount of net physiotherapy of 4 hours per week of gait training. All patients received an additional half hour of training per day of upper limb strengthening, static balance training in sitting position, range of motion, and stretching exercises.

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## Severinsen et al. Effects of Resistance Training and Aerobic Training on Ambulation in Chronic Stroke. 2014.

TREATMENT GROUP 1. The participants followed a standardized, but individually adapted, physical training program equally dosed with respect to time (Appendix 1). Each training session consisted of a 5-min warm-up period using a lower extremity cycle ergometer (Monark) followed by approximately 1 hr of group-specific training. All AT sessions were continuously pulse monitored, and every fifth non-AT session was pulse monitored. All training sessions were supervised by the same physiotherapist, and all groups were habituated to the intended training intensity by a gradual increase in training intensity during the first 2- 4 wks (Appendix 1). High-intensity progressive RT of both lower limbs (n= 14) consisted of three sets of eight repetitions targeted at an intensity of 80% of one repetition maximum (1RM; i.e., the maximal load that can be lifted once). 1RM was adjusted every second week. In reality, the targeted intensity of 80% of 1RM was too ambitious. The authors had estimated that when participants could lift more than eight repetitions in a specific exercise, this would correspond to approximately 80% of 1RM, but the results of this study show that it was rather approximately 70% of 1RM on average for the dif- ferent exercises used. Eight-repetition maximum loading corresponds to the recommended loading (8- to 12-repetition maximum) for novice and moderately trained persons training for increased strength according to the American College of Sports Medicine guidelines (this is explained further in Appendix 1). Exercises were performed bilaterally, each limb separately, using RT machines (Nordic Gym). Hip extension and flexion were per- formed while standing, whereas knee extension, ankle dorsal flexion, ankle plantar flexion, and leg press were performed seated, with knee flexion being performed in a prone position.

TREATMENT GROUP 2. The participants followed a standardized, but individually adapted, physical training program equally dosed with respect to time (Appendix 1). Each training session consisted of a 5-min warm-up period using a lower extremity cycle ergometer (Monark) followed by approximately 1 hr of group-specific training. All AT sessions were continuously pulse monitored, and every fifth non-AT session was pulse monitored. All training sessions were supervised by the same physiotherapist, and all groups were habituated to the intended training intensity by a gradual increase in training intensity during the first 2- 4 wks (Appendix 1). All training sessions were supervised by the same physiotherapist, and all groups were habituated to the intended training intensity by a gradual increase in training intensity during the first 2-4 wks (Appendix 1). Aerobic Training High-intensity AT (n= 13) consisted of 15 mins of strenuous cycle ergometer (Monark) exercise, three times at each session. Training intensity was regularly modified by the physiotherapist, with the aim of reaching a pulse rate of 75% of the heart rate reserve. 26 If heart rate measurements were unreliable, as was the case in patients with atrial fibrillation, the Borg Scale was used.

TREATMENT GROUP 3. The participants followed a standardized, but individually adapted, physical training program equally dosed with respect to time (Appendix 1). Each training session consisted of a 5-min warm-up period using a lower extremity cycle ergometer (Monark) followed by approximately 1 hr of group-specific training. All AT sessions were continuously pulse monitored, and every fifth non-AT session was pulse monitored. All training sessions were supervised by the same physiotherapist, and all groups were habituated to the intended training intensity by a gradual increase in training intensity during the first 2- 4 wks (Appendix 1). Low-intensity RT of the arms (n= 16) consisted of three sets of 15 repetitions less than 60% of 1RM bilaterally. The participants performed elbow flex-ion and extension and shoulder abduction and combined shoulder movements using a pulley.

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## Shin et al. The Effects of Rehabilitation Exercise Using a Home Video Game (PS2) on Gait Ability of Chronic Stroke Patients. 2010.

CONTROL GROUP 1. Controls were matched by age, gender and statue with reference to their medical charts[18].

TREATMENT GROUP 1. In this study, exercise session in game exercise group begins with a warm-up(5 min) followed by an exercise period(50 min) and a 5-min cool-down period. Warm-up and cool-down exercises consisted of muscle stretching, deep breathing and range of motion exercise. The applied game programs and their components were described in table 1.Home video game device were the Playstation 2(Sony, Japan) and eyetoy play(Sony, Japan), a commercially available gaming system that uses a video capture interface to allow the user to interact directly with their own television screen[15, 16]. Objects within the game environment move and react when contacted by the user’s image, creating an interactive experience between sound and visual feedback indicate the success or failure of movement relative to the game task. Participants practiced for 60 min. sessions at a frequency of 3 times a week, for a total of 6 weeks[19, 20].

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Sivenius et al. The significance of intensity of rehabilitation of stroke--a controlled trial. 1985.

CONTROL GROUP 1. The patients in NT received the normal physical therapy in the conventional medical wards, the duration and amount of which was determined by the internists. The patients were discharged from these departments to their homes or, if it was not possible, to old age homes or chronic care departments of community hospitals, where some of them were able to obtain physiotherapy. The guiding principle was, however, that no patient’s therapy was worsened as a result of the study.

TREATMENT GROUP 1. The patients in IT were also initially treated in medical wards of the local University Hospital. After this initial period the majority of the patients was admitted to Vaajasalo Hospital. This hospital is a former epilepsy hospital which is now a part of the regional neurological health care organization. Its one department was redesigned into a stroke rehabilitation unit with the purpose especially to treat stroke patients. The rest of the patients in IT were treated in neurological wards of the University Hospital. The principle was that physiotherapy should be given as long as functional recovery was taking place or the patient could perform independent tasks. The amount of therapy was measured as the number of sessions of therapy given physicial, occupational, or speech therapist. Usually one physiotherapy session lasted half an hour. When a patient in IT was in the medical ward of the University Hospital she/he was treated by a physiotherapist twice a day.

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## Smania et al. Reduced-Intensity Modified Constraint-Induced Movement Therapy Versus Conventional Therapy for Upper Extremity Rehabilitation After Stroke : A Multicenter Trial. 2012.

CONTRON GROUP 1. Prior to the start of the study the steering committee designed the EG mCIMT) and CG treatment protocols. To ensure uniformity in the delivery of treatment, one therapist from each center was taught the mCIMT treatment protocol and the other was taught the CG protocol. Participants in both groups received 1-hour, individual treatment sessions as outpatients and 1-hour of household activities 5 days a week (Monday to Friday) for 2 consecutive weeks. In addition, patients in the EG wore a splint on their unaffected arm for at least 12 of their waking hours (Monday to Friday). The splint permitted the unaffected arm to assist in transfers and ambulation (shoulder and elbow movement were permitted), but it prevented use of the hand, forcing the patient to use the affected arm to perform ADLs. Adherence to splint use was controlled by instructing the patient’s caregiver to monitor the patient at least 6 times during waking hours. If the patient was found without a splint, the caregiver recorded the incident in a time log. If 4 of these incidents occurred, the patient was excluded from the study. The household activities consisted of 30 functional everyday activities (switching on the light, combing one’s hair, etc). The patient, supervised by a caregiver, was Required to repeat each activity for approximately 2 minutes, for a total of 1 hour. The caregiver was required to document the start and end time of each therapy session performed at home. The household activities were the same (type of exercises and duration) for both groups. The outpatient treatment was carried out in the morning and the household activities in the afternoon. Each session consisted of 3 types of exercises involving the paretic arm: (a) 20 minutes of passive mobilization and stretching of the affected, 39 (b) 30 minutes of exercises based on active motility tasks, and (c) 10 minutes of standard ADLs activities, as in the EG.27,2.

TREATMENT GROUP 1. Prior to the start of the study the steering committee designed the EG mCIMT) and CG treatment protocols. To ensure uniformity in the delivery of treatment, one therapist from each center was taught the mCIMT treatment protocol and the other was taught the CG protocol. Participants in both groups received 1-hour, individual treatment sessions as outpatients and 1-hour of household activities 5 days a week (Monday to Friday) for 2 consecutive weeks. In addition, patients in the EG wore a splint on their unaffected arm for at least 12 of their waking hours (Monday to Friday). The splint permitted the unaffected arm to assist in transfers and ambulation (shoulder and elbow movement were permitted), but it prevented use of the hand, forcing the patient to use the affected arm to perform ADLs. Adherence to splint use was controlled by instructing the patient’s caregiver to monitor the patient at least 6 times during waking hours. If the patient was found without a splint, the caregiver recorded the incident in a time log. If 4 of these incidents occurred, the patient was excluded from the study. The household activities consisted of 30 functional everyday activities (switching on the light, combing one’s hair, etc). The patient, supervised by a caregiver, was Required to repeat each activity for approximately 2 minutes, for a total of 1 hour. The caregiver was required to document the start and end time of each therapy session performed at home. The household activities were the same (type of exercises and duration) for both groups. Each session consisted of 3 types of activities involving the paretic arm: (a) 10 minutes of passive mobilization of the affected arm joints through full ROM to prevent secondary myoarticular damage and give sensory stimulation, (b) 40 minutes of training based on “repetitive practice” and “shaping,”37,38 and (c) 10 minutes of standard ADLs activities that were challenging and contextually appropriate. 27,28 With regard to repetitive practice, a list of fine motor and manipulative gross motor activities that elicit movement behaviors of interest and include a range of functional and play activities were established to engage the patients in active intervention and to sustain attention and motivation. Specific activities were selected by considering (a) joint movements with pronounced deficits, (b) joint movements that the therapist felt had the greatest potential for improvement, and (c) patient’s preference for activities that have similar potential for improving identified movements. The tasks were made progressively more difficult as the patient improved in performance by increasing speed or accuracy, increasing repetition, or creating performance-sensitive adaptations. Task constraints were adapted to allow success and were removed as one’s performance improved. Task performance was recorded, and task-specific structured feedback was provided for encouragement in a consistent manner. Only positive reinforcement was used. Activities belonged to 1 of 6 categories: board games (eg, Connect Four, Hanoi Tower), card games (eg, poker), manipulative games (eg, dominoes), puzzles, arts and crafts (eg, drawing), and gross motor activities (eg, bowling). Each activity was repeated continuously for approximately 10 minutes. An example of repetitive task practice is the popular game “Connect Four”37 whose motor components involve grasping the disc, appropriately orienting the disc for placement into a slot, bringing the disc to the top of a grid, and releasing the disc into the appropriate slot. Depending on the patient’s motor capabilities and designated target movements, the game was structured differently to grade the difficulty of a specific movement (eg, as the patient improved, discs were placed differently so that picking them up was more difficult). On the other hand, shaping is an operant conditioning method, in which a behavioral objective is approached in small steps, by progressively increasing difficulty. Therapists altered constraints to grade tasks according to target movements they wanted the patient to achieve. The strategies includeed varying temporal (eg, time required for the task), spatial (eg, location of the object), and accuracy constraints. Only positive feedback was given to the participant who was always rewarded with enthusiastic approval for improvement, and never blamed or punished for failure. 6,29

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## Smith et al. Remedial therapy after stroke: a randomized controlled trial. 1981.

CONTROL GROUP 1. The three rehabilitation regimens compared were:(a) intensive attendance in the rehabilitation department four whole days a week(group1,46 patients);(b) conventional-attendance three half days a week (group 2, 43 patients); and (c) no routine rehabilitation; these patients were regularly visited at home by a health visitor, referred back to hospital or to other services if necessary, and encouraged to continue with exercises taught while in hospital (group 3,44 patients). Patients in groups 1 and 2 received physiotherapy and occupational therapy in groups and individually for up to six months(except for four patients in group 1 and five in group 2 who made a full recovery earlier), and time spent in therapy was recorded. Thirty-three patients with speech difficulties also received speech therapy. (Results of this component of the trial will be reported separately.

CONTROL GROUP 2. The three rehabilitation regimens compared were:(a) intensive attendance in the rehabilitation department four whole days a week(group1,46 patients);(b) conventional-attendance three half days a week (group 2, 43 patients); and (c) no routine rehabilitation; these patients were regularly visited at home by a health visitor, referred back to hospital or to other services if necessary, and encouraged to continue with exercises taught while in hospital (group 3,44 patients). Patients in groups 1 and 2 received physiotherapy and occupational therapy in groups and individually for up to six months(except for four patients in group 1 and five in group 2 who made a full recovery earlier), and time spent in therapy was recorded. Thirty-three patients with speech difficulties also received speech therapy. (Results of this component of the trial will be reported separately.

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## Sonoda et al. Full-time integrated treatment program, a new system for stroke rehabilitation in Japan. 2004.

CONTROL GROUP 1. The conventional rehabilitation program was composed of 40 mins of physical therapy and 40 mins of occupational therapy per day, 5 days/wk. Therapy focused on gait and exercise related to ADLs. Orthoses were used if necessary. Passive range of motion exercise of the affected side and muscle strengthening exercise of the unaffected side were included. Speech therapy was also performed on a 5-day/wk basis, if necessary.

TREATMENT GROUP 1. In the FIT program, regular rehabilitation treatment is composed of 40 mins of physical therapy and 40 mins of occupational therapy per day, similar to the conventional treatment, but for 7 days/wk rather than for only 5 days/wk. Speech therapy is performed on a 5-day/wk basis, if necessary. In addition, patients are encouraged to stay out of the sleeping area during the daytime and to use the wide corridor instead. They freely ambulate in the corridor and speak and interact with each other instead of lying in bed. Self-initiated exercise such as standing and walking under supervision of nurses is performed. Patients perform self-care activities on their own accord, with some help if necessary. Most patients, except for those with decreased initiative, adapt well to this environment and utilize its advantages. As they work, nurses can see patients exercising and can give instructions concerning the performance of daily activities; thus, these instructions concerning ADLs can be recognized as a kind of exercise. So, the total amount of exercise is much increased in the FIT program.

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## Stein et al. Comparison of Two Techniques of Robot-Aided Upper Limb Exercise Training After Stroke. 2004.

TREATMENT GROUP 1. All subjects underwent a battery of assessment tools performed by a single physical therapist not other- wise involved in the study and who was blinded to the patient’s group assignment. All subjects received 6 wks of robot-aided exercise. Training was con- ducted three times each week for 1-hr sessions, for a total of 18 hrs of robot-aided exercise training per subject. During therapy, the subjects’ paretic arm was supported by a molded wrist/hand orthosis that was attached to end-effector (handle) of the robot arm. All evaluation and training exercises consisted of reaching tasks in the horizontal plane that involved shoulder and elbow movements. Specifically, subjects were asked to move between a center target and eight peripheral targets arranged in a circular display. As they attempted to move the robot’s handle toward designated targets, the computer screen in front of them provided visual feedback of the target location and movement of the robot handle (Fig. 1). Sixty repetitions of each “round” of moving to the set of eight targets were per- formed during each training session, and three rounds were performed with the robot inactive for the purposes of assessment. A total of 1,024 individual target-oriented movements were completed by subjects during each training session. A total of approximately 40 mins of each 1-hr session was spent performing robot-aided exercises, with the remainder of the session used for set-up and for several brief rest periods between training exercises. The therapist supervising the robotic therapy provided instructions and some general encouragement but no feedback regarding specific performance. Robot training was per- formed using the InMotion2 robot (Interactive Motion Technologies, Cambridge MA), a commercial ver- sion of the MIT-Manus robot that has been used in previous studies of upper limb rehabilitation after stroke.16 –19 A robotic assessment of motor abilities was administered to all subjects at study entry. This assessment task, like the training task, consisted of reaching for each of eight virtual targets circumferentially surround- ing the center target (Fig. 1). The resistance training task was of the same form as the active assisted task but with the robot programmed to provide resistance to the desired movement. The amount of resistance was determined and modified by a control algorithm that used robotic measures of the subject’s muscle strength to increase or de- crease the effort required to reach the targets. These measures were obtained at the end of each treatment session to determine the amount of force to be delivered by the robot during the next session. A maximum force of 28 N was provided by the robot as resistance during training exercises. The number of repetitions of the training task was the same in subjects receiving active-assisted training and those receiving resistance training. Over the course of therapy, subjects in each treatment group performed approximately 18,000 repetitive reaching movements with their paretic arm.

TREATMENT GROUP 2. All subjects underwent a battery of assessment tools performed by a single physical therapist not other- wise involved in the study and who was blinded to the patient’s group assignment. All subjects received 6 wks of robot-aided exercise. Training was con- ducted three times each week for 1-hr sessions, for a total of 18 hrs of robot-aided exercise training per subject. During therapy, the subjects’ paretic arm was supported by a molded wrist/hand orthosis that was attached to end-effector (handle) of the robot arm. All evaluation and training exercises consisted of reaching tasks in the horizontal plane that involved shoulder and elbow movements. Specifically, subjects were asked to move between a center target and eight peripheral targets arranged in a circular display. As they attempted to move the robot’s handle toward designated targets, the computer screen in front of them provided visual feedback of the target location and movement of the robot handle (Fig. 1). Sixty repetitions of each “round” of moving to the set of eight targets were per- formed during each training session, and three rounds were performed with the robot inactive for the purposes of assessment. A total of 1,024 individual target-oriented movements were completed by subjects during each training session. A total of approximately 40 mins of each 1-hr session was spent performing robot-aided exercises, with the remainder of the session used for set-up and for several brief rest periods between training exercises. The therapist supervising the robotic therapy provided instructions and some general encouragement but no feedback regarding specific performance. Robot training was per- formed using the InMotion2 robot (Interactive Motion Technologies, Cambridge MA), a commercial ver- sion of the MIT-Manus robot that has been used in previous studies of upper limb rehabilitation after stroke.16 –19 A robotic assessment of motor abilities was administered to all subjects at study entry. This assessment task, like the training task, consisted of reaching for each of eight virtual targets circumferentially surround- ing the center target (Fig. 1). During active-assisted training, the robot provided assistance in reaching each target if the subject was unable to reach it independently. For subjects able to reach the target independently, the robot assisted with guidance to the target to im- prove the quality and efficiency of the movement and provided a tactile cue by nudging the arm toward the target.

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## Stinear et al. Priming the motor system enhances the effects of upper limb therapy in chronic stroke. 2008.

CONTROL GROUP 1. All participants were provided with a set of wooden blocks, and instructed to perform two self-directed, home-based tasks with their affected upper limb. The blocks were a variety of shapes, with the dimensions of each side ranging from 2 to 9 cm. The container with matching holes was15 cm 3 in size. The first task was to pick up and transport each block 20 cm, using a visual distance guide. The second task was to manipulate each block, by picking up and slotting it through the appropriately shaped hole in the block container. All participants were able to perform both tasks, though with a range of speed and accuracy. The goal was to spend 10 min performing these tasks with the affected hand three times per day over 4 weeks. Transporting or manipulating all 12 blocks constituted one repetition of each task. Patients were asked to record the number of repetitions performed of each task, and the total amount of time, for each session. Patients were randomized to motor practice alone (control group) or APBT for 10–15 min followed by

motor practice (APBT group). All control group patients were offered the APBT intervention after a 1-month washout period. Data from ‘cross-over’ patients were included in the APBT group analysis if they had no change in FM score during the control intervention and still met the study’s inclusion criteria at the time of ‘cross-over’

TREATMENT GROUP 1. All participants were provided with a set of wooden blocks, and instructed to perform two self-directed, home-based tasks with their affected upper limb. The blocks were a variety of shapes, with the dimensions of each side ranging from 2 to 9 cm. The container with matching holes was15 cm 3 in size. The first task was to pick up and transport each block 20 cm, using a visual distance guide. The second task was to manipulate each block, by picking up and slotting it through the appropriately shaped hole in the block container. All participants were able to perform both tasks, though with a range of speed and accuracy. The goal was to spend 10 min performing these tasks with the affected hand three times per day over 4 weeks. Transporting or manipulating all 12 blocks constituted one repetition of each task. Patients were asked to record the number of repetitions performed of each task, and the total amount of time, for each session. Patients were randomized to motor practice alone (control group) or APBT for 10–15 min followed by

motor practice (APBT group). The APBT group were provided with an APBT device developed in our laboratory that allows up to 135 rhythmic flexion-extension of the unaffected wrist, which in turn drives the passive flexion-extension of the affected wrist in a mirror-symmetric pattern. APBT produces afferent input from the passive stretch of wrist flexors and extensors, and long finger flexors and extensors, all of which were engaged by the subsequent motor practice. Patients were instructed to focus attention on the unaffected wrist at the beginning of each APBT session, to establish smooth, rhythmic movement. They were instructed to then shift their attention to the affected wrist, and allow it to be passively driven. In the third week, they were instructed to imagine that they were actively producing the movements of their affected wrist, with progression towards bilaterally active movements in the fourth week. This was intended to ensure that all patients started the intervention using the device in the same way, and then progressed towards active movement in the fourth week, to the best of their abilities. Motor imagery was included in the third week, as previous work has shown that it activates cortical motor areas (Ehrsson et al., 2003; Hanakawa et al., 2003), increases the excitability of M1 (Facchini et al ., 2002; Stinear and Byblow, 2003; Stinear et al., 2006), and can improve upper limb function in chronic stroke patients (Dijkerman et al ., 2004; Page et al ., 2007). Patients recorded the actual amount of time spent using the device in each session.

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## Subramanian et al. Arm Motor Recovery Using a Virtual Reality Intervention in Chronic Stroke: Randomized Control Trial. 2013.

CONTROL GROUP 1. Participants in both groups (PE, VE) repetitively pointed toward 6 targets placed just beyond arm’s length, without physically touching the target in either environment. Earlier work by Cirstea et al 21 showed that reaching training-based improvement in movement variables (eg, error) led to an asymptotic level only after 30 to 35 repetitions, depending on arm motor impairment level. This number was doubled to ensure high practice intensity. The total number—72 trials—was divided into 3 blocks of 24, with 5-minute inter-block intervals. A prerecorded verbal randomized target sequence was played back on the computer, instructing participants to point to the next target. Each training session averaged 45 minutes in both environments. The acquisition phase was 12 days spaced over 4 weeks (3 times/wk).For both environments, participants sat with the back supported and hips and knees flexed to 90°, shoulder abducted (20°) and internally rotated, elbow slightly flexed, forearm pronated, and wrist in neutral. Prior to movement, the index finger was placed ipsilaterally on a 41.5-cm high platform, 10 cm lateral to the hip (starting position, Figure 1A). This position was chosen to encourage full-range shoulder and elbow movement during pointing. A research assistant seated behind the participant ensured that the arm starting position was similar before each trial during interventions and kinematic assessments. Participants were instructed to point as fast and as accurately as possible.

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## Sullivan et al. Step training with body weight support: Effect of treadmill speed and practice paradigms on poststroke locomotor recovery. 2002.

CONTROL GROUP 1: All subjects received 12 sessions of BWSTT over a 4-to-5-week training phase and returned for 1- and 3-month follow ups. The frequency and duration of training was designed to best represent the standard of care for outpatient visits that may be available to individuals with chronic stroke. Each session included four 5-minute walking bouts for a total of 20 minutes of TM walking per session. Heart rate was monitored to assess the subject’s exercise tolerance. During the training phase, the only therapeutic intervention a subject received was the 20 minutes per session of BWSTT. Subjects did not receive any other physical training such as overground ambulation or strengthening and endurance exercise. Throughout the training phase and until the completion of the 3-month follow-up, subjects were required to refrain from any TM walking other than what was part of the experimental protocol. Participants were fitted in a harness (Medical Harnessa), which was then connected to an overhead suspension system positioned over a treadmill (fig 1). The suspension system was an overhead-motorized pneumatic lift with a digital readout displaying the amount of BWS (Neuro IIb). By using the BWS guidelines described by Visintin et al,14 up to 40% BWS was provided initially and progressively decreased as the subject increased activity tolerance and could maintain proper limb kinematics throughout stance and swing with the therapist’s assistance. Subjects were trained with the assistance of 1 physical therapist and 1 aide (fig 1). One person was positioned behind the subject and provided proximal stability at the hips. This person was responsible for monitoring upright posture, pelvic position, and weight shift. The second person was positioned at the hemiparetic lower limb and provided assistance with stepping and limb control during stance and swing. This person also monitored stride characteristics and cadence. The training strategy focused on the following key components that were normalized for each subject as much as possible: upright trunk alignment, weight shift, and weight bearing through the lower limbs, limb kinematics for stance and swing, coordinated stride characteristics between the limbs, and reciprocal arm swing (see fig 1).16 Subjects were not allowed to wear a lower-extremity orthosis during training. They were encouraged to use reciprocal arm swing as much as possible. For safety, subjects were positioned within parallel bars but were discouraged from using the bars for upper-extremity support. Initially, subjects were given the option to use the bar until they gained confidence but were quickly transitioned to

either a bungee cord positioned in front of the subject and suspended across the parallel bars or no upper-extremity support at all. The training protocol required that the subject complete training at the speed assigned by group membership. Subjects in the slow or fast group walked at 1 speed (0.5 or 2.0mph, respectively) and the variable group walked at 4 different speeds. A subject was allowed to take as many rests as needed throughout each session in addition to the regularly scheduled

rest at the 5-minute interval. The loading on the lower extremities was progressively decreased if the subject maintained proper limb kinematics. However, we continued BWS as needed to aid the subject in effective stepping at their assigned speed.

TREATMENT GROUP 1: All subjects received 12 sessions of BWSTT over a 4-to-5-week training phase and returned for 1- and 3-month follow ups. The frequency and duration of training was designed to best represent the standard of care for outpatient visits that may be available to individuals with chronic stroke. Each session included four 5-minute walking bouts for a total of 20 minutes of TM walking per session. Heart rate was monitored to assess the subject’s exercise tolerance. During the training phase, the only therapeutic intervention a subject received was the 20 minutes per session of BWSTT. Subjects did not receive any other physical training such as overground ambulation or strengthening and endurance exercise. Throughout the training phase and until the completion of the 3-month follow-up, subjects were required to refrain from any TM walking other than what was part of the experimental protocol. Participants were fitted in a harness (Medical Harnessa), which was then connected to an overhead suspension system positioned over a treadmill (fig 1). The suspension system was an overhead-motorized pneumatic lift with a digital readout displaying the amount of BWS (Neuro IIb). By using the BWS guidelines described by Visintin et al,14 up to 40% BWS was provided initially and progressively decreased as the subject increased activity tolerance and could maintain proper limb kinematics throughout stance and swing with the therapist’s assistance. Subjects were trained with the assistance of 1 physical therapist and 1 aide (fig 1). One person was positioned behind the subject and provided proximal stability at the hips. This person was responsible for monitoring upright posture, pelvic position, and weight shift. The second person was positioned at the hemiparetic lower limb and provided assistance with stepping and limb control during stance and swing. This person also monitored stride characteristics and cadence. The training strategy focused on the following key components that were normalized for each subject as much as possible: upright trunk alignment, weight shift, and weight bearing through the lower limbs, limb kinematics for stance and swing, coordinated stride characteristics between the limbs, and reciprocal arm swing (see fig 1).16 Subjects were not allowed to wear a lower-extremity orthosis during training. They were encouraged to use reciprocal arm swing as much as possible. For safety, subjects were positioned within parallel bars but were discouraged from using the bars for upper-extremity support. Initially, subjects were given the option to use the bar until they gained confidence but were quickly transitioned to

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rest at the 5-minute interval. The loading on the lower extremities was progressively decreased if the subject maintained proper limb kinematics. However, we continued BWS as needed to aid the subject in effective stepping at their assigned speed.

TREATMENT GROUP 2: All subjects received 12 sessions of BWSTT over a 4-to-5-week training phase and returned for 1- and 3-month follow ups. The frequency and duration of training was designed to best represent the standard of care for outpatient visits that may be available to individuals with chronic stroke. Each session included four 5-minute walking bouts for a total of 20 minutes of TM walking per session. Heart rate was monitored to assess the subject’s exercise tolerance. During the training phase, the only therapeutic intervention a subject received was the 20 minutes per session of BWSTT. Subjects did not receive any other physical training such as overground ambulation or strengthening and endurance exercise. Throughout the training phase and until the completion of the 3-month follow-up, subjects were required to refrain from any TM walking other than what was part of the experimental protocol. Participants were fitted in a harness (Medical Harnessa), which was then connected to an overhead suspension system positioned over a treadmill (fig 1). The suspension system was an overhead-motorized pneumatic lift with a digital readout displaying the amount of BWS (Neuro IIb). By using the BWS guidelines described by Visintin et al,14 up to 40% BWS was provided initially and progressively decreased as the subject increased activity tolerance and could maintain proper limb kinematics throughout stance and swing with the therapist’s assistance. Subjects were trained with the assistance of 1 physical therapist and 1 aide (fig 1). One person was positioned behind the subject and provided proximal stability at the hips. This person was responsible for monitoring upright posture, pelvic position, and weight shift. The second person was positioned at the hemiparetic lower limb and provided assistance with stepping and limb control during stance and swing. This person also monitored stride characteristics and cadence. The training strategy focused on the following key components that were normalized for each subject as much as possible: upright trunk alignment, weight shift, and weight bearing through the lower limbs, limb kinematics for stance and swing, coordinated stride characteristics between the limbs, and reciprocal arm swing (see fig 1).16 Subjects were not allowed to wear a lower-extremity orthosis during training. They were encouraged to use reciprocal arm swing as much as possible. For safety, subjects were positioned within parallel bars but were discouraged from using the bars for upper-extremity support. Initially, subjects were given the option to use the bar until they gained confidence but were quickly transitioned to

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rest at the 5-minute interval. The loading on the lower extremities was progressively decreased if the subject maintained proper limb kinematics. However, we continued BWS as needed to aid the subject in effective stepping at their assigned speed.

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## Sullivan et al. Effects of Task-Specific Locomotor and Strength Training in Adults Who Were Ambulatory After Stroke: Results of the STEPS Randomized Clinical Trial. 2007.

TREATMENT GROUP 1. The goal of the treatment sessions was to have each participant engage in a 1-hour physical therapy program that included a moderate-intensity progressive exercise protocol that is representative of what therapists may do in a usual treatment session. Intervention consisted of physical therapist–supervised exercise conducted in 1-hour sessions, 4 days per week, for 6 weeks. Protocol variations for missed visits were acceptable if the total 24 visits were accomplished within an 8-week period. Four exercise interventions were used. Three exercise interventions were designed to improve gait speed or LE strength, and one UE exercise intervention was designed as a sham intervention, not to include any active component that would improve gait speed or LE strength. The exercise interventions were: (1) BWSTT, (2) limb-loaded resistive leg cycling (CYCLE), (3) LE muscle-specific progressive-resistive exercise (LE-EX), and (4) UE ergometry (UE-EX). (For video clips of these exercises, visit this article online at www.ptjournal.org). After baseline assessments, participants were randomly assigned to a combination exercise. program that consisted of the following exercise pairs: BWSTT/UE-EX, CYCLE/UE-EX, BWSTT/CYCLE, and BWSTT/LE-EX. Participants engaged in the exercise 4 days per week. Exercise type was on alternate days (eg, BWSTT session on one day followed by CYCLE session on the alternate day). Based on participant preference, a rest day was provided on Wednesday or Friday, with no exercise on the weekend. All participants received the same number of treatment sessions and contact time with a physical therapist in order to minimize the Hawthorne effect. 49 Two separate comparisons were conducted: (1) BWSTT/UE-EX and CYCLE/UE-EX and (2) BWSTT/UE-EX, BWSTT/ CYCLE, and BWSTT/LE-EX. The first comparison examined the efficacy of task-specific treadmill training with BWS compared with a resistive cycling program that emphasized LE strengthening of muscle groups used in gait. The second comparison allowed for an analysis of the efficacy of an exercise program that combines task-specific treadmill training with BWS with a progressive resistive exercise program (either resistive LE cycling or LE muscle specific progressive-resistive exercise) compared with task-specific treadmill training with BWS alone. sk-specific walking exercise using body- weight support and therapist assistance during treadmill training.

TREATMENT GROUP 2. The goal of the treatment sessions was to have each participant engage in a 1-hour physical therapy program that included a moderate-intensity progressive exercise protocol that is representative of what therapists may do in a usual treatment session. Intervention consisted of physical therapist–supervised exercise conducted in 1-hour sessions, 4 days per week, for 6 weeks. Protocol variations for missed visits were acceptable if the total 24 visits were accomplished within an 8-week period. Four exercise interventions were used. Three exercise interventions were designed to improve gait speed or LE strength, and one UE exercise intervention was designed as a sham intervention, not to include any active component that would improve gait speed or LE strength. The exercise interventions were: (1) BWSTT, (2) limb-loaded resistive leg cycling (CYCLE), (3) LE muscle-specific progressive-resistive exercise (LE-EX), and (4) UE ergometry (UE-EX). (For video clips of these exercises, visit this article online at www.ptjournal.org). After baseline assessments, participants were randomly assigned to a combination exercise. program that consisted of the following exercise pairs: BWSTT/UE-EX, CYCLE/UE-EX, BWSTT/CYCLE, and BWSTT/LE-EX. Participants engaged in the exercise 4 days per week. Exercise type was on alternate days (eg, BWSTT session on one day followed by CYCLE session on the alternate day). Based on participant preference, a rest day was provided on Wednesday or Friday, with no exercise on the weekend. All participants received the same number of treatment sessions and contact time with a physical therapist in order to minimize the Hawthorne effect. 49 Two separate comparisons were conducted: (1) BWSTT/UE-EX and CYCLE/UE-EX and (2) BWSTT/UE-EX, BWSTT/ CYCLE, and BWSTT/LE-EX. The first comparison examined the efficacy of task-specific treadmill training with BWS compared with a resistive cycling program that emphasized LE strengthening of muscle groups used in gait. The second comparison allowed for an analysis of the efficacy of an exercise program that combines task-specific treadmill training with BWS with a progressive resistive exercise program (either resistive LE cycling or LE muscle specific progressive-resistive exercise) compared with task-specific treadmill training with BWS alone. Lower-extremity cycling with the limb loaded in the extension phase of the cycling revolution.

TREATMENT GROUP 3. The goal of the treatment sessions was to have each participant engage in a 1-hour physical therapy program that included a moderate-intensity progressive exercise protocol that is representative of what therapists may do in a usual treatment session. Intervention consisted of physical therapist–supervised exercise conducted in 1-hour sessions, 4 days per week, for 6 weeks. Protocol variations for missed visits were acceptable if the total 24 visits were accomplished within an 8-week period. Four exercise interventions were used. Three exercise interventions were designed to improve gait speed or LE strength, and one UE exercise intervention was designed as a sham intervention, not to include any active component that would improve gait speed or LE strength. The exercise interventions were: (1) BWSTT, (2) limb-loaded resistive leg cycling (CYCLE), (3) LE muscle-specific progressive-resistive exercise (LE-EX), and (4) UE ergometry (UE-EX). (For video clips of these exercises, visit this article online at www.ptjournal.org). After baseline assessments, participants were randomly assigned to a combination exercise. program that consisted of the following exercise pairs: BWSTT/UE-EX, CYCLE/UE-EX, BWSTT/CYCLE, and BWSTT/LE-EX. Participants engaged in the exercise 4 days per week. Exercise type was on alternate days (eg, BWSTT session on one day followed by CYCLE session on the alternate day). Based on participant preference, a rest day was provided on Wednesday or Friday, with no exercise on the weekend. All participants received the same number of treatment sessions and contact time with a physical therapist in order to minimize the Hawthorne effect. 49 Two separate comparisons were conducted: (1) BWSTT/UE-EX and CYCLE/UE-EX and (2) BWSTT/UE-EX, BWSTT/ CYCLE, and BWSTT/LE-EX. The first comparison examined the efficacy of task-specific treadmill training with BWS compared with a resistive cycling program that emphasized LE strengthening of muscle groups used in gait. The second comparison allowed for an analysis of the efficacy of an exercise program that combines task-specific treadmill training with BWS with a progressive resistive exercise program (either resistive LE cycling or LE muscle specific progressive-resistive exercise) compared with task-specific treadmill training with BWS alone. Progressive-resistive exercise program for paretic hip flexors and extensors, knee flexors and extensors, and ankle dorsiflexors and plantar flexors.

TREATMENT GROUP 4. The goal of the treatment sessions was to have each participant engage in a 1-hour physical therapy program that included a moderate-intensity progressive exercise protocol that is representative of what therapists may do in a usual treatment session. Intervention consisted of physical therapist–supervised exercise conducted in 1-hour sessions, 4 days per week, for 6 weeks. Protocol variations for missed visits were acceptable if the total 24 visits were accomplished within an 8-week period. Four exercise interventions were used. Three exercise interventions were designed to improve gait speed or LE strength, and one UE exercise intervention was designed as a sham intervention, not to include any active component that would improve gait speed or LE strength. The exercise interventions were: (1) BWSTT, (2) limb-loaded resistive leg cycling (CYCLE), (3) LE muscle-specific progressive-resistive exercise (LE-EX), and (4) UE ergometry (UE-EX). (For video clips of these exercises, visit this article online at www.ptjournal.org). After baseline assessments, participants were randomly assigned to a combination exercise. program that consisted of the following exercise pairs: BWSTT/UE-EX, CYCLE/UE-EX, BWSTT/CYCLE, and BWSTT/LE-EX. Participants engaged in the exercise 4 days per week. Exercise type was on alternate days (eg, BWSTT session on one day followed by CYCLE session on the alternate day). Based on participant preference, a rest day was provided on Wednesday or Friday, with no exercise on the weekend. All participants received the same number of treatment sessions and contact time with a physical therapist in order to minimize the Hawthorne effect. 49 Two separate comparisons were conducted: (1) BWSTT/UE-EX and CYCLE/UE-EX and (2) BWSTT/UE-EX, BWSTT/ CYCLE, and BWSTT/LE-EX. The first comparison examined the efficacy of task-specific treadmill training with BWS compared with a resistive cycling program that emphasized LE strengthening of muscle groups used in gait. The second comparison allowed for an analysis of the efficacy of an exercise program that combines task-specific treadmill training with BWS with a progressive resistive exercise program (either resistive LE cycling or LE muscle specific progressive-resistive exercise) compared with task-specific treadmill training with BWS alone. Upper-extremity cycle ergometry as sham exercise condition.

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## Sunderland et al. Enhanced physical therapy improves recovery of arm function after stroke. A randomized controlled trial. 1992.

CONTROL GROUP 1. The CT patients were treated by the clinical physiotherapists. Those assigned to ET were immediately transferred to the project therapists for physiotherapy and occupational therapy for the arm.This was supplementary to the input from clinical occupational therapists which was the same for both groups. Most of the physiotherapy for the two groups was given in different parts of the same rehabilitation unit. Project therapists did not treat any patient in the CT group. Conventional physiotherapy in the Frenchy Hospital is loosely based on the “neurophysiological" techniques. The texts by Bobath30 and Johnstone3’ describe the major techniques used. The emphasis is on expert hands-on treatment by the therapist and patients are not routinely instructed to exercise between therapy sessions. Active movement may not be encouraged until abnormal muscle tone is well controlled. Therapy in both groups was monitored throughout the course of the study. For each CT patient, one physiotherapy session per month (chosen at random) was observed by the project coordinator. Treatment given in the ET group was recorded in the treatment notes by the project therapists immediately following each session.

TREATMENT GROUP 1. The CT patients were treated by the clinical physiotherapists. Those assigned to ET were immediately transferred to the project therapists for physiotherapy and occupational therapy for the arm.This was supplementary to the input from clinical occupational therapists which was the same for both groups. Most of the physiotherapy for the two groups was given in different parts of the same rehabilitation unit. Project therapists did not treat any patient in the CT group. There were two aims. First, to give more intensive treatment for the arm, with the amount and type of therapy for the leg being similar to that in the CT group. Second, to use behavioral methods to encourage the patient and family to be active participants in arm rehabilitation,32 and to avoid the patient being a passive recipient of expert therapy. Specific aims were to promote greater adherence to self-directed exercise programmes,” to combat overprotectiveness from spouses,” to prevent learned non-use of the affected arm,20 and to facilitate learning of new motor skills.35 36 An eclectic approach was taken in selection of treatment techniques, which included Bobath exercises, EMG biofeedback, micro-computer games and goal-setting. Emphasis was placed on setting the patient tasks of graded difficulty and providing objective feedback on performance. Therapy in both groups was monitored throughout the course of the study. For each CT patient, one physiotherapy session per month (chosen at random) was observed by the project coordinator. Treatment given in the ET group was recorded in the treatment notes by the project therapists immediately following each session.

CONTROL GROUP 2. The CT patients were treated by the clinical physiotherapists. Those assigned to ET were immediately transferred to the project therapists for physiotherapy and occupational therapy for the arm.This was supplementary to the input from clinical occupational therapists which was the same for both groups. Most of the physiotherapy for the two groups was given in different parts of the same rehabilitation unit. Project therapists did not treat any patient in the CT group. Conventional physiotherapy in the Frenchy Hospital is loosely based on the “neurophysiological" techniques. The texts by Bobath30 and Johnstone3’ describe the major techniques used. The emphasis is on expert hands-on treatment by the therapist and patients are not routinely instructed to exercise between therapy sessions. Active movement may not be encouraged until abnormal muscle tone is well controlled. Therapy in both groups was monitored throughout the course of the study. For each CT patient, one physiotherapy session per month (chosen at random) was observed by the project coordinator. Treatment given in the ET group was recorded in the treatment notes by the project therapists immediately following each session.

TREATMENT GROUP 2. The CT patients were treated by the clinical physiotherapists. Those assigned to ET were immediately transferred to the project therapists for physiotherapy and occupational therapy for the arm.This was supplementary to the input from clinical occupational therapists which was the same for both groups. Most of the physiotherapy for the two groups was given in different parts of the same rehabilitation unit. Project therapists did not treat any patient in the CT group. There were two aims. First, to give more intensive treatment for the arm, with the amount and type of therapy for the leg being similar to that in the CT group. Second, to use behavioral methods to encourage the patient and family to be active participants in arm rehabilitation,32 and to avoid the patient being a passive recipient of expert therapy. Specific aims were to promote greater adherence to self-directed exercise programmes,” to combat overprotectiveness from spouses,” to prevent learned non-use of the affected arm,20 and to facilitate learning of new motor skills.35 36 An eclectic approach was taken in selection of treatment techniques, which included Bobath exercises, EMG biofeedback, micro-computer games and goal-setting. Emphasis was placed on setting the patient tasks of graded difficulty and providing objective feedback on performance. Therapy in both groups was monitored throughout the course of the study. For each CT patient, one physiotherapy session per month (chosen at random) was observed by the project coordinator. Treatment given in the ET group was recorded in the treatment notes by the project therapists immediately following each session.

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## Sungkarat et al. Efficacy of an insole shoe wedge and augmented pressure sensor for gait training in individuals with stroke: a randomized controlled trial. 2011.

CONTROL GROUP 1. Participants in both groups participated in 15 physical therapy sessions (60 minutes/session, 5 days/week). For each 60-minute session, 30 minutes focused on gait retraining and 30 minutes involved other conventional stroke rehabilitation programmes. The conventional stroke rehabilitation programme included neuromuscular facilitation techniques, therapeutic exercises, balance and functional training.

TREATMENT GROUP 1. Participants in both groups participated in 15 physical therapy sessions (60 minutes/session, 5 days/week). For each 60-minute session, 30 minutes focused on gait retraining and 30 minutes involved other conventional stroke rehabilitation programmes. Gait training included pre-gait activities such as weight-bearing and weight-shifting activities, stepping, strengthening of the lower extremities and practise of walking overground with and without manual and verbal guidance.

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## Sutbeyaz et al. Mirror Therapy Enhances Lower-Extremity Motor Recovery and Motor Functioning After Stroke: A Randomized Controlled Trial. 2007.

CONTROL GROUP 1. Both the mirror group and the placebo group participated in a conventional stroke rehabilitation program, 5 days a week, 2 to 5 hours a day, for 4 weeks. The conventional program is patient-specific and consists of neurodevelopmental facilitation techniques, physical therapy, occupational therapy, and speech therapy (if needed). Subjects were in a semi-seating position on a bed, while the mirror board (40 70cm) was positioned between the legs perpendicular to the subject’s midline, with the nonparetic leg facing the reflective surface. Subjects observed the reflection of the nonparetic leg while flexing and extending the ankle at a self-selected speed under supervision but without additional verbal feedback. The placebo group performed the same exercise for the same duration, but the nonreflecting side of the mirror was used.

EXPERIMENTAL GROUP 1. Both the mirror group and the placebo group participated in a conventional stroke rehabilitation program, 5 days a week, 2 to 5 hours a day, for 4 weeks. The mirror group received an additional 30 minutes a day of a mirror therapy program consisting of non-paretic ankle dorsiflexion movements. Subjects were in a semi-seating position on a bed, while the mirror board (40 70cm) was positioned between the legs perpendicular to the subject’s midline, with the nonparetic leg facing the reflective surface. Subjects observed the reflection of the nonparetic leg while flexing and extending the ankle at a self-selected speed under supervision but without additional verbal feedback. The placebo group performed the same exercise for the same duration, but the nonreflecting side of the mirror was used.

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## Tanaka et al. Effects of gait rehabilitation with a footpad-type locomotion interface in patients with chronic post-stroke hemiparesis: a pilot study. 2012.

CONTROL GROUP 1. Patients were allocated by a computer-generated sequence into odd numbers (group A) and even numbers (group B). Group A underwent an ‘intervention phase’ followed by a ‘non-intervention phase’, whereas group B underwent the ‘non-intervention phase’ first, and then the ‘intervention phase’. We did not provide an interval between the phases. The intervention phase in this study comprised baseline, GaitMaster training and follow-up, and the non-intervention phase comprised baseline, non-training and follow-up.

TREATMENT GROUP 1. Patients were allocated by a computer-generated sequence into odd numbers (group A) and even numbers (group B). Group A underwent an ‘intervention phase’ followed by a ‘non-intervention phase’, whereas group B underwent the ‘non-intervention phase’ first, and then the ‘intervention phase’. We did not provide an interval between the phases. The intervention phase in this study comprised baseline, GaitMaster training and follow-up, and the non-intervention phase comprised baseline, non-training and follow-up.

In the intervention phase, after a four-week baseline period, patients performed gait rehabilitation with the GaitMaster4 two or three times a week for a total of 12 GaitMaster training sessions (4–6 weeks), followed by four weeks of follow-up. In the non-intervention phase, we performed baseline, non-training and follow-up rehabilitation, with each segment lasting four weeks.

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## Taub et al. A Placebo-Controlled Trial of Constraint-Induced Movement Therapy for Upper Extremity After Stroke. 2006.

CONTROL GROUP 1. The placebo control group was designed to control for the duration and intensity of patient–therapist interactions and therapeutic activities. These participants received a general fitness program in which they performed strength, balance, and stamina training exercises, played games that provided cognitive challenges, and practiced relaxation exercises for 6 hours per day for 10 consecutive week days. Their answers to a laboratory standard questionnaire about their expectations before the intervention (Table 1) suggests that they found the control treatment to be credible.

TREATMENT GROUP 1. The CI therapy group received both components of a published protocol2 derived from the work with deafferented monkeys (ie, paretic arm training and contralateral arm restraint).5 The training was administered intensively for 6 hours per day with an additional hour of interpolated rest on each weekday of the 2-week treatment period. The training consisted primarily of a procedure termed shaping (supplemental Appendix I, available online at http://stroke.ahajournals.org),7,8which involved: (1) quantifying and very frequent immediate feedback concerning improvements in the speed and quality of movement (QOM), (2) selecting tasks that were tailored to address the motor deficits of the individual patient, (3) modeling, prompting, and cuing of task performance, and (4) systematically increasing the difficulty level of the task performed in small steps when 5 trials of improved performance occurred. The CI therapy participants also wore a resting hand splint/sling ensemble on their less affected upper extremity that prevented use of that arm for a target of 90% of waking hours for the entire 14-day treatment period. The rationale was to promote use of the more affected arm outside the laboratory when safety permitted. Additional behavioral techniques, such as behavioral contracts and problem solving (supplemental Table I, available online at <http://stroke.ahajournals.org>) were used to facilitate transfer of treatment gains from the therapeutic to the home setting.

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## Thaut et al. Rhythmic Auditory Stimulation Improves Gait More Than NDT/Bobath Training in Near-Ambulatory Patients Early Poststroke: A Single-Blind, Randomized Trial. 2007.

CONTROL GROUP 1. Both groups were assessed by blinded physical therapists who performed the Barthel Index 15 and the Fugl-Meyer Scale.16 The Fugl-Meyer score was 31.4 for the control group and 33.3 for the RAS group (balance and lower extremity function combined). The Barthel Index score was 45.5 for the control group and 47.5 for the RAS group. Patients entered the study within 4 weeks of onset, as soon as they could complete 5 stride cycles with handheld assistance by the therapist, that is, with no more than support of the forearm, wrist, and elbow at approximately 90 degrees of elbow flexion on the nonparetic side. Handheld assistance was available to all patients throughout training when needed. Mean entry date poststroke was 21.3 ± 10.8 days for the RAS group and 22.3 ± 14.7 for the NDT/Bobath group. The study duration was 3 weeks, with gait train-ing daily for 30 minutes, 5 times per week. Four gait therapists for each group conducted the training to ensure consistency in training protocols and procedures. Each center had its own independently trained pool of therapists. Therapists were not blinded to the treatment conditions of the study. However, because both conditions are considered full treatment conditions, no performance bias was expected. Total walking time was tracked in both groups to ensure consistent exercise duration. Pre-gait exercises were not included in the actual training period of the experimental trials and were carried out in similar fashion in both groups if therapeutically indicated. The control group trained the same amount of time and distance, following NDT and Bobath principles as well as using similar instructions about gait parameters to practice, but without rhythmic auditory cuing.

TREATMENT GROUP 1. Both groups were assessed by blinded physical therapists who performed the Barthel Index 15 and the Fugl-Meyer Scale.16 The Fugl-Meyer score was 31.4 for the control group and 33.3 for the RAS group (balance and lower extremity function combined). The Barthel Index score was 45.5 for the control group and 47.5 for the RAS group. Patients entered the study within 4 weeks of onset, as soon as they could complete 5 stride cycles with handheld assistance by the therapist, that is, with no more than support of the forearm, wrist, and elbow at approximately 90 degrees of elbow flexion on the nonparetic side. Handheld assistance was available to all patients throughout training when needed. Mean entry date poststroke was 21.3 ± 10.8 days for the RAS group and 22.3 ± 14.7 for the NDT/Bobath group. The study duration was 3 weeks, with gait train-ing daily for 30 minutes, 5 times per week. Four gait therapists for each group conducted the training to ensure consistency in training protocols and procedures. Each center had its own independently trained pool of therapists. Therapists were not blinded to the treatment conditions of the study. However, because both conditions are considered full treatment conditions, no performance bias was expected. Total walking time was tracked in both groups to ensure consistent exercise duration. Pre-gait exercises were not included in the actual training period of the experimental trials and were carried out in similar fashion in both groups if therapeutically indicated. RAS training followed established protocols 7,17 using a metronome and specifically prepared music tapes in digital MIDI format to ensure temporal precision and tempo stability as well as full capacity for frequency modulation of the stimulus based on patient needs. After an initial cadence assessment, cuing frequencies were matched to the gait cadence for the first quarter of the session. During the second quarter, cue frequencies were increased in 5% increments as kinematically indicated without compromising postural and dynamic stability. During the third quarter, adaptive gait patterns, for example, ramp or step walking, were practiced. The last quarter was spent fading the cues intermittently to train for independent carryover.

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## Timmermans et al. Original Study Effect of Mental Practice on the Improvement of Function and Daily Activity Performance of the Upper Extremity in Patients With Subacute Stroke: A Randomized Clinical Trial. 2013.

CONTROL GROUP 1. Patients in the control group received therapy as usual. 13In addition, they were instructed to practice additional bimanual upper extremity techniques based on NDT principles.14 NDT or the Bobath concept focuses on the active involvement of the patient where the patient tries to move using key points of control and reflex-inhibiting patterns. 15 Earlier studies did not confirm any additional effect of NDT exercises over therapy as usual in stroke. 15,16 Because in this study thepurpose of the control intervention was primarily to match the total amount of practice between groups, NDT exercises seem adequate for this purpose. The control group patients received a booklet explaining all tasks and were instructed to practice for 10 minutes at least three times a day. Every 2 weeks, the home-based training sessions were evaluated by the OT. Total contact time with the OT in the experimental and control groups was equal.

TREATMENT GROUP 1. The experimental group of patients received their regular therapy 13 and, additionally, MP-based arm training. The MP training was supervised by an occupational therapist (OT). After baseline measurements, the patients were educated as to basic imagery principles and the importance of regular imagery training in increasing therapy success. During the first week, the patients were taught how to use the MP techniques to improve arm function. A training task tailored to the functional level of the individual patients was selected by the OT. Six different MP training tasks were available, with gradually increasing difficulty, namely: “holding paper,”“ grasp/hold/release of a glass,”“handle a pen to mark a cross on a paper, ”“ take a telephone call, ”“bring glass to mouth,”and “pour water from a jar into a glass.” For all tasks, a training DVD guided the patient. Each DVD was programmed in three steps. Performance of all activities was shown from a first-person perspective (an “over-the-shoulder”view). In the first step,five repetitions of correct performance are shown on the screen combined with a verbal explanation. In the second step,five repetitions of task performance were shown without verbal explanation; patients were asked to mentally practice the movement. In the third step, no guidance during task performance was given except visual and verbal cues indicating the end of the task performance over 5 repetitions. DVDs were available for every task for right- and left- handers. Patients had to practice at least three times a day for 10 minutes each session. During the intervention period, functional arm and hand progress was evaluated by the OT every 2 weeks. If a patient’s functional level on a task improved, a new task was chosen and the DVD was changed. The total intervention lasted for 6 weeks.

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## Timmermans et al. Effects of task-oriented robot training on arm function, activity, and quality of life in chronic stroke patients: a randomized controlled trial. 2014.

CONTROL GROUP 1. Training was provided during 8 weeks, 4 times/week, twice a day for 30 minutes (separated by 0.5 hour to 1 hour of rest). At the start of the training program participants in both groups chose a minimum of 2 out of 4 skills to train:‘drinking from a cup’,’eating with knife and fork’‘taking money from a purse’ or ‘ using a tray’. The reason for letting patients choose the tasks they preferred most, was that we wanted to provide in both groups, to some extent, goal oriented training where patients would train towards personally set goals. This to enhance patient compliance, patient motivation and self-efficacy [39-41]. The tasks for which exercises were provided are chosen out of a list of training preferences for stroke patients [42]. Before training, participants were educated about the principles of task-oriented arm-hand training and the importance of frequent training to enhance therapy success. Video-instructions were used to explain the exercises. The video-instructions were organised per task, and within the task per skill component. Patients could easily select by themselves the appropriate training content. For each skill component at least 5 exercises were given in increasing difficulty level. The training program was similar for the experimental group and the control group, the only difference being the use of technology in the experimental group. Both groups received the same video-instructions, together with a tool box filled with training objects and posters how to use different objects with increasing difficulty levels (e.g. round glass with anti-slip material→normal glass→ wine glass). The exercises were done by (dis)placing objects on pre-printed templates, which were the same in both groups. The experimental group,by combining the T-TOAT training with the use of a Haptic Master robot received trajectory guidance through haptic feedback; while the control group had to master all upper extremity movements without support. Training in both, the experimental and control group, was supervised by a physiotherapist, occupational therapist or movement scientist. The therapist was present during the training (for both groups) to answer questions of the patients when necessary, to assist with advice on the use of objects, or to provide assistance in adaptations of the Haptic TOAT software. Assistance or resistance during training was adjusted between training sessions, by changing the strength of the spring force or damping in the Haptic Master software, in order to always maximally challenge the patient according to his/her potential. The patients were offered exercises that they could just about manage successfully without an increase of their compensatory strategies during movement performance. This approach is supportive of motor learning in stroke patients [33]. The therapists used the assistance and damping facilities in the software according to their clinical experience. No recordings were made of how therapists actually used these training facilities. Both groups received equal attention of the therapist. Compliance was determined as the percentage of training sessions patients attended relative to the maximal total of 64 training sessions. Patients continued their usual care outside of this intervention. The usual care therapy did not consist of arm-hand activities at the ICF activity level.

TREATMENT GROUP 1. For training, the T-TOAT (Technology-supported Task-Oriented Arm Training) method [33] was applied. The training method comprises of breaking down skills into functional components that maintain a strong relationship with the original skill itself. For each of these components exercises are offered at gradually increasing levels of difficulty, based on progress criteria from the fields of exercise physiology [34], and motor learning [35]. With regard to principles from exercise physiology, patients were instructed to not only focus on training coordination with low weight objects, but also include series where a number of repetitions was performed with heavier objects, in order to train on endurance (e.g. 50% of maximal weight, 3×15 repetitions) and strength (e.g. submaximal weights, 8–10 repetitions) [36]. With regard to motor learning, treatment variability was encouraged as patients were asked to use as many different objects as possible (e.g. different shapes and sizes of cutlery, different kinds of cups and glasses, several shapes and sizes of purses, different coins, etc.). Also patients were explicitly asked to mix different exercises and different tasks as random practise is known to support motor learning and retention of training effects through high contextual interference [37,38]. Participants are encouraged to first train on components of a skill (e.g. reach out to cup,grasp cup,lift cup,bring cup to mouth,empty cup in mouth, place cup on table), after which the complete action (e.g. drinking from a cup), sequencing all components, is trained. The “ Haptic-TOAT” software tool [33] was used to enable the use of the T-TOAT method in combination with the Haptic Master robot. Individual movement trajectories can be recorded for each patient, in order to train on the for each patient optimal path. The 3D positions (x,y,z coordinates) are logged with a sample rate of 100 Hz, and can be saved and replayed. The number of repetitions can be adjusted per patient. Several modes can be used: the passive mode (for patients with very little strength or for learning the movement trajectory), or the active mode. In the passive mode, the trajectory is covered by the Haptic Master, taking the patient’s arm along the recorded path. In the active mode, the patient performs the arm movement along the recorded trajectory, whereby a deviation from the trajectory is corrected by bouncing into a wall, the diameter of the tunnel around the trajectory can be set by the therapist (a larger diameter is more difficult). Also correction of trajectory deviation is supported by a spring, with customizable strength, that pulls the robot end effector (and thus the patient arm) back to the optimal movement trajectory (stronger spring = easier). In addition to the spring force, damping (allowing for strength training) and addition of a force in the vertical direct ion (either supporting the arm against gravity or addition of extra load, both possible at the wrist and distal part of the forearm via the orthotic arm-HM interface) may be set at each point of the trajectory with the same graphical user interface. The T-TOAT method and its use with the Haptic Master are extensively described in a paper of Timmermans et al. [33].

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## Treger et al. Modified Constraint-Induced Movement Therapy Improved Upper Limb Function in Subacute Poststroke Patient: A Small-Scale Clinical Trial. 2012.

CONTROL GROUP 1. The average hospitalization period in the acute neurologic rehabilitation department was two months. An average, the intervention began 2 weeks after admission. Before and after the intervention period, patients in both groups received standard rehabilitation. During the intervention period, participants in both groups participated in occupational therapy sessions 5 times a week, dedicated to improving upper limb function. Subjects in both groups reviewed 30 minutes of individual treatment sessions and 30 minutes of group exercises (up to 4 patients in a group). Both groups received intensive training of the affected upper limb based on a task-oriented approach, emphasizing repetitive practice of functional activities and behavioral shaping, while the unaffected hand of subjects in the modified CIMT group was restricted by wearing a special mitten. Functional tasks included reaching forward or up to move a cup, picking up coins, using a utensil to eat, combing hair, writing, and other functional movements similar to those of daily activities. The specific tasks that were part of the outcome test were not included in the CIMT or the control group training. In addition, both groups received daily sessions (45 minutes) of physical therapy, and if needed 30 minutes of speech therapy.

TREATMENT GROUP 1. The average hospitalization period in the acute neurologic rehabilitation department was two months. The RCT subjects reviewed a modified CIMT or control intervention for two weeks. An average, the intervention began 2 weeks after admission. Before and after the intervention period, patients in both groups received standard rehabilitation. During the intervention period, participants in both groups participated in occupational therapy sessions 5 times a week, dedicated to improving upper limb function. Subjects in both groups reviewed 30 minutes of individual treatment sessions and 30 minutes of group exercises (up to 4 patients in a group). Both groups received intensive training of the affected upper limb based on a task-oriented approach, emphasizing repetitive practice of functional activities and behavioral shaping, while the unaffected hand of subjects in the modified CIMT group was restricted by wearing a special mitten. Functional tasks included reaching forward or up to move a cup, picking up coins, using a utensil to eat, combing hair, writing, and other functional movements similar to those of daily activities. The specific tasks that were part of the outcome test were not included in the CIMT or the control group training. In addition, both groups received daily sessions (45 minutes) of physical therapy, and if needed 30 minutes of speech therapy. To discourage the use of the less affected hand outside the therapy sessions, participants in the modified CIMT group wore a restrictive mitten for a target of 4 hours per day, every day, for two weeks.

# V Authors

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## van der Port et al. Effects of circuit training as alternative to usual physiotherapy after stroke: randomized controlled trial. 2012.

CONTROL GROUP 1. Patients allocated to the control group received usual outpatient physiotherapy, mainly one to one treatments tailored to the patient with a physiotherapist who had not been on the circuit training course at one of the participating rehabilitation centres. Sessions designed to improve control of standing balance, physical condition, and walking competency were provided according to Dutch physiotherapy guidelines. 11 There were no additional restrictions with respect to content, time, or duration of the physiotherapy.

TREATMENT GROUP 1. Patients assigned to the intervention group received a 90 minute,graded task oriented circuit training program twice a week over a 12 week period (24 sessions). The training included eight different workstations, intended to improve meaningful tasks relating to walking competency. 9 At each workstation, participants worked together in pairs: while one participant performed the task for three minutes, the other observed their performance. After three minutes of practice or observation, they switched roles.After six minutes at the workstation, each pair had one minute to go to the next workstation. Each participant’s performance (such as counts) was recorded in a training log, which was used as a feedback and motivational tool during the next sessions. Motivational music was played in the background during the entire training session. The totalFIT-Stroke program included four stages: warming up (5 minutes), circuit training (60 minutes), evaluation and a short break (10 minutes), and group game (15 minutes). The physiotherapist and sports therapists who conducted the program were trained on a one day course before the FIT-Stroke trial started. The staff recorded patients’ attendance at the sessions and adverse events (such as falls, heart problems) during the intervention. Serious adverse events were defined as any fall or other adverse event related to treatment that required a hospital or GP visit. Serious adverse events were reported to the medical ethics . committee.

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## van Delden et al. Unilateral Versus Bilateral Upper Limb Training After Stroke: The Upper Limb Training After Stoke Clinical Trial. 2013.

CONTROL GROUP 1. After obtaining informed consent, a pretest of outcome variables was performed. Next, patients were randomized in permuted blocks and allocated to 1 of the 3 intervention groups. Concealed allocation was effectuated online using the minimization method. After randomization, there was a 6-week intervention period. The posttests were conducted during the week after intervention. Follow- up tests were conducted 6 weeks after the posttests. The mBATRAC therapy involved a modification of the original bilateral arm training with rhythmic auditory cueing protocol 2 , which targeted rhythmic flexion and extension movements about the wrist rather than movements of proximal parts of the upper limb. The DMCT was an exercise therapy on the basis of existing guidelines for upper limb rehabilitation after stroke, discarding specific elements of mCIMT and mBATRAC. All patients received 60-minute therapy sessions, 3 days a week for 6 consecutive weeks. They were also instructed to practice outside of therapy hours and encouraged to perform activities of daily living according to the concept of their allocated treatment.

TREATMENT GROUP 1. After obtaining informed consent, a pretest of outcome variables was performed. Next, patients were randomized in permuted blocks and allocated to 1 of the 3 intervention groups. Concealed allocation was effectuated online using the minimization method. After randomization, there was a 6-week intervention period. The posttests were conducted during the week after intervention. Follow- up tests were conducted 6 weeks after the posttests. The mCIMT therapy involved repetitive task practices and shaping of the desired movements,1,6 with an emphasis on the increase of control of wrist and finger extensors. Patients were encouraged to wear a mitt on the nonparetic hand for 6 hours each weekday.

TREATMENT GROUP 2. After obtaining informed consent, a pretest of outcome variables was performed. Next, patients were randomized in permuted blocks and allocated to 1 of the 3 intervention groups. Concealed allocation was effectuated online using the minimization method. After randomization, there was a 6-week intervention period. The posttests were conducted during the week after intervention. Follow- up tests were conducted 6 weeks after the posttests. The mBATRAC therapy involved a modification of the original bilateral arm training with rhythmic auditory cueing protocol 2 , which targeted rhythmic flexion and extension movements about the wrist rather than movements of proximal parts of the upper limb. The DMCT was an exercise therapy on the basis of existing guidelines for upper limb rehabilitation after stroke, discarding specific elements of mCIMT and mBATRAC. All patients received 60-minute therapy sessions, 3 days a week for 6 consecutive weeks. They were also instructed to practice outside of therapy hours and encouraged to perform activities of daily living according to the concept of their allocated treatment.

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## van der Lee et al. Forced Use of the Upper Extremity in Chronic Stroke Patients : Results From a Single-Blind Randomized Clinical Trial. 1999.

CONTROL GROUP 1. Patients were treated in groups of 4 in the outpatient clinic of the Department of Rehabilitation Medicine of the University Hospital Vrije Universiteit. All 4 patients in each group received the same treatment for 2 consecutive weeks, 5 days a week, 6 hours a day. The contrast between the intervention conditions was focused on the presence or absence of forced use. Therefore, the cointerventions, consisting of group activities, exercises, and therapist attention, were kept equal between groups. In accordance with the concept that practice should be aimed at functional goals,17 the treatment was focused on housekeeping activities, handicrafts, and games. Physical therapists selected the most appropriate activities for each individual patient on the basis of the patient’s residual sensorimotor capacity. The groups were always supervised by 1 or 2 physical or occupational therapists, and patients received continuous verbal feedback and stimulation and, if necessary, hands-on facilitation of movements and inhibition of inappropriate muscle contraction. Much attention was paid to the avoidance of associated proximal movements and to relaxation, by means of verbal guidance. A more detailed description of the schedule of activities can be obtained on request from the corresponding author.

TREATMENT GROUP 1. Patients were treated in groups of 4 in the outpatient clinic of the Department of Rehabilitation Medicine of the University Hospital Vrije Universiteit. All 4 patients in each group received the same treatment for 2 consecutive weeks, 5 days a week, 6 hours a day. All patients in the experimental groups had their healthy arm immobiLized by a resting splint and a closed arm sling, which was attached to the waist. Patients were encouraged to wear the splint at home during the 12 days of treatment, whereas the sling was only used during treatment hours. Every day the use of the splint at home was registered by the patients in a logbook. As instructed, the patients did not wear the splint when traveling, sleeping, dressing, or during toilet activities. In the reference groups the patients were treated according to the NDT method.11 All activities were performed bimanually and, if necessary, the affected arm was supported with the unaffected hand. Symmetry of posture and inhibition of inappropriate “synergistic” movements were emphasized.

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## van Nes et al. Long-Term Effects of 6-Week Whole-Body Vibration on Balance Recovery and Activities of Daily Living in the Postacute Phase of Stroke: A Randomized, Controlled Trial. 2006.

CONTROL GROUP 1. All patients were treated with either WBV or exercise therapy on music (ETM) on each working day during 6 weeks of their admission in the rehabilitation center. Both treatments consisted of four sessions of 45 seconds stimulation interrupted by a 1-minute break between each session. In this way, a total of 120 treatment sessions were given per patient. During the ETM, patients were instructed to adopt the same standing position as during the WBV. The whole program consisted of regular exercises for the trunk, arm, and leg muscles interrupted by periods of relaxation. ETM was given either individually or in small groups of two to three patients and was supervised by an experienced physical therapist as well. To standardize ETM between the participating rehabilitation centers, five different compact discs were recorded, one for each day of the week, to guide the exercises so that patients in different centers received the same type of treatment. Before the onset of the study, all treating physical therapists received specific instructions on both interventions to ensure uniformity in the treatment procedures. They were also instructed not to communicate with the patients about the possible goals of or rationale for either treatment. In addition to the WBV or ETM treatments, all patients participated in an individualized treatment program consisting of at least five 30-minute individual sessions of physical therapy, five 60-minute group sessions of physical therapy, and three 30-minute individual sessions of occupational therapy augmented with speech and language therapy and psychologic treatment if necessary.

TREATMENT GROUP 1. All patients were treated with either WBV or exercise therapy on music (ETM) on each working day during 6 weeks of their admission in the rehabilitation center. Both treatments consisted of four sessions of 45 seconds stimulation interrupted by a 1-minute break between each session. In this way, a total of 120 treatment sessions were given per patient. By selecting this specific intensity of WBV, all patients received a strong stimulation of their proprioceptive afferents 10 (in particular Ia and II afferents), whereas muscular fatigue was prevented. 17 ETM of this intensity was considered a “sham” treatment. WBV was provided through a commercially available device.\* This apparatus consists of a moveable rectangular platform built within a circular ground surface on which a support bar is mounted at the front. The platform makes fast oscillating movements around a sagittal axis in the middle. Subjects were required to stand on the platform with their feet at an equal and standardized distance from the axis of rotation so that the vibration amplitude was 3 mm. The frequency was set at its maximum of 30 Hz. Patients who could stand independently (Functional Ambulation Categories [FAC] 3to5) were instructed to adopt a “squat” position with slight flexion at the hips, knees, and ankle joints to damp the vibrations approximately at the pelvic level. They were allowed to hold the support bar (see Figure 1A). Patients who could not yet stand independently (FAC 0 to 2) were supported at their buttocks by a height-adjustable bench with their knees and hips in 45° flexion while holding onto the support bar as well (see Figure 1B). An experienced physical therapist supervised all the WBV administrations. Before the onset of the study, all treating physical therapists received specific instructions on both interventions to ensure uniformity in the treatment procedures. They were also instructed not to communicate with the patients about the possible goals of or rationale for either treatment. In addition to the WBV or ETM treatments, all patients participated in an individualized treatment program consisting of at least five 30-minute individual sessions of physical therapy, five 60-minute group sessions of physical therapy, and three 30-minute individual sessions of occupational therapy augmented with speech and language therapy and psychologic treatment if necessary.

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## van Vilet et al. Comparison of Bobath based and movement science based treatment for stroke: a randomised controlled trial. 2005.

CONTROL GROUP 1. Patients were randomly allocated to one of two treatment groups. One group received a BB treatment,17 18 25 the other an MSB treatment. 19 26–28 Prior to randomisation, treatment was the routine (BB) treatment. Following randomisation, which occurred within 2 weeks following the stroke, the two treatments were delivered by different groups of physiotherapists using prepared written guidelines, consisting of theoretical concepts for practice and main clinical objectives, based on their own knowledge and experience and their interpretation of the literature. Different physiotherapy assistants were available to assist physiotherapists for each treatment group. The BB treatment was delivered by physiotherapists working on the ward who used it routinely before the study began. The amount of daily treatment was matched to the amount given by existing ward physiotherapists. Ward occupational therapists also used the allocated treatment. Patients received the allocated treatment during outpatient physiotherapy. Treatment continued for as long as was needed, rather than a standardised length of time, because of the varying needs of patients and to reflect usual hospital practice. The primary outcome measures were the Rivermead Motor Assessment 29 and the Motor Assessment Scale (MAS), 30 which measure the consequences of motor impairment. The first was developed by therapists using the BB treatment and the second was developed by therapists using the MSB treatment. Secondary measures were the ten hole peg test, 31

the 6 m walk test, 32 and the Modified Ashworth Scale. 33 The Nottingham Sensory Assessment 34 was used to measure sensory impairment. Measures of activities of daily living were the Barthel Index 35 and Extended Activities of Daily Living scale. 36 One month following randomisation, patients were assessed on four other baseline variables using the Sheffield Screening Test for Acquired Language Disorders, 37 Rey figure copy, 38 Star cancellation test, 39 and Story Recall 40 as measures of cognitive impairment. The 1 month delay was necessary because of the long length of the initial assessment.

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## Variqui et al. Effect of Coordination Biofeedback on (Re)Learning Preferred Postural Patterns in Post-stroke Patients. 2011.

TREATMENT GROUP 1. The protocol lasted four weeks and included three sessions per week (see Figure 2). Sessions 1, 6, 7, and 12 were the test sessions. In these sessions, participants from the three groups performed ten 60-s trials with the imposed pattern (i.e., 0° or 180°). Data were collected for both legs but the bioFB information originated only from the affected leg (aFB). The other sessions were learning sessions. Thus, for each pattern, protocol took place on two weeks and included a pretest (day 1), four practice sessions (days 3, 5, 8 and 10) and a posttest (day 12). Participants from the two experimental groups performed four sessions of learning with each imposed pattern. In each session, they were asked to produce twelve 60-s trials with the bioFB originating from the nonaffected side (naFB, Group A) or from the affected side (aFB, Group B). Patients were allowed to rest as long as they wished between trials.

TREATMENT GROUP 2.The protocol lasted four weeks and included three sessions per week (see Figure 2). Sessions 1, 6, 7, and 12 were the test sessions. In these sessions, participants from the three groups performed ten 60-s trials with the imposed pattern (i.e., 0° or 180°). Data were collected for both legs but the bioFB information originated only from the affected leg (aFB). The other sessions were learning sessions. Thus, for each pattern, protocol took place on two weeks and included a pretest (day 1), four practice sessions (days 3, 5, 8 and 10) and a posttest (day 12). Participants from the two experimental groups performed four sessions of learning with each imposed pattern. In each session, they were asked to produce twelve 60-s trials with the bioFB originating from the nonaffected side (naFB, Group A) or from the affected side (aFB, Group B). Patients were allowed to rest as long as they wished between trials.

CONTROL GROUP 1. The protocol lasted four weeks and included three sessions per week (see Figure 2). Sessions 1, 6, 7, and 12 were the test sessions. In these sessions, participants from the three groups performed ten 60-s trials with the imposed pattern (i.e., 0° or 180°). Data were collected for both legs but the bioFB information originated only from the affected leg (aFB). The other sessions were learning sessions. Thus, for each pattern, protocol took place on two weeks and included a pretest (day 1), four practice sessions (days 3, 5, 8 and 10) and a posttest (day 12). The control group (Group C) practiced a stand-up task during 15 min instead of using the bioFB device. The 15-min period corresponded to the practice time experienced by participants from groups A and B in the bioFB task, but with no specific postural training. During the first session with the bioFB set-up, a familiarization period of 15 min in which they learned how to move the target dots in the ankle-hip space. Pattern order was counterbalanced in each group. During this period, patients continued their daily physical therapy at the rate of two 30-min sessions per day.

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## Verheyden et al. Additional Exercises Improve Trunk Performance After Stroke: A Pilot Randomized Controlled Trial. 2009.

CONTROL GROUP 1. Patients in the experimental and control groups received the conventional multidisciplinary stroke rehabilitation program provided by the rehabilitation center. The conventional treatment program is patient-specific and consists mainly of physiotherapy, occupational therapy, and nursing care. Neuropsychological and speech therapy are provided if needed. Therapists combine elements from different neurological treatment concepts but the main emphasis is on the neuro-developmental treatment concept and on motor relearning strategies.

TREATMENT GROUP 1. Patients in the experimental and control groups received the conventional multidisciplinary stroke rehabilitation program provided by the rehabilitation center. The conventional treatment program is patient-specific and consists mainly of physiotherapy, occupational therapy, and nursing care. Neuropsychological and speech therapy are provided if needed. Therapists combine elements from different neurological treatment concepts but the main emphasis is on the neuro-developmental treatment concept and on motor relearning strategies. In addition to the conventional treatment, patients from the experimental group received 30 minutes of extra training, 4 times a week, for 5 weeks. In total, 10 hours of additional training were given. The additional exercises consisted of selective movements of the upper and lower part of the trunk in supine and sitting.Supine exercises, with the legs bent and the feet resting on the treatment table, included selective anterior-posterior movements of the pelvis, extension of the hips (bridging), and rotation of the trunk initiated from the upper and lower part of the trunk. Exercises in a sitting position included: flexion and extension of the trunk (the patient flexes and extends the trunk without moving the trunk forwards or backwards); flexion and extension of the lumbar part of the spine (this involves selective anteflexion and retroflexion of the lower part of the trunk); flexion and extension of the hips with the trunk extended (with an extended trunk, the movement is initiated in the hips and the patient brings the extended trunk forwards and backwards); ateral flexion of the trunk initiated from the shoulder and pelvic girdle (from the shoulder girdle means that the patient touches the exercise table with one elbow and returns to the starting position, from the pelvic girdle means that the patient lifts one side of the pelvis and returns to the starting position); rotation from the upper and lower part of the trunk (from the upper part of the trunk means that the patient moves each shoulder forwards and backwards, from the lower part of the trunk means that the patient, while sitting in the upright position, moves each knee forwards and backwards); and finally shuffling forwards and backwards on an exercise table (the participant shifts the weight from one side to the other and moves forwards and backwards on the exercise table). Exercises were gradually introduced and the number of repetitions was determined by the therapist on the basis of the patients’ performance.

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## Verma et al. Task-Oriented Circuit Class Training Program with Motor Imagery for Gait Rehabilitation in Poststroke Patients: A Randomized Controlled Trial. 2011.

CONTROL GROUP 1. Subjects in the control group (n = 15) participated in the conventional poststroke lower extremity rehabilitation program based on the Bobath’s neurodevelopmental technique. 6 The control group program was matched for duration, number, and frequency of the sessions with the experimental group program.

TREATMENT GROUP 1. The experimental group (n = 15) received 15 minutes of MI followed by 25 minutes of TOCCT for a total of 40 minutes, 7 days per week for 2 weeks (14 sessions). MI comprised imagining walking abilities and tasks related to a real-life situation (Table 1). The participants were familiarized with the MI during a preintervention session and educated about the basic imagery principles. A therapist with previous clinical experience with such techniques with poststroke patients administered the MI. The MI program of 15 to 25 minutes was given on an individual basis. The participants were also asked to keep a diary of their MI practice to measure the rehearsal frequency after ach treatment session. TOCCT was provided to groups comprising up to 4 patients at any one time with a physiotherapist or occupational therapist for supervision. One caretaker was allowed to ensure safety for the participant who required assistance. The program included different workstations and was intended to improve the meaningful tasks related to walking competency, such as balance control, stair walking, turning, transfers, and speed walking. Further, each session consisted of a continuous practice of standing and walking-related tasks on specified workstations with a minimal break (Table 1). The participants were encouraged to perform for all the workstations in all of the program’s sessions. Although the allocated period of TOCCT was 25 minutes, subjects who could not perform the minimum duration/repetition were given 10 extra minutes. Further, the participants who could finish the minimum dosage were allowed to increase the duration/frequency of the tasks of their expertise, subject to a maximum of 35 minutes with no sign of any discomfort.

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## Vistin et al. A New Approach to Retrain Gait in Stroke Patients Through Body Weight Support and Treadmill Stimulation. 1998

CONTROL GROUP 1. The 100 subjects were randomized into one of two groups: the experimental group (BWS, n5 50) and the control group (no-BWS,n5 50) by block randomization within strata identified according to initial level of ambulatory status (low/high). Low ambulatory status was defined as nonambulatory or requiring maximal assistance to walk. High ambulatory status was defined as needing moderate or minimal assistance or walking independently with or without super ision but with residual gait deviations. The control group received gait training on a treadmill with no BWS, ie, while bearing full weight on their lower extremities. The overhead harness (Figure 1) consists of a pelvic belt that attaches around the hips and two thigh straps with anterior and posterior attachments to the pelvic band. 23 The harness vertically supports the subject over the treadmill and is attached to a suspension system with a force transducer that signals the amount of body weight supported by the apparatus. Individuals in the BWS group were provided up to 40% BWS at the beginning of training, and the percentage of BWS was progressively decreased as the subject’s gait pattern and ability to walk improved. Subjects in the control group wore the harness as a measure of security and to ensure similar experimental conditions between the two groups, but no BWS was provided. Both groups received gait training for 6 weeks at a frequency of four times per week. Gait training was performed by the subject’s treating therapist in the physiotherapy department. During each session the patients were allowed to walk for a maximum of three trials and for a total duration not exceeding 20 minutes. The subject’s pulse and heart rate were monitored before initiation of each session and again after each trial to ensure that it not surpass a baseline established by the physician. The treadmill used (Burdick T500 model) permitted walking to be initiated from 0.0 mph and increased by increments of 0.1 mph. The subject could also hold onto a horizontal bar attached to the front of the treadmill for stability. In addition to gait training, all subjects included in the trial, regardless of group allocation, received regular weekday physiotherapy aimed at maximizing function.

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## Volpe et al. A novel approach to stroke rehabilitation; robot-aided sensorimotor stimulation. 2000.

CONTROL GROUP 1. All patients experienced similar standard physical and occupational pre stroke therapy. The control group received a similar initial exposure to the robot with the exception that half the trials were preformed with the unimpairment upper limb, and when the patient could not perform the task with the affected limb, her or she used the unimpaired limb to complete the task or the technician assisted movement. The robot never actively moved the limbs of the patients in the control group. The control group was exposed to the robot one hour per week.

TREATMENT GROUP 1. All patients experienced similar standard physical and occupational pre stroke therapy. For 1 hour per day, 5 days a week patients in the robot treated group were required to move the handle at the tip of a robot which in turn moved a cursor on a screen. A trained research assistant provided a standardized set of instructions and was always in attendance. The patient sat with shoulders strapped into a custom foam lined chair that would be positioned to face a support board on which was drawn a series of round targets (1cm), over which the robot arm handle was suspended. The patient’s paralyzed limb was supported at the elbow by a low friction pad that slid along the surface of the support board. No patient could voluntarily grip the handle at the tip of the robot, so the patients hand was placed in a custom foam lined holder that was attached to the handle. The wrist was in a neutral position and the fingers were placed around the handle. The patient faced a video screen that provided visual feedback in the form of target identical to those drawn in the support board in front of the patient and that tracked the movement of the robot handle. Auditory feedback indicated correct movements. If the patient did not respond, the robot guided the patients hand to the target in the same fashion as “hand over hand” therapy. 19-21. The exercise protocol were focused on shoulder and elbow movement patterns and were organized in three batches, each batch consisting of 20 repetitions. These trials were preceded by technician guided exercise for a complete protocol. Over the minimum 25 sessions, robot trained patients received at least 1500 repetitions of goal directed movement to a target.

# W Authors

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## Wade et al. Physiotherapy intervention late after stroke and mobility. 1992.

CONTROL GROUP 1. Once accepted into the trial, each patient was assessed by an independent (non-treating) physiotherapist immediately, one to six weeks later, and then about three, six, and nine months after the second assessment. Assessments took place at the patient’s home, and the independent assessor was not informed of the patient’s treatment group. Ten patients were entered too late to complete the last assessment. Table I shows the trial design. There were two initial assessments, primarily to monitor the reliability of the assessment procedures. After the second assessment, patients were randomized to receive physiotherapy either immediately or after a three month delay (that is, after the assessment at three months). Thus at the assessment at three months half the patients had the intervention and half were controls. Randomization was by restricted randomization (permuted blocks of 10) with random number tables.’

TREATMENT GROUP 1. Once accepted into the trial, each patient was assessed by an independent (non-treating) physiotherapist immediately, one to six weeks later, and then about three, six, and nine months after the second assessment. Assessments took place at the patient’s home, and the independent assessor was not informed of the patient’s treatment group. Ten patients were entered too late to complete the last assessment. Table I shows the trial design. There were two initial assessments, primarily to monitor the reliability of the assessment procedures. After the second assessment, patients were randomized to receive physiotherapy either immediately or after a three month delay (that is, after the assessment at three months). Thus at the assessment at three months half the patients had the intervention and half were controls. Randomization was by restricted randomization (permuted blocks of 10) with random number tables.’

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## Waldman et al. Effects of robot-guided passive stretching and active movement training of ankle and mobility impairments in stroke. 2013.

CONTROL GROUP 1. The instructed exercise for the control group involved stretching the plantar flexors and active movement exercises for ankle mobility and strength. The biomechanical evaluation sessions used the robotic rehabilitation device following the one-hour training protocol in the same manner as the robot group. The subjects were given verbal and written instructions to do passive stretching of their calf muscles followed by active movement exercises of the impaired ankle at home 3 times a week. Each subject’s ability to perform the stretching and exercises was reassessed after the first week and third week by weekly phone call. Each subject was given a log to keep track of their training which was collected after 3 weeks and 6 weeks from the start of the study.

TREATMENT GROUP 1. A portable rehabilitation robot with controlled passive stretching and active movement training capabilities and a computer game interface (Fig. 1) was used for the treatment and outcome measures (Chung, Bai, Rymer & Zhang, 2005; Selles et al., 2005). The subject sat on a chair with their affected knee extended and foot strapped onto a footplate with ankle dorsiflexion (DF) at 0◦ (Fig. 1). Biomechanical and clinical evaluations were performed at pre-evaluation, post-evaluation, and 6-week follow-up. Subjects in the robot group had 18 sessions (3 times a week over 6 weeks) at a research laboratory in a rehabilitation hospital. Each session was an hour long training using the portable rehabilitation robot. The robotic therapy included both passive stretching for ROM therapy and active movement training for strengthening therapy. The device stretched the ankle throughout the ROM to extreme DF and plantar flexion (PF) until a specified peak resistance torque was reached with the stretching velocity controlled based on the resistance torque (the higher the resistance, the slower the stretching) (Zhang et al., 2002). The ankle was held at the extreme DF position for a period of time to let stress relaxation of the plantar flexors occur before it was rotated back to the other extreme position (Chung et al., 2005; Selles et al., 2005). After a period of stretching of 20 minutes, the subject would use the stretched muscles immediately in active movement training for 30 minutes by using biofeedback computer games including active assistive games and resistance games The last 10 minutes of the session was another period of stretching for cool down.

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## Walker et al. Occupational therapy for stroke patients not admitted to hospital: a randomised controlled trial. 1999.

CONTROL GROUP 1. Baseline assessments were done before randomisation in the patients’ home 1 month after the stroke. We assessed activities of daily living with the Barthel index10 (range 0–20, higher scores denote greater independence) and the extended activities of daily living scale (EADL,1 1 range 0–22, higher scores denote greater ability in instrumental activities of daily living). The Riverbed motor assessment gross function section12 (range 0–13, higher scores denote greater motor ability) was used to assess motor performance. Mood was assessed by the general health questionnaire 28 13 (range 0–84, higher scores denote worse psychological health). The carer strain index 14 (range 0–13, higher scores denote greater strain) was used to assess the caregivers. We recorded information about the services the patients reported that they had received since the onset of stroke patients were then allocated randomly to occupational therapy or tono intervention (control group). Randomisation was by numbered,sealed, opaque envelopes prepared from random-number tables. Patients in the control group received no additional input from the research therapist, but may have received input from existing services, as would occur in routine practice.

TREATMENT GROUP 1. Baseline assessments were done before randomisation in the patients’ home 1 month after the stroke. We assessed activities of daily living with the Barthel index10 (range 0–20, higher scores denote greater independence) and the extended activities of daily living scale (EADL,1 1 range 0–22, higher scores denote greater ability in instrumental activities of daily living). The Riverbed motor assessment gross function section12 (range 0–13, higher scores denote greater motor ability) was used to assess motor performance. Mood was assessed by the general health questionnaire 28 13 (range 0–84, higher scores denote worse psychological health). The carer strain index 14 (range 0–13, higher scores denote greater strain) was used to assess the caregivers. We recorded information about the services the patients reported that they had received since the onset of stroke patients were then allocated randomly to occupational therapy or tono intervention (control group). Randomisation was by numbered,sealed, opaque envelopes prepared from random-number tables. Patients allocated to occupational therapy received visits from a research occupational therapist for up to 5 months. The frequency of treatment was agreed between the therapist, patient, and, if relevant, the carer. The aim of therapy was independence in personal and instrumental activities of daily living. Personal care included activities such as bathing, feeding, dressing, and stair mobility. Instrumental activities of daily living included activities such as outdoor mobility, driving a car, travelling by public transport, and household chores. Patients were also encouraged to take part in leisure pursuits. The focus of therapy was active intervention rather than assessment or liaison. Specific tasks were set as homework when possible.

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## Walker et al. Use of Visual Feedback in Retraining Balance Following Acute Stroke. 2000.

CONTROL GROUP 1. The conventional therapy training protocol was an extension of the regular rehabilitation program. Symmetrical weight distribution was encouraged through verbal and tactile cues and was made more difficult by the addition of arm activities or actions requiring trunk rotation. Stools of various heights were used to support the nonparetic lower limb and to increase weight bearing on the affected side. In an effort to improve rhyth-mic weight-shifting ability, subjects practiced shifting their weight in forward and backward directions and side to side while performing reaching tasks such as dropping beanbags through a hoop. In all cases, programs were set up on an individual basis. The amount of time spent on items varied according to an individual’s ability and tolerance as judged by the physical therapist. Competence in a certain skill was not required prior to moving on to the next item.

CONTROL GROUP 2. The conventional therapy training protocol was an extension of the regular rehabilitation program. Symmetrical weight distribution was encouraged through verbal and tactile cues and was made more difficult by the addition of arm activities or actions requiring trunk rotation. Stools of various heights were used to support the nonparetic lower limb and to increase weight bearing on the affected side. In an effort to improve rhyth-mic weight-shifting ability, subjects practiced shifting their weight in forward and backward directions and side to side while performing reaching tasks such as dropping beanbags through a hoop. In all cases, programs were set up on an individual basis. The amount of time spent on items varied according to an individual’s ability and tolerance as judged by the physical therapist. Competence in a certain skill was not required prior to moving on to the next item.

TREATMENT GROUP 1. Visual feedback training involved the use of the Balance Master and accompanying software (version 3.4). The Balance Master consists of 2 forceplates positioned side by side (each measuring 23 -46 cm) with transducers mounted along the anterior-posterior center line of each plate. The output is digitized, and the software provides the user with feedback about the CoG location (adjusting for subject height [ie 0.55 3height 20]) in the form of a cursor displayed on a monitor. For the purpose of training stance symmetry, the forceplates served as weigh scales, and bars reflecting the weight transferred through each leg were displayed on the monitor. Symmetrical weight distribution was presumed when the bars on the computer screen were the same height. Tactile and verbal cues were provided as necessary to ensure proper alignment and stability of the hips, knees, and trunk (erect posture with no observable leaning to one side). The task was progressed through the addition of an upper-extremity activity or introducing trunk rotation. To increase weight bearing on the affected limb, subjects were instructed to shift their weight until the bars on the computer corresponded to a preset target. To encourage weight shifting, the visual feedback group moved their CoG and observed the corresponding cursor movement (representing CoG position) on the computer screen. Targets positioned on the screen were used to encourage weight shifting as subjects attempted to move the cursor in a desired direction toward the targets. Increasing the distance between the targets, decreasing the time required to move between the targets, adding an upper-extremity activity, or altering the foot position increased the task difficulty. The positioning of the targets was set relative to the theoretical limits of stability (LOS), which is based on the assumption that individuals could shift their CoG 6.25 degrees anteriorly, 4.45 degrees posteriorly, and 8 degrees to each side from a resting position 20 Initially, the targets were set at positions approximating 30% of the LOS; however, the targets were moved closer toward the LOS as individuals consistently achieved the training goal. In this manner, the task remained challenging. Additionally, rhythmic weight shifting was encouraged by having subjects shift their weight forward and backward or from side to side while keeping pace with a moving target. Software provided with the Balance Master was used for the training protocols.

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## Wang et al. Efficacy of Bobath versus orthopedic approach on impairment and function at different motor recovery stages after stroke: a randomized controlled study. 2005.

TREATMENT GROUP 1. Based on Bobath philosophy, the participant actively participates in a treatment that is individualized, constantly modified according to the subject response, and geared toward functional activities. Emphasis was placed on retraining normal alignment and normal movement patters based on Bobath treatment principles. These patters were facilitated through appropriate sensory and prioceptive input, direct manual facilitation, key point control, and verbal and visual feedback. 5, 14, 15. Normalizing muscle tone, re-educating the postural reaction and training for trunk control are internal for parts of Bobath treatment, and were practiced extensive during the treatment session to optimize balance reaction and movement quality. The approach used in this study strictly adhered to the principles described in detail in the Bobath and Davis tests. 5, 15. In this study, two treating physical therapists had attended the Bobath course on adult he,oplegia. Both therapists had been qualified for more than 10 years with at least five years of Bobath practice. Each patient received 40-min Bobath program sessions, five sessions a week, for a total of 20 sessions.

TREATMENT GROUP 2. The orthopedic treatment techniques included passive, assistive, active, and progressive resistive exercise. 4 The process attempted to elicit motion joint by joint, under all volitional control by the patients. The functional activities, such as rolling, sitting up, transfer and gait, focus on multiple repetitions for specific activities, were also practiced as early as possible during the 40 min treatment session. Gait training was usually started near a horizontal bar that supported the patient on his or her non-affected side. The two treating physical therapists had been qualified for more than 10 years with at least five years of orthopedic practice on patients with stroke. Patients in the orthopedic group received 40 minute treatment program each session, five sessions a week, for a total of 20 sessions.

TREATMENT GROUP 3. Based on Bobath philosophy, the participant actively participates in a treatment that is individualized, constantly modified according to the subject response, and geared toward functional activities. Emphasis was placed on retraining normal alignment and normal movement patters based on Bobath treatment principles. These patters were facilitated through appropriate sensory and prioceptive input, direct manual facilitation, key point control, and verbal and visual feedback. 5, 14, 15. Normalizing muscle tone, re-educating the postural reaction and training for trunk control are internal for parts of Bobath treatment, and were practiced extensive during the treatment session to optimize balance reaction and movement quality. The approach used in this study strictly adhered to the principles described in detail in the Bobath and Davis tests. 5, 15. In this study, two treating physical therapists had attended the Bobath course on adult he,oplegia. Both therapists had been qualified for more than 10 years with at least five years of Bobath practice. Each patient received 40-min Bobath program sessions, five sessions a week, for a total of 20 sessions.

TREATMENT GROUP 4. The orthopedic treatment techniques included passive, assistive, active, and progressive resistive exercise. 4 The process attempted to elicit motion joint by joint, under all volitional control by the patients. The functional activities, such as rolling, sitting up, transfer and gait, focus on multiple repetitions for specific activities, were also practiced as early as possible during the 40 min treatment session. Gait training was usually started near a horizontal bar that supported the patient on his or her non-affected side. The two treating physical therapists had been qualified for more than 10 years with at least five years of orthopedic practice on patients with stroke. Patients in the orthopedic group received 40 minute treatment program each session, five sessions a week, for a total of 20 sessions.

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## Werner et al. EFFECTIVENESS OF AN INTENSIVE OUTPATIENT REHABILITATION PROGRAM FOR POSTACUTE STROKE PATIENTS. 1996.

CONTROL GROUP 1. Initial screening was performed with a self administered questionnaire and followed by interview and examination by a physiatrist to determine eligibility. Patients were then randomized into treatment and control groups. A random three digit number table was used to place individuals in either the treatment or the control group based on whether the number was greater or less than 667. If the number was equal to or less than 667, they were placed in the treatment group, and those with a number that was greater than 667 were assigned as controls. Patients were randomized sequentially as they met the screening criteria. Thirty three were randomized into the treatment group and 16 into the control group. Additional control patients were recruited from the same three rehabilitation centers, using the same self administered questionnaire, but this mailing was done a year later.Both groups were evaluated at baseline, after 3 and 9 mo, by an occupational therapist who was not involved in the treatment of these patients and was blinded as to which group each person had been assigned. The evaluation consisted of the Functional Independence Measure (FIM),12-14Jepsen hand function evaluation,15 Brunnstrom's motor rating,16timed evaluation of stair climbing, transfers, and walking speed. 17 Individuals also completed standardized questionnaires, which evaluated selfesteem and psychological health using the Sickness Index Profile (SIP)18, 19 and the Beck's Depression Scale 20-22.

TREATMENT GROUP 1. Initial screening was performed with a self administered questionnaire and followed by interview and examination by a physiatrist to determine eligibility. Patients were then randomized into treatment and control groups. A random three digit number table was used to place individuals in either the treatment or the control group based on whether the number was greater or less than 667. If the number was equal to or less than 667, they were placed in the treatment group, and those with a number that was greater than 667 were assigned as controls. Patients were randomized sequentially as they met the screening criteria. Thirty three were randomized into the treatment group and 16 into the control group. Additional control patients were recruited from the same three rehabilitation centers, using the same self administered questionnaire, but this mailing was done a year later.Both groups were evaluated at baseline, after 3 and 9 mo, by an occupational therapist who was not involved in the treatment of these patients and was blinded as to which group each person had been assigned. The evaluation consisted of the Functional Independence Measure (FIM),12-14Jepsen hand function evaluation,15 Brunnstrom's motor rating,16timed evaluation of stair climbing, transfers, and walking speed. 17 Individuals also completed standardized questionnaires, which evaluated selfesteem and psychological health using the Sickness Index Profile (SIP)18, 19 and the Beck's Depression Scale 20-22.

The treatment intervention consisted of an intensive 12 wk outpatient rehabilitation program. The control group did not receive any outpatient therapy. Patients receiving treatment were divided into four cohorts with eight or nine individuals in each cohort; the cohorts were staggered with one starting every 3 mo. The treatment patients received 1 hr of physical and 1 hr of occupational therapy, 4 days/wk, for a duration of 12 wk. All physical and occupational therapy interventions were performed by one registered physical and occupational therapist. An initial assessment by a physiatrist, physical Therapist, and occupational therapist followed by a team meeting defined the necessary interventions, which were oriented toward functional tasks such as transfers, walking, self care, and feeding. Treatment modalities included strengthening, stretching, mobilization, and muscle retraining/facilitation.

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## Werner et al. Treadmill Training With Partial Body Weight Support and an Electromechanical Gait Trainer for Restoration of Gait in Subacute Stroke Patients : A Randomized Crossover Study. 2002.

TREATMENT GROUP 1. The harness-secured patients were positioned on 2 footplates, whose movements simulated stance and swing phases with a ratio of 60% to 40% between the 2 phases. Cadence, stride length, and thus velocity could be set individually from 0 to 2.5 km/h. A servo-controlled motor assisted the gait movement, with the rotation speed of the gear system being kept constant, and the vertical and horizontal movements of the center of mass were controlled in aphase-dependent manner by ropes attached to the harness and connected to the gear system. A pulley could relieve part of the body weight (Figure 1). Body weight was partially supported to compensate for the paresis of the affected lower limb, and this support was reduced as soon as the patient could take his or her full weight. The clinical criteria were the patients’ abilities to extend their hips and to carry weight sufficiently on the affected lower limbs. The target training velocity was relatively slow (0.25 to 0.40 m/s) to avoid overexertion of the patients. Previous work had shown that relatively young hemiparetic subjects walking at their maximum speed on the belt (at a mean of 1.14 m/s) reached a maximum heart rate of 130 beats/min and a maximum lactate level of 2.9 mmol/L. 15 In another study, ambulatory hemiparetic patients even tolerated speed-dependent treadmill training with maximum belt velocities of up to 1.5 m/s 16 Treatment duration/session was 15 to 20 minutes with an optional break after 10 minutes. Physical help, eg, for the control of the paretic knee or assistance of hip extension, in the stance phase was administered according to individual needs.

TREATMENT GOUP 2. Treadmill training consisted of a motor-driven treadmill, whose speed could be varied from 0 to 5 km/h. The patients wore a modified parachute harness, and a simple pulley released part of the body weight, as on the gait trainer (Figure 2). Treatment conditions (amount of body weight support, velocity, and duration) corresponded to those on the gait trainer (Table 1). Physical assistance eg, for setting the paretic limb, knee control, assistance of hip and trunk erection, and body weight shift was administered according to individual needs.

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## Westlake et al. Pilot study of Lokomat versus manual-assisted treadmill training for locomotor recovery post-stroke. 2009.

CONTROL GROUP 1. Both groups received 12 sessions (3×/wk over 4 weeks)involving 30 min of stepping per session. At least one 2–3 minute break was provided after 15 min. Total set up and treatment time never exceeded 1 hr. Training speeds were maintained below 0.69 m/s (2.5 km/h) in the slow groups and above 0.83 m/s (3 km/h) in the fast groups.Within the fast groups, locomotor training was either started at 0.83 m/s or progressed to this speed as early as possible (e.g. by Session 3) while maintaining gait quality, i.e. symmetrical, foot clearance, without knee buckling. Treadmill speed was progressed in 0.2 km/hr increments approximately every 5 min as long as the above-mentioned gait quality was observed by the therapists. If a new high speed could not be maintained for an extended period, training would ensue in 2–3minute intervals at the higher speed followed by 2–3 minutes at a lower speed .BWS was initiated at 35%.The Lokomat system used for this study includes the Lokolift,a compliant, electromechanical body-weight support system that monitors and adjusts unweighting in realtime to maintain BWS at the prescribed level. This BWS system contrasts with the stiff, counterweighted support system used in the original Lokomat models. A compliant system adjusts to the participant's center of gravity throughout the gait cycle, enabling vertical pelvic movement similar to overground gait, supporting symmetrical movement and producing kinetics similar to overground walking [21,25]. If the maximal treadmill speed, 0.69 m/s (2.5 km/h) in the slow group or 1.4 m/s(5 km/h) in the fast group, was reached, BWS was reduced in increments of 5% as long as gait quality was maintained. Our goal during training was to improve gait kinematics. To achieve this objective, all participants trained without an ankle-foot orthosis, assistance was reduced once safety was no longer a concern, and rest periods were provided if gait quality was noted to deteriorate. In addition, handrail use has been shown to significantly alter the gait pattern and thus was strongly discouraged [25]. Participants in the manual-BWSTT group were treated by1–2 skilled physical therapists/trainers who provided manual guidance of the more affected limb, trunk stabilization/alignment, and verbal and visual cues to normalize stepping kinematics. Our intent in using this number of therapists was to mimic clinic feasibility and training in previous reports [20]. The target gait pattern included: adequate trunk alignment, weight shift, acceptance to and from the paretic limb and temporal symmetry between limbs. The treating therapist individualized treatment to facilitate trunk and limb control throughout the gait cycle. Common cues included coaching to: increase plantar flexion propulsion and/orhip flexion at swing initiation, increase dorsiflexion and knee extension at heel strike, and maintain neutral knee alignment (i.e. avoid hyperextension) at mid stance. A second trainer provided pelvic stabilization and assistance with weight shift/acceptance as needed. Participants in both groups were provided visual feedback via a full length mirror placed at the front of the treadmill.

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## Whitall et al. Bilateral and Unilateral Arm Training Improve Motor FunctionThrough Differing Neuroplastic Mechanisms: A Single-Blinded Randomized Controlled Trial. 2011.

CONTROL GROUP 1. Training occurred 3 times per week for 6 weeks, typical of an outpatient clinic, for a total of18 sessions for each participant. There was a 9-week limit for completing the 18 sessions.30 DMTE involved a customized set of 4 exercises based on euro developmental principles,including thoracic spine mobilization with weight shifting, scapular mobilization, weight bearing with the paretic arm (elbow fixed), and opening the hand with finger extension. This treatment emphasizes handling techniques that facilitate body and limbs to assume “normal”positions. Participants were encouraged to actively move during the handling. DMTE was performed using the same time schedule as BATRAC (4 cycles of active continuous 5-minute training followed by 10 minutes of rest). Participants of both groups had equal, one-on-one contact with trainers and equal time training, but the number of movements per participant varied according to ability; 5 minutes of active continuous training was sufficient before a rest. A treatment fidelity study, conducted by personnel not affiliated with the study, confirmed study protocols.41

TREATMENT GROUP 1. Training occurred 3 times per week for 6 weeks, typical of an outpatient clinic, for a total of18 sessions for each participant. There was a 9-week limit for completing the 18 sessions.30 For BATRAC, participants were seated at the training apparatus that consisted of T-bar handles attached to nearly frictionless linear tracks. They completed 5 minutes of training with the arms moving simultaneously (in phase) away and then toward the body in time to a metronome set at their preferred speed, followed by 10 minutes of rest. Training continued for 5 minutes with the arms moving alternately (antiphase) again with auditory cuing at a preferred speed, followed by 10 minutes of rest. In-phase and antiphase training blocks were repeated once each, achieving a total of 20 minutes of active continuous bilateral arm training in 1 hour for each participant. Frequency was held constant after the third session to allow for initial task adaptation. Participants who were unable to grasp the handles independently had their hands strapped to the T-bar. If necessary, antigravity arm support was provided to avoid an improper arm position during the training; however, the participants were encouraged to produce the forward and backward motions actively and to reach further with their paretic arm throughout the training period by increasing the distance to the target stop. Neither frequency nor resistance was progressed. Participants were encouraged to actively move during the handling. DMTE was performed using the same time schedule as BATRAC (4 cycles of active continuous 5-minute training followed by 10 minutes of rest). Participants of both groups had equal, one-on-one contact with trainers and equal time training, but the number of movements per participant varied according to ability; 5 minutes of active continuous training was sufficient before a rest. A treatment fidelity study, conducted by personnel not affiliated with the study, confirmed study protocols.41

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## Widen Holmqvist et al. A Randomized Controlled Trial of Rehabilitation at Home After Stroke in Southwest Stockholm. 1998.

CONTROL GROUP 1. In each case, the case manager was responsible for coordination of the discharge procedure,most of the at-home therapy, coordination between therapists in the home rehabilitation team, and contact with the neurologist responsible. A program approximately 3 to 4 months in duration was tailored for each patient. The frequency of therapy contacts for the patients receiving rehabilitation at home was decided by the providing therapist in consultation with the patient and his or her family. The frequency of home visits was gradually reduced until the therapist discharged the patient. Two half-hour meetings per week were scheduled for coordination purposes by the home rehabilitation team.If continued rehabilitation was required after such a period, the patient was referred to routine outpatient rehabilitation.The intervention strategy was based on prior experience. 9 The home rehabilitation program emphasized a task- and context-oriented approach, which implies that the patient performs guided, supervised,or self-directed activities in a functional and familiar context. The choice of activities was based on patients’ personal interests, and adherence to structured training between therapy sessions was promoted. The spouse, when available, was encouraged to be an active participant in the rehabilitation process. Individual counseling, which focused on education, applying information learned in practical situations, and solving problems occurring in the home, was offered to the spouse if needed. The duration and type of therapy were recorded in a protocol by the therapists. Patients were asked to keep diaries between therapy sessions on time and type of training. The control group consisted of the stroke patients who received routine rehabilitation service. All patients in this group were also admitted to the Department of Neurology. If required (and after evaluation by specialists from geriatric or rehabilitation clinics) the patients were transferred for continued inpatient rehabilitation and/or day care. In this context, routine rehabilitation denotes a heterogeneous set of interventions ranging from the best established in the hospital, day care, and/or outpatient care, to others introduced during the study period, such as daily afferent sensory stimulation bylow frequency transcutaneous electrical nerve stimulation and home-based rehabilitation initiated by the Department of Geriatrics. Follow-up visits were scheduled at 3, 6, and 12 months after stroke

TREATMENT GROUP 1. In each case, the case manager was responsible for coordination of the discharge procedure,most of the at-home therapy, coordination between therapists in the home rehabilitation team, and contact with the neurologist responsible. A program approximately 3 to 4 months in duration was tailored for each patient. The frequency of therapy contacts for the patients receiving rehabilitation at home was decided by the providing therapist in consultation with the patient and his or her family. The frequency of home visits was gradually reduced until the therapist discharged the patient. Two half-hour meetings per week were scheduled for coordination purposes by the home rehabilitation team.If continued rehabilitation was required after such a period, the patient was referred to routine outpatient rehabilitation.The intervention strategy was based on prior experience. 9 The home rehabilitation program emphasized a task- and context-oriented approach, which implies that the patient performs guided, supervised,or self-directed activities in a functional and familiar context. The choice of activities was based on patients’ personal interests, and adherence to structured training between therapy sessions was promoted. The spouse, when available, was encouraged to be an active participant in the rehabilitation process. Individual counseling, which focused on education, applying information learned in practical situations, and solving problems occurring in the home, was offered to the spouse if needed. The duration and type of therapy were recorded in a protocol by the therapists. Patients were asked to keep diaries between therapy sessions on time and type of training. Follow-up visits were scheduled at 3, 6, and 12 months after stroke

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## Winstein et al. A randomized controlled comparison of upper-extremity rehabilitation strategies in acute stroke: A pilot study of immediate and long-term outcomes. 2004.

CONTROL GROUP 1. Standard Care. Standard care for the upper extremity was delivered primarily by occupational therapists and could include muscle facilitation exercises emphasizing the neurodevelopmental treatment approach, 23 neuromuscular electric stimulation applied primarily for shoulder subluxation, stretching exercises, activities of daily living including self-care where the upper limb was used as an assist if appropriate, and caregiver training.Basing our decision on practical concerns pertaining to the inpatient setting and previous findings with humans14,26 and primates,27 we chose 1h/d, 5d/wk for 4 weeks (20h) as an effective and tolerable dose for this trial. Because the average inpatient stay was less than 4 weeks (23.111.1d), the additional time needed to fulfill the 20 hours stipulated by the trial was completed in an outpatient setting.

TREATMENT GROUP 1. Functional Training plus Standard Care.Task-specific functional training focused on the systematic and repetitive practice of tasks that could be performed within the level of available voluntary motion. Tasks were progressively arranged and customized to account for any unique proximal-to-distal recovery patterns of reaching and grasping actions. All tasks were designed to be standard, repeatable, and to have some functional goal (eg, pointing, grasping, stirring). The principles of motor learning were applied as the physical therapists systematically provided knowledge of results and progressed task difficulty to keep the participants challenged, motivated, and engaged.24 Doable tasks were ordered randomly during practice to facilitate learning and to mimic real-world activities.25 For FT task training, none of the items contained in the FTHUE were chosen as tasks for systematic practice. Basing our decision on practical concerns pertaining to the inpatient setting and previous findings with humans14,26 and primates,27 we chose 1h/d, 5d/wk for 4 weeks (20h) as an effective and tolerable dose for this trial. Because the average inpatient stay was less than 4 weeks (23.111.1d), the additional time needed to fulfill the 20 hours stipulated by the trial was completed in an outpatient setting. Two experienced physical therapists, each a board-certified neurologic clinical specialist, applied the 20 hours of treatment to the FT and ST groups over 4 to 6 weeks. This treatment regimen was separate (ie, it was added to the standard dose of occupational and physical therapy).

TREATMENT GROUP 2. Strengthening and motor control plus standard care. Strengthening and motor control training used resistance to available arm motion to increase strength. Exercises were performed using either eccentric, isometric, or concentric muscle contractions, and concentric exercises were performed in a gravity-lessened position or against gravity, if possible. These exercises were progressed to repetitions against resistance using free weights, Theraband strips, or grip devices for the fingers. Progression of exercises used a protocol of highintensity progressive resistance training of shoulder, elbow, wrist, and hand motions. If, during the resistance phase, undesired associated movements or an increase in muscle tone was evident, the training bout was interrupted for a short period and then resumed after muscle tone was reduced or undesired associated movements were diminished. This strengthening program was implemented on alternate days for 3 days a week. On other days, the same exercises were performed with less resistance and greater speeds. As with the FT intervention, knowledge of results (eg, load, number of repetitions) was provided systematically during the therapy. Basing our decision on practical concerns pertaining to the inpatient setting and previous findings with humans14,26 and primates,27 we chose 1h/d, 5d/wk for 4 weeks (20h) as an effective and tolerable dose for this trial. Because the average inpatient stay was less than 4 weeks (23.111.1d), the additional time needed to fulfill the 20 hours stipulated by the trial was completed in an outpatient setting. Two experienced physical therapists, each a board-certified neurologic clinical specialist, applied the 20 hours of treatment to the FT and ST groups over 4 to 6 weeks. This treatment regimen was separate (ie, it was added to the standard dose of occupational and physical therapy).

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## Wittenberg et al. Constraint-Induced Therapy in Stroke: Magnetic-Stimulation Motor Maps and Cerebral Activation. 2003.

CONTROL GROUP 1. In contrast, the control therapy was designed to be less intense (3 h/day on weekdays and no treatment on weekends) but also aimed to improve task performance with the non affected side. Passive therapy (stretching and heat) was provided to the affected upper extremity for 1 h during those weekday sessions. While the treatment group received 8 days of 6 h and 2 weekend days of 4 hof daily therapy, the control group received 8 days of 3 h of therapy, and 2 weekend days of rest. The control therapy group was meant to control for expectations related to having an inpatient rehabilItation intervention.

TREATMENT GROUP 1. Therapy in the CI group consisted of restraint of the unaffected upper extremity during waking hours and task-oriented therapy of the affected upper extremity17on 10 continuous inpatient days for 6 h a day (except 4 h a day on weekends).Therapy involved progressively improving motor task performance by a successive approximation procedure during combined physical, occupation-al, and recreational therapy. Restraint of the unaffected arm was accomplished in the CI group with a hand-splint and sling ensemble; its purpose wasto reduce temptation to use the unaffected side. While the treatment group received 8 days of 6 h and 2 weekend days of 4 hof daily therapy, the control group received 8 days of 3 h of therapy, and 2 weekend days of rest.

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## Wolf et al. Effect of constraint-induced movement therapy on upper extremity function 3 to 9 months after stroke. 2006.

CONTROL GROUP 1. The control condition was usual and customary care. Because this care might affect functional gains among participants, an attempt was made to track care received through participant reports collected during monthly phone calls by project staff and during the scheduled testing sessions. Usual and customary care ranged from no treatment to the application of mechanical interventions (orthotics) or various occupational and physical therapy approaches in the home, day treatment programs, or outpatient hospital visits. Participants in the control condition were offered the same CIMT regimen after the 12-month evaluation session.

TREATMENT GROUP 1. Participants in the intervention group were taught to apply an instrumented protective safety mitt and encouraged to wear it on their less-impaired upper extremity for a goal of 90% of their waking hours over a 2-week period, including 2 weekends, for a total of 14 days. On each weekday, participants received shaping (adaptive task practice) and standard task training of the paretic limb for up to 6 hours per day. The former is based on the principles of behavioral training21,22 that can also be described in terms of motor learning derived from adaptive or part-task practice.23,24 Standard task practice is less structured (ie, repetition of tasks is not conducted as individual trials of discrete movements); it involves functional activities performed continuously for a period of 15 to 20 minutes (eg, eating, writing). Adherence to mitt use while the participants were in the research laboratory was usually very high. Behavioral techniques to enhance mitt use outside of the laboratory are described in detail elsewhere16,25 and included use of a behavioral contract, caregiver contract, mitt compliance device, and daily schedule. After completing each treatment, participants were encouraged to practice 2 to 3 tasks daily at home. Adherence to the extralaboratory treatment components was monitored regularly via a physical sensor and timer placed in the mitt and by a home diary. In the few occasions when patient home diary reports did not match outputs from the mitt monitoring device, participants were informed of the discrepancy and accurate reports resulted thereafter. Malfunctions in the monitoring device rarely occurred, but such devices were replaced immediately. Participants were encouraged to perform about 30 minutes of task practice daily following completion of the intervention period.

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## Wu et al. Kinematic and clinical analyses of upper-extremity movements after constraint-induced movement therapy in patients with stroke: A randomized controlled trial. 2007.

CONTROL GROUP 1.Treatment regimens were designed to ensure that patients received equal treatment intensity (2h/d, 5d/wk for 3 consecutive weeks) directly supervised by the occupational therapists. The intervention was provided at 2 centers under the supervision

of 2 separate occupational therapists. These 2 therapists were trained in the administration of the CIMT protocol by the investigators and completed a written competency test before subject treatment. During the treatment period, structured daily treatment notes were made and reviewed by the investigators to ensure the standardization of treatment. All trainings were provided on an individual basis. Subjects were blind to the study hypotheses. All subjects received routine interdisciplinary stroke rehabilitation separate from the study treatment that occurred during the regularly scheduled occupational therapy sessions. The interdisciplinary stroke rehabilitation was delivered by a variety of treatment disciplines including physical therapists and psychologists. The intensity of the interdisciplinary rehabilitation was the same for all participants (1.5h/d for 5d/wk). In the traditional intervention group, the treatment involved neurodevelopmental therapy emphasizing functional task practice when possible, stretching and weight bearing with the more affected arm, and fine-motor dexterity training.

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## Wu et al. A Randomized Controlled Trial of Modified Constraint-Induced Movement Therapy for Elderly Stroke Survivors: Changes in Motor Impairment, Daily Functioning, and Quality of Life. 2007.

CONTROL GROUP 1. We applied a randomized pretest and posttest control group design. Subjects were individually randomized into themCIMT or the traditional rehabilitation group by using a table of random numbers (fig 1).35Before and after the 3-week intervention period, the tests were administered in random order by a blinded rater. Prior to administration of clinical measures (FMA, FIM), the blinded rater was trained to properly administer these 2 measures. This training included careful examination of written instructions and repeated practice. Rater competence was assessed by a senior certified occupational therapist.For both groups, the study treatment occurred during the regularly scheduled occupational therapy (OT) session and all other routine interdisciplinary stroke rehabilitation proceeded as usual. When 2 or more study subjects were in the OT clinic at the same time, they were assigned to different treatment areas without opportunities to observe each other or rearranged to receive therapy at different times to prevent unintended crossover.

TREATMENT GROUP 1. We applied a randomized pretest and posttest control group design. Subjects were individually randomized into themCIMT or the traditional rehabilitation group by using a table of random numbers (fig 1).35Before and after the 3-week intervention period, the tests were administered in random order by a blinded rater. Prior to administration of clinical measures (FMA, FIM), the blinded rater was trained to properly administer these 2 measures. This training included careful examination of written instructions and repeated practice. Rater competence was assessed by a senior certified occupational therapist.For both groups, the study treatment occurred during the regularly scheduled occupational therapy (OT) session and all other routine interdisciplinary stroke rehabilitation proceeded as usual. When 2 or more study subjects were in the OT clinic at the same time, they were assigned to different treatment areas without opportunities to observe each other or rearranged to receive therapy at different times to prevent unintended crossover. Each subject assigned to mCIMT participated in individualized, 2-hour therapy sessions, 5 times a week for 3 weeks.Shaping and adaptive and repetitive task practice techniques were used during the training sessions. Therapy concentrated on the affected limb use in functional tasks chosen by patients and the treating therapist, including turning on and off a light switch, reaching forward to move a jar from one place to another, picking up a cup and drinking from it, picking up a hairbrush and combing hair, and other activities similar to those performed on a daily basis. Approximately 15 minutes of therapy was spent on normalization of muscle tone of the affected limb as needed. During the 3-week period, the patients’ unaffected hands and wrists were placed in mitts with selF adhesive (Velcro) straps every weekday for 6 hours identified as a time of frequent arm use. With equivalent time and intensity of treatment, patients in the traditional rehabilitation group received standard therapy. During a 2-hour therapy session, approximately 75% of traditional rehabilitation focused on neurodevelopmental techniques emphasizing functional task practice when possible, as well as stretching of the affected limb, weight bearing with the affected limb, and fine motor dexterity activities. Approximately 25% of traditional rehabilitation focused on compensatory techniques using the unaffected limb to perform functional tasks and assist the affected limb during task performance.

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## Wu et al. Randomized Trial of Distributed Constraint-Induced Therapy Versus Bilateral Arm Training for the Rehabilitation of Upper-Limb Motor Control and Function After Stroke. 2010.

CONTROL GROUP 1. Treatment regimens were designed to ensure that all groups received an equal amount of therapy (ie, 2 hours daily for 5 d/wk for 3 consecutive weeks). This treatment frequency and duration were determined from previous studies of dCIT8,9,11,14 and BAT14 that showed beneficial effects on movement strategies and functional outcomes. The dCIT group focused on using a mitt to restrict the unaffected hand for 6 hours daily and intensively train the affected UE in functional tasks, including reaching to move a cup, picking up coins, picking up a utensil to take food, grasping and releasing various blocks, and other functional movements involved in daily activities. The level of challenge was adapted according to patient ability and improvement during training. Hours of mitten wear each day were recorded by the patients and con-firmed by the caregivers.

TREATMENT GROUP 1. Treatment regimens were designed to ensure that all groups received an equal amount of therapy (ie, 2 hours daily for 5 d/wk for 3 consecutive weeks). This treatment frequency and duration were determined from previous studies of dCIT8,9,11,14 and BAT14 that showed beneficial effects on movement strategies and functional outcomes. he BAT group concentrated on the simultaneous movements in symmetric or alternating patterns of both UEs in functional tasks, which involved lifting 2 cups, picking up 2 pegs, grasping and releasing 2 towels, wiping the table with 2 hands, and so on.

TREATMENT GROUP 2. Treatment regimens were designed to ensure that all groups received an equal amount of therapy (ie, 2 hours daily for 5 d/wk for 3 consecutive weeks). This treatment frequency and duration were determined from previous studies of dCIT8,9,11,14 and BAT14 that showed beneficial effects on movement strategies and functional outcomes. Approximately 75% of the therapy in the CT group was based on the principles of neurodevelopmental treatment. This training component included functional task practice for hand function, UE coordination, balance, stretching, and weight bearing of the affected UE. Approximately 25% of the control intervention addressed compensatory practice on functional tasks with the unaffected UE or both UEs.

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## Wu et al. Constraint-Induced Therapy With Trunk Restraint for Improving Functional Outcomes and Trunk-Arm Control After Stroke: A Randomized Controlled Trial. 2012.

CONTROL GROUP 1. All participants were unaware of the study hypotheses and were randomized to the dCIT-TR, dCIT, or control group by a prestratification strategy based on the participating site (Fig. 1). All treatments were dose matched (2 hours per day, 5 days per week, for 3 weeks) and administered with 1-to-1 supervision. Participants in the control group received usual and customary care, which primarily consisted of treatment based on neurodevelopmental principles, emphasizing stretching and weight bearing by the affected UE, improving fine motor dexterity, and practicing functional activities when possible. Practicing functional or dexterity activities involved unilateral and bilateral tasks with the affected UE and both UEs, with assistance from the unaffected UE. Daily treatment content included, for example, passive range of motion, stretching of the affected limb, or facilitatory and inhibitory techniques for 10 minutes and uni-lateral and bilateral task training for50 minutes each. For each type of task training, about 2 therapeutic activities were required, with 20 to30 minutes of practice of each activty. Possible unilateral tasks involved moving the pegs on a vertical tower or putting chessmen into the holes on a board, and possible bilateral tasks involved picking up cones with the hands clasped or scooping beans from a bowl with one hand while the other hand stabilized the bowl.

TREATMENT GROUP 1. All participants were unaware of the study hypotheses and were randomized to the dCIT-TR, dCIT, or control group by a prestratification strategy based on the participating site (Fig. 1). All treatments were dose matched (2 hours per day, 5 days per week, for 3 weeks) and administered with 1-to-1 supervision. All participants were unaware of the study hypotheses and were randomized to the dCIT-TR, dCIT, or control group by a prestratification strategy based on the participating site (Fig. 1). All treatments were dose matched (2 hours per day, 5 days per week, for 3 weeks) and administered with 1-to-1 supervision. Training of the affected UE with dCIT-TR included shaping skills and repetitive practice of functional tasks.26Shaping skills involved practicing parts of tasks for a successive approximation of the task goal, and each part of a task was practiced for 20 to 30 minutes within 1 training session. In repetitive task practice, the functional tasks appropriate for a participant were used in their entirety, and each was practiced for 20 to 30 minutes within 1 training session. Verbal feedback and physical assistance were applied to help participants. regain task skills and performance.Daily treatment content included practice of, for example, 3 parts of tasks (eg, grasping and releasing blocks, using a tablecloth to wipe a table with elbow flexion and extension, and opening and closing a clothespin) and 2 whole functional tasks (eg, simulated tea-making activity and picking up coins from a bag).Therapists adjusted the difficulty of the tasks according to the capability of the participants (eg, relative distance between the participant and the target and the weight, size,shape, or texture of the target). Participants were required to wear a mitt on the unaffected hand and wrist (6 hours per day for 3 weeks)and report the time wearing the mitt outside clinic sessions in daily logs.To facilitate participants’ engagement in active problem solving,therapists also discussed with them the possible difficulties encountered while performing daily activities with hand restraint and the possible solutions for those problems.The TR harness that participants wore during the training sessions has Velcro straps (Velcro USA Inc,Manchester, New Hampshire) that secure the trunk to the chair back and restrain anterior trunk and rotation movements (Fig. 2). The harness was adjusted individually so that it did not interfere with arm movements.

TREATMENT GROUP 2. All participants were unaware of the study hypotheses and were randomized to the dCIT-TR, dCIT, or control group by a prestratification strategy based on the participating site (Fig. 1). All treatments were dose matched (2 hours per day, 5 days per week, for 3 weeks) and administered with 1-to-1 supervision. Participants in the dCIT group received an intervention that was similar to the dCIT-TR intervention but did not include TR.

# Y Authors

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## Yang et al. Gait outcomes after additional backward walking training in patients with stroke. A randomised controlled trial. 2005.

CONTROL GROUP 1. Subjects in both groups participated in 40 min of conventional training programme three times a week for three weeks. The conventional training programme focused on strengthening, function and mobility activities, including gait training. The gait preparatory training section takes up approximately 20/30% of each session’s time.All conventional training sessions were performed by a qualified and experienced physical therapist. Subjects in the experimental group received additional 30 min of backward walking training for three weeks at a frequency of three times per week.

TREATMENT GROUP 1. Subjects in both groups participated in 40 min of conventional training programme three times a week for three weeks. The conventional training programme focused on strengthening, function and mobility activities, including gait training. The gait preparatory training section takes up approximately 20/30% of each session’s time. The backward walking training programme was based on methods as described by Davies.22 First, the subject is asked to take a step backwards within parallel bars and can support him- or herself with the unaffected hand as required. The therapist provides assistance to move the subject’s leg in the correct pattern; preventing the subject from moving the leg back in full extension. When the subject can move the leg back with the correct pattern, the therapist gradually reduces the amount of assistance. Secondly, as the movement components have been practised, and the subject has taken over actively with only slight help, the therapist facilitates walking backwards within parallel bars. Thirdly, the subject walks backwards actively away from the parallel bars. Finally, the distance and speed of walking backwards is progressively increased. All backward walking training sessions were performed by qualified and experienced physical therapist.

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## Yang et al. Task-oriented progressive resistance strength training improves muscle strength and functional performance in individuals with stroke. 2006.

CONTROL GROUP 1.

TREATMENT GROUP 1. Subjects in the experimental group participated in 30 min of task-oriented progressive resistance strength training three times a week for four weeks. The progressive resistance strength training programme was designed as a circuit class, with subjects completing practice at a series of workstations. The workstations were designed to strengthen the muscles in the bilateral lower limbs in a functionally relevant way. The six workstations incorporated into the circuit were: (1) standing and reaching in different directions for objects located beyond arm’s length to promote loading of the lower limbs and activation of lower limb muscles;(2) sit-to-stand from various chair heights to strengthen the lower limb extensor muscles;(3) stepping forward and backward onto blocks of various heights to strengthen the lower limb muscles; (4) stepping sideways onto blocks of various heights to strengthen the lower limb muscles; (5) forward step-up onto blocks of various heights to strengthen the lower limb muscles; (6) heel(s) raise and lower while maintain-ing in a standing posture to strengthen the plantar-flexor muscles.14Each workstation was 5 min induration for each exercise class. Each subject participated in a one-to-one therapy. A qualified and experienced physical therapist supervised each class and was responsible for ensuring that the amount and intensity of the exercise at each station was graded to each subject’s functional level. Subjects were encouraged to work as hard as possible at each workstation and were also given verbal feedback and instructions aimed at improving performance. Progressions included in-creasing the number of repetitions completed within 5 min at a workstation and increasing complexity of the exercise performed at each work-station, such as the distance reached in standing,reducing the height of the chair during sit-to-stand, and the height of the blocks.

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## Yang et al. Virtual reality-based training improves community ambulation in individuals with stroke: A randomized controlled trial. 2008.

CONTROL GROUP 1. All subjects were asked to walk on a motorized treadmill,starting at a self-selected comfortable walking speed. After each training session, the treadmill speed was increased by 5% of the training speed. If the subject maintained the speed and felt safe for20 s, the treadmill speed was then increased by 5% during next training session. To prevent subjects from experiencing a fall during training, the therapist stood beside the subject within arm’s reach and the subjects were allowed to grab the handrails if necessary. For monitoring purpose heart rate was measured during each training session. The subjects in the control group received nine sessions of treadmill training (20-min/session, three sessions a week) over a 3-week period. While walking on the treadmill, the subject was asked to execute different tasks. The tasks included lifting legs to simulate stepping over the obstacle, uphill and downhill walking, and fast walking.

TREATMENT GROUP 1. All subjects were asked to walk on a motorized treadmill,starting at a self-selected comfortable walking speed. After each training session, the treadmill speed was increased by 5% of the training speed. If the subject maintained the speed and felt safe for20 s, the treadmill speed was then increased by 5% during next training session. To prevent subjects from experiencing a fall during training, the therapist stood beside the subject within arm’s reach and the subjects were allowed to grab the handrails if necessary. For monitoring purpose heart rate was measured during each training session. The subjects in the experimental group received nine sessions of virtual reality-based treadmill training (20-min/session, three sessions a week) over a 3-week period. The virtual environment was designed to simulate a typical community in Taipei. The scenarios consisted of lane walking, street crossing, obstacles striding across, and park stroll (Fig. 2). The training program was progressed through different levels of complexity requiring faster walking speeds, successful adaptation to changes in obstacle heights and surface slopes (uphill and downhill), and increasing decision making opportunities to avoid collisions.

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## Yang et al. Cortical Reorganization Induced by Body Weight–Supported Treadmill Training in Patients With Hemiparesis of Different Stroke Durations. 2010.

CONTROL GROUP 1. Subjects in the control group received the general exercise program for 50 minutes 3 times a week for a total of 12 sessions. The general exercise program included stretching, strengthening, endurance, and overground walking training.

CONTROL GROUP 2. Subjects in the control group received the general exercise program for 50 minutes 3 times a week for a total of 12 sessions. The general exercise program included stretching, strengthening, endurance, and overground walking training.

TREATMENT GROUP 1. Subjects in the experimental group received 30-minute BWSTT followed by the 20-minute general exercise program, 3 sessions a week, for a total of 12 sessions. The protocol of BWSTT according to our previous study is briefly described.3The overhead harness involving a pelvic belt primarily sup-ported the pelvis and lower abdomen. Support of less than 40%of the body weight was provided and decreased to the maxi-mum extent possible. The criterion for determining the amount of BWS was the patient’s ability to carry the remaining load on the paretic limb with less than 15° of knee flexion during single-support phase. The amount of BWS determined by the therapist was progressively decreased if the patient’s ability increased with training. The treadmill speed was adjusted based on the subject’s comfortable walking speed. The treatments were provided by the same 2 physiotherapists. They assisted in correcting patients’ gait pattern and directed the movement of the pelvis during training.

TREATMENT GROUP2. Subjects in the experimental group received 30-minute BWSTT followed by the 20-minute general exercise program, 3 sessions a week, for a total of 12 sessions. The protocol of BWSTT according to our previous study is briefly described.3The overhead harness involving a pelvic belt primarily sup-ported the pelvis and lower abdomen. Support of less than 40%of the body weight was provided and decreased to the maxi-mum extent possible. The criterion for determining the amount of BWS was the patient’s ability to carry the remaining load on the paretic limb with less than 15° of knee flexion during single-support phase. The amount of BWS determined by the therapist was progressively decreased if the patient’s ability increased with training. The treadmill speed was adjusted based on the subject’s comfortable walking speed. The treatments were provided by the same 2 physiotherapists. They assisted in correcting patients’ gait pattern and directed the movement of the pelvis during training.

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## Yang et al. Effect of biofeedback cycling training on functional recovery and walking ability of lower extremity in patients with stroke. 2014.

CONTROL GROUP 1. One group underwent an additional 30-minute cycling training with a stationary bike (MOTOmed viva,RECK-Technik, Betzenweiler, Germany) for 4 weeks (cycling period), followed by regular rehabilitation only in the next4 weeks (noncycling period). The other group under went the same 8-week training in the reverse order. The bike panel (11.3 cm8.4 cm) showed parameters of revolutions per minute (rpm), symmetry of bilateral lower limb exertion (the best performanceZ50/50), cycling distance(kilometer), performance (Watt), and resistance (0e20grade). Data during cycling on these parameters were recorded in a bike chip. The biofeedback cycling training was provided by an independent, qualified physical therapist not involved in participants’ rehabilitation.The 30-minute biofeedback cycling training consisted of two bike sessions, including 15 minutes each of forward and backward cycling. The following protocols were adhered to in every training session: (1) preparation: participants were seated on a chair in front of the bike. For each participant,the distance from the seat to the crank axis was standardized by allowing their knee joint to have a maximum of110e120flexion throughout the entire pedaling cycle.Heart rate and blood pressure were measured; (2) passive warm up: 150-second passive cycling; the legs of the participant were passively moved by the bike with a constant speed of 25 rpm; (3) active pedaling: 10-minute training of active cycling; participants were required to maintain a pedaling speed of 60 rpm (range: 50e70 rpm)and focus on the visual feedback of load symmetry of their lower extremities to be 50/50 shown on the bike panel. The exercise intensity of active pedaling was set at Stage 13 of the Borg scale[12], which corresponds to “a little strenuous” intensity; (4) passive cool down: 150 seconds of passive cycling; the participants’ legs were passively moved by the bike at a constant speed of 25 rpm; and (5) terminal step: the heart rate and blood pressure were measured and noted after each pedaling session

TREATMENT GROUP 1. One group underwent an additional 30-minute cycling training with a stationary bike (MOTOmed viva,RECK-Technik, Betzenweiler, Germany) for 4 weeks (cycling period), followed by regular rehabilitation only in the next4 weeks (noncycling period). The other group under went the same 8-week training in the reverse order. The bike panel (11.3 cm8.4 cm) showed parameters of revolutions per minute (rpm), symmetry of bilateral lower limb exertion (the best performanceZ50/50), cycling distance(kilometer), performance (Watt), and resistance (0e20grade). Data during cycling on these parameters were recorded in a bike chip. The biofeedback cycling training was provided by an independent, qualified physical therapist not involved in participants’ rehabilitation.The 30-minute biofeedback cycling training consisted of two bike sessions, including 15 minutes each of forward and backward cycling. The following protocols were adhered to in every training session: (1) preparation: participants were seated on a chair in front of the bike. For each participant,the distance from the seat to the crank axis was standardized by allowing their knee joint to have a maximum of110e120flexion throughout the entire pedaling cycle.Heart rate and blood pressure were measured; (2) passive warm up: 150-second passive cycling; the legs of the participant were passively moved by the bike with a constant speed of 25 rpm; (3) active pedaling: 10-minute training of active cycling; participants were required to maintain a pedaling speed of 60 rpm (range: 50e70 rpm)and focus on the visual feedback of load symmetry of their lower extremities to be 50/50 shown on the bike panel. The exercise intensity of active pedaling was set at Stage 13 of the Borg scale[12], which corresponds to “a little strenuous” intensity; (4) passive cool down: 150 seconds of passive cycling; the participants’ legs were passively moved by the bike at a constant speed of 25 rpm; and (5) terminal step: the heart rate and blood pressure were measured and noted after each pedaling session

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## Yavuzer et al. The effect of balance training on gait late after stroke. A randomized controlled trial. 2006.

CONTROL GROUP 1. Subjects in both the experimental (n/22) and the control group (n/19) participated in our conventional stroke rehabilitation programme, 5 days a week, 25 h/day, for eight weeks. The conventional programme is patient-specific and consists of neurodevelopmental facilitation techniques, physiotherapy, occupational therapy and speech therapy (if needed). Physiotherapy focused on positioning, range of motion and progressive resistive exercises, together with training in endurance, walking and activities of daily living. Postural control exercises include maintenance of standing and shift of the weight loads to the paretic side. Therapists combine elements of Brunnstrom’s movement therapy, Bobath neurodevelopmental treatment and proprioceptive neuromuscular facilitation techniques according to the patients’ needs and performance. This personalized rehabilitative care is designed to help the patient regain the ability to function as independently as possible at home, work, and in the community. It involves learning to perform the daily activities of living in order to achieve the best possible quality of life.

TREATMENT GROUP 1. Subjects in both the experimental (n/22) and the control group (n/19) participated in our conventional stroke rehabilitation programme, 5 days a week, 25 h/day, for eight weeks. In addition to eight weeks of conventional programme, the experimental group received 15 min of balance training once daily, five days a week for three weeks,1,24,25 using the Nor-Am Target Balance Training System (Nor-am Patient Care Products, Oakville, Ontario, Canada) in ‘standing stability’ mode. The Nor-Am device is a portable balance trainer system including a dual forceplate made up of four load cells that detect pressure. Connected to a monitor, it provides visual representation of a person’s centre of gravity. Menu-driven exercise tasks depict still or moving targets on the computer monitor. Subjects stood with one bare foot on each forceplate with their eyes open (according to the manufacturer’s instructions). Support devices or personal assistance were providedwhen needed. The subjects were instructed to maintain or shift their weight, in the sagittal and frontal plane as appropriate, to make the representation of their centre of gravity reach the targets presented visually. In this study, because the Nor-Am device was used for intervention purposes only and not for assessment, data obtained from the balance trainer were not analysed statistically.

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## Yavuzer et al. “Playstation eyetoy games” improve upper extremity-related motor functioning in subacute stroke: a randomized controlled clinical trial. 2008.

CONTROL GROUP 1. Both the EyeToy group and the control group participated in a conventional stroke rehabilitation program, 5 days a week, 2-5 hours/day for 4 weeks. The conventional program is patient-specific and consists of neurodevelopmental facilitation techniques, physiotherapy, occupational therapy, and speech therapy (if needed). The duration of the treatment for upper limb was approximately 1 hour. For the same4-weeks of period, the EyeToy group received an additional 30 minutes of VR therapy program. During the VR sessions, patients were seated close to a TV monitor. And ask to follow thirty minutes of treatment with “Playstation EyeToy” games per day consisting of flexion and extension of the paretic shoulder, elbow and wrist as well as abduction of the paretic shoulder using “Kung-Foo”, “Goal Attack”, “MrChef”,“Dig” and “Home-Run” games, in addition to conventional stoke rehabilitation program, 5 days a week,2-5 hours/day for 4 weeks. The authors chose the games according to the patients’ abilities and encouraged the patients in the EyeToy group to use their paretic arm while playing. The game “Kung-Foo” was used for training reaching. It gets harder when the patient completed the stage, or performance bar reduces to zero according to his level. The authors used “Smashing the ice cubes” and “Demolishing the wall” to train elbow extension (an out of synergy movement). In the game “Dig”, the patients were asked to hit the brunches but save the other items,which may help problem solving. The game “MrChef”was very popular among women as it includes cook-ing activities in a kitchen, while men liked “KungFoo”, “Goalkeeper” and “Dig” games. “Goalkeeper” isa soccer game that really helps the patients shift the weight to the paretic side while standing. During the games the patient had to hit the target by elbow extension in correct order and as fast as possible. Based not he mental practice treatment, the control group only watched the games for the same duration but did not involve into the games physically.

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## Yelnik et al. Rehabilitation of Balance After Stroke With Multisensorial Training: A Single-Blind Randomized. 2008.

CONTROL GROUP 1. NDT-based treatment. Global sensorimotor rehabilitation, based on the neurodevelopmental approach described by Bobath,15targeting more on the control of weight bearing and shifting in erect stance and the quality of gait with less emphasis on the response to destabilization situations.

TREATMENT GROUP 1. multisensorial treatment. Physical rehabilitation based on the manipulation of the sensory information required to maintain balance, attention being paid to the amount of exercise, that is, duration and intensity, rather than the quality of the movement. Most of the exercises were conducted in visual deprivation, thus challenging the selection and synthesis by the brain of vestibular and somatosensory information.

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## Yen et al. Effectiveness of Modified Constraint-Induced Movement Therapy on Upper Limb Function in Stroke Subjects. 2005.

CONTROL GROUP 1. An an observer-blinded randomized clinical trial, all subjects were assigned randomly into 2 groups- m-CIMT and control. Subjects in the control group received their regular program, such as physical therapy (gait training, facilitation, balance training...etc.) or occupational therapy. Basic information was recorded before treatment. The Wolf Motor Function Test (WMFT)(22), a15-item timed instrument, was used as the outcome mea-sure. All 15 items were tested twice in both pretreatmentand post treatment evaluations. In each evaluation, the better one was chosen for comparison.

TREATMENT GROUP 1. An an observer-blinded randomized clinical trial, all subjects were assigned randomly into 2 groups- m-CIMT and control. Subjects in the m-CIMT group received a 2-week (6 hrs/day) treatment based on the modified CIMT(6). Basic information was recorded before treatment. The Wolf Motor Function Test (WMFT)(22), a15-item timed instrument, was used as the outcome mea-sure. All 15 items were tested twice in both pretreatmentand post treatment evaluations. In each evaluation, the better one was chosen for comparison. Modified CIMT reserving the mass training of the affected arm, a procedure termed “shaping”, was carried out for 2 weeks (6 hrs/days) without any physical restriction of the intact one. The shaping procedure involved(1) Providing explicit verbal feedback for small improvements in task performance, (2) Selecting tasks that were tailored to address the motor deficits of the individual patient, and (3) Helping the subjects to carryout parts of a movement that they, at first, can not per-form(11,22-24). A battery of approximately 50 tasks was used for shaping, from which a subset of 15 to 20 tasks were 18Acta Neurologica Taiwanica Vol 14 No 1 March 2005selected for individual subjects(10). The household objects(e.g., jars, eating utensils, spring-loaded clothespins) and standard devices used in physical and occupational therapy were used as the task objects in this study(10).

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## Yen et al. Gait Training-Induced Change in Corticomotor Excitability in Patients With Chronic Stroke. 2008.

CONTROL GROUP 1. Participants were randomly assigned to either the experimental or control group by an independent person who selected 1 of the sealed envelopes 30 minutes before the start of the intervention. All participants were evaluated prior to the commencement of training (baseline) and at the end of the 4-week training period (post treatment). Since we had limited resources, this study did not use a blinded assessor. However, we attempted to minimize bias by using standardized testing instruction sand protocols. All participants underwent a 50-minute general physical therapy session (2 to 5 sessions a week) over a period of 4 weeks. These sessions involved stretching, muscle strengthening, balance, and overground walking train-ing. Furthermore, the participants in the experimental group received 12 additional sessions of BWSTT (30-min/session, 3 sessions a week) over a 4-week period.

TREATMENT GROUP 1. Participants were randomly assigned to either the experimental or control group by an independent person who selected 1 of the sealed envelopes 30 minutes before the start of the intervention. All participants were evaluated prior to the commencement of training (baseline) and at the end of the 4-week training period (post treatment). Since we had limited resources, this study did not use a blinded assessor. However, we attempted to minimize bias by using standardized testing instruction sand protocols. All participants underwent a 50-minute general physical therapy session (2 to 5 sessions a week) over a period of 4 weeks. These sessions involved stretching, muscle strengthening, balance, and overground walking train-ing. Furthermore, the participants in the experimental group received 12 additional sessions of BWSTT (30-min/session, 3 sessions a week) over a 4-week period. BWSTT involved treadmill training (EN-MILL, BonteZwolle BV, the Netherlands) using a body weight−sup-ported system (Biodex, Shirley, NY). A BWS of less than40% of the body weight was provided and was decreased to the maximum extent possible.14The criterion for decreasing the amount of BWS was the patient’s ability to carry the remaining load on the paretic leg with less than15 degrees of knee flexion during the single-support phase.12,15The treadmill speed was determined according to the patient’s ability. If the patient’s ability increased with training, BWS was initially decreased and the speed was then increased.The subject was trained with the assistance of 1 or 2physical therapists. The main purpose of this training was to normalize the gait pattern of individuals in terms of maintaining a neutral position of the ankle joint during the swing phase and knee extension during the stance phase to the maximum possible extent. The participants were not permitted to use a lower-extremity orthosis during the training phase, were instructed to refrain from holding a handrail if possible, and were encouraged to use reciprocal arm swing.9,14

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## You et al. Virtual Reality-Chronic Stroke : An Experimenter-Blind Randomized Study Induced Cortical Reorganization and Associated Locomotor Recovery in Chronic Stroke : An Experimenter-Blind Randomized Study. 2005.

CONTROL GROUP 1.

TREATMENT GROUP 1. The IREX VR system requires a television monitor, a video camera, cyber gloves and virtual objects, scenes, and a large screen. The video camera was used to capture and track movement and immerse the patient inside VR scene. The system offers an alternative to the problems existing in other VR systems because the patients do not require head-mounted displays, data gloves, or other peripheral devices that connect to the computer. This enables them to move freely about in the real world while allowing manipulation of the virtual objects and navigation in the 3D virtual world.10,19As illustrated in Figure 1, the Stepping up/down and the Shark bait, Snowboard games were interfaced with virtual environments to facilitate range of motion, balance, mobility, stepping, and ambulation skills. The VR tasks were designed to focus on the development of the different skills as described previously, with each game programmed to exercise 1 or multiple aspects of trunk, pelvis, hip, knee, and ankle movement.19A detailed description of the VR intervention protocol is available in the Appendix (available online athttp://www.strokeaha.org).Augmented feedback about knowledge of results (KR), such as error rate and amount of lifting weights (resistive force), and knowledge of performance (KP), such as movement quality, was provided at the end of each game. Because these motor tasks require complex intersegmental coordination and were initially difficult for some patients because of synergistic patterns, we made a series of modifications in the VR parameter, including speed of a stimulus and resistive force based on their performance and progress.10,19As their ability to perform the exercise increased, we gradually challenged them by either increasing resistive force (ie, adding weights) or speed of the stimulus. Initially, a high frequency (90%) of augmented KP or KR feedback was gradually lessened as performance improved.10Each game was played 5, and depending on a game, within each game, there were 3 levels of 88 to 131 opportunities to perform the exercise. The intervention was given for 60minutes per day, 5per week for 4 weeks.

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## Young et al. The Bradford community stroke trial: eight week results. 1991/1992.

CONTROL GROUP 1. These patients attended one of four day hospitals. Two were within the Bradford HealthAuthority: a 30-place purpose built day hospital forming part of a geriatric rehabilitation hospital and a smaller newly converted day hospital forming an isolated unit in the community. Two were within Airedale Health Authority: a 30-place day hospital part of a district general hospital site and a smaller 15-place unit forming part of a community rehabilitation hospital. All the day hospitals are consultant led and staffed by physiotherapists, occupational therapists, doctors and nurses with other members of the multidisciplinary team available as necessary. Trial patients attended the nearest day hospital twice a week for at least eight week sand received multidisciplinary rehabilitation which included individual and group occupational therapy and physiotherapy given by experienced therapists. All patients were reviewed at regular intervals by the day hospital staff and therapy treatment modified as necessary.

TREATMENT GROUP 1. Patients assigned to this group were treated by one of five community physiotherapists. Two specialized in treatment of stroke patients; two specialized in treatment of elderly patients and one was a general physiotherapist. An important suggested advantage of home physiotherapy is the greater flexibility of treatment delivery which allows the physiotherapist to respond to individual patient need. 14 To reflect this advantage of home physiotherapy, the frequency and duration of treatment sessions for the trial patients was left to the discretion of individual therapists. However, to prevent an imbalance between the amount of therapy given, an upper limit of 20hours treatment over the eight weeks was agreed with the five physiotherapists.For both trial treatments the amount of therapy given to the patients was recorded by the staff concerned. All the trial patients were to receive at least eight weeks treatment, the patients were then reviewed and treatment continued or discontinued according to their needs.