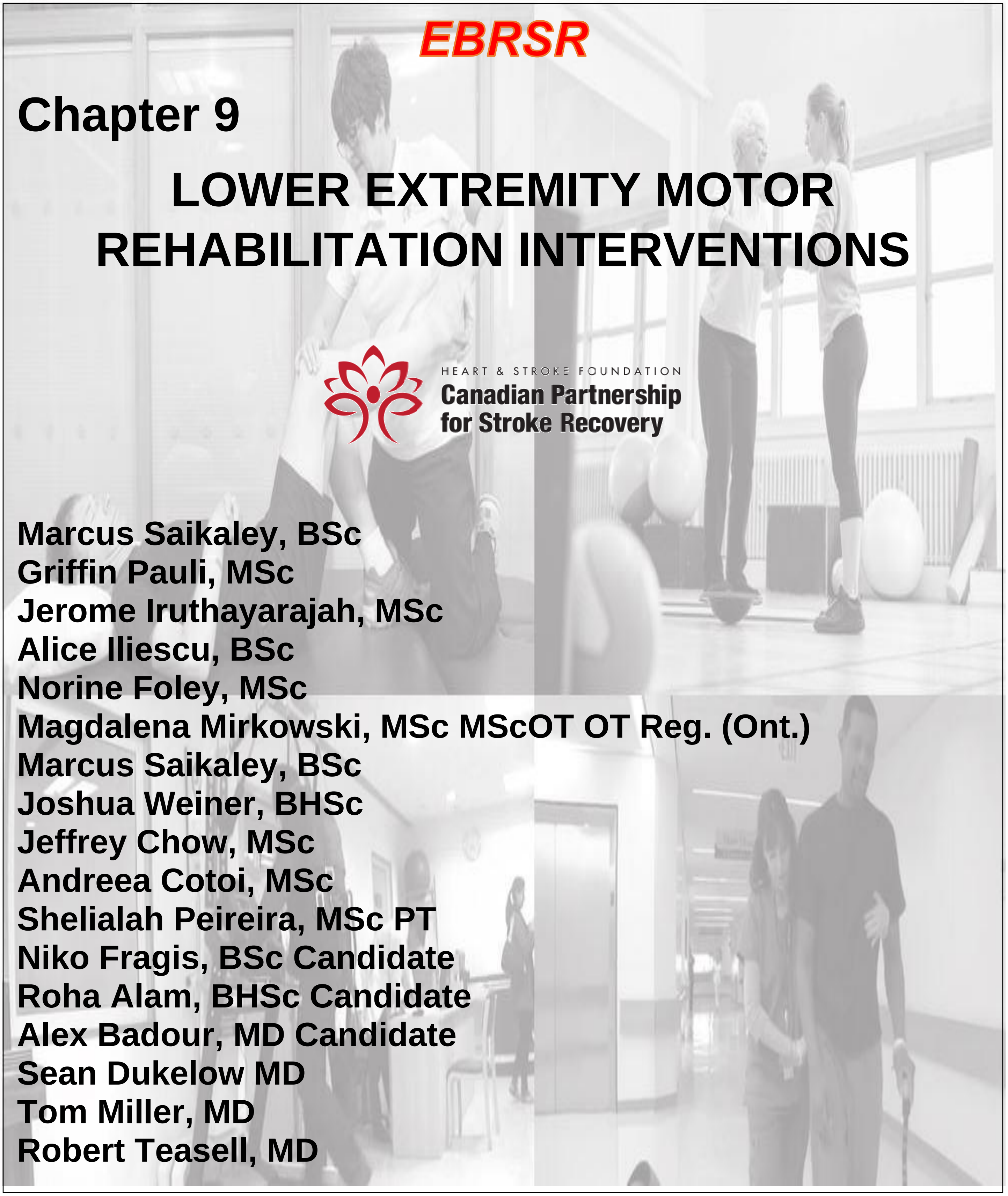

EBRSR

Chapter 9

LOWER EXTREMITY MOTOR REHABILITATION INTERVENTIONS

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Key points

The literature is mixed regarding motor relearning programmes for improving motor function.

The literature is mixed regarding the Bobath concept approach for improving activities of daily living.

Sit-to-stand training may be beneficial for improving gait and muscle strength, but not functional ambulation.

Sit-to-stand training with asymmetrical foot position may be beneficial for improving balance.

The Neater Uni-wheelchair may be beneficial for improving motor function and activities of daily living.

Trunk training may be beneficial for improving balance of lower limb rehabilitation after stroke.

The literature is mixed concerning trunk training's ability to improve functional ambulation.

Trunk training may not be beneficial for improving gait of lower limb rehabilitation after stroke.

Task-specific training may be beneficial for improving functional ambulation and gait.

The literature is mixed regarding the effectiveness of task-specific training for improving balance.

The literature is mixed regarding the effectiveness stair or ramp training to improve balance when compared to flat surface training.

mCIMT may be beneficial for improving gait and balance following stroke.

More research is needed to draw conclusions about the effect of mCIMT on other aspects of post-stroke rehabilitation.

Overground walking may be beneficial for improving motor function and functional ambulation.

Overground waking may not be beneficial for improving other aspects of stroke rehabilitation.

Cycle ergometer training may be beneficial for improving motor function, balance, and activities of daily living.

Cycle ergometer training may not be beneficial for improving functional ambulation.

Bodyweight shift techniques may not be beneficial for improving multiple measures of stroke rehabilitation.

Balanced-focused exercise, early intensive physiotherapy, and aerobic exercise may not be beneficial for improving balance or other areas of stroke rehabilitation.

Balance focused exercise training may be beneficial for activities of daily living.

Balance training with feedback may not be beneficial for post-stroke rehabilitation in improving motor function, ambulation, or balance .

The literature is mixed concerning the effect of perturbation-based balance training with feedback in improving balance.

The literature is mixed concerning the effect of dynamic stretching in improving functional ambulation, range of motion, and balance.

Dynamic stretching may be beneficial for improving gait.

Ankle-foot orthoses (chignon, dynamic, plantar stoop) may not be beneficial in improving balance and gait following stroke.

Hippotherapy may be beneficial for improving balance and activities of daily living, while the literature is mixed regarding hippotherapy for improving functional ambulation and gait following stroke.

EMG biofeedback with conventional therapy may not be beneficial for improving functional ambulation, gait, and range of motion.

Gait training with movement or postural control visual biofeedback may not be beneficial for improving balance following stroke.

The literature is mixed regarding the effect of dual motor task training on functional ambulation and gait.

The literature is mixed regarding the effect of dual cognitive-motor training on functional ambulation, balance, and gait.

The literature is mixed regarding mental practice combined with different types of physical therapy (task-specific training, conventional therapy, gait training) for improving functional ambulation and balance.

Action observation with gait training may be beneficial for improving functional ambulation, balance, and gait.

Mirror therapy may be helpful in improving motor function.

Mirror therapy may not be beneficial for improving functional ambulation.

The literature is mixed regarding the effect of mirror therapy on gait.

Aquatic therapy may be beneficial for improving functional ambulation, activities of daily living, and muscle strength.

The literature is mixed regarding the effects of aquatic therapy for improving gait.

Aquatic therapy may not be beneficial for improving balance.

The literature is mixed regarding strength and resistance training for functional ambulation, gait, and motor strength.

Strength and resistance training may be helpful for improving balance.

Strength and resistance training may not be beneficial for improving functional mobility.

Treadmill training with rhythmic auditory stimulation may be helpful in improving functional ambulation and gait.

Overground gait training with rhythmic auditory stimulation may be helpful in improving functional ambulation and gait.

The literature is mixed regarding the effect of caregiver-mediated programs for improving activities of daily living, balance and functional ambulation.

The literature is mixed with respect to the effect of virtual reality training on functional ambulation, balance, and gait.

Virtual reality training may not be beneficial in improving activities of daily living.

Virtual reality with treadmill training may be helpful in improving balance and functional ambulation.

The literature is mixed regarding the effect of end-effector gait training on functional ambulation and muscle strength.

End-effector assisted gait training with or without functional electrical stimulation may be helpful in improving functional mobility.

End-effector assisted gait training may not be beneficial for improving balance and activities of daily living.

Exoskeleton systems may not be beneficial for improving motor function, functional ambulation, functional mobility, balance, activities of daily living, and muscle strength.

Functional electrical stimulation may be beneficial for improving functional ambulation, gait, activities of daily living, and muscle strength.

The literature is mixed concerning the effect of functional electrical stimulation on improving motor function and spasticity.

Functional electrical stimulation may not be beneficial for improving balance, and stroke severity.

NMES may be beneficial for muscle strength, range of motion and spasticity.

NMES may not be beneficial for improving motor function, functional ambulation and mobility or gait.

TENS may be beneficial for improving functional mobility, functional ambulation, balance, gait and spasticity.

The literature is mixed concerning the effect of TENS on improving motor function, activities of daily living, and muscle strength.

Whole-body vibration may not be beneficial for improving balance, and functional ambulation, and muscle strength.

Electrical stimulation with mirror therapy may be beneficial for improving functional ambulation, balance and muscle strength.

Tactile and peroneal nerve stimulation may not be beneficial for improving functional ambulation.

The literature is mixed concerning the effects of remote ischemic conditioning on improving muscle strength.

Thermal stimulation may be beneficial for improving motor function, functional ambulation, and activities of daily living.

The literature is mixed concerning the effect of thermal stimulation on improving muscle strength and spasticity.

Thermal stimulation may not be beneficial for improving balance.

Extracorporeal shockwave therapy may be beneficial for improving spasticity.

The literature is mixed concerning the effect extracorporeal shockwave therapy on improving range of motion.

Repetitive peripheral magnetic stimulation may be beneficial for improving muscle strength.

rTMS may be beneficial for improving functional ambulation, gait, activities of daily living, muscle strength, and stroke severity.

The literature is mixed concerning the effect of rTMS on improving motor function, and balance.

The literature is mixed concerning the effect of TBS on improving balance.

TBS may not be beneficial for improving motor function, functional ambulation, or activities of daily living.

tDCS may be beneficial for improving motor function and muscle strength.

tDCS may not be beneficial in improving functional ambulation, gait and balance.

Galvanic vestibular stimulation may not be beneficial for improving balance.

The use of antidepressants may be beneficial for improving motor function.

The literature is mixed regarding use of antidepressants for improving activities of daily living and muscle strength.

The use of antidepressants may not be helpful in improving functional ambulation and stroke severity.

Vasodilators may be beneficial for improving motor function after stroke.

Long-term edaravone may be beneficial for improving functional ambulation.

Stimulants may not be beneficial for improving motor function, functional ambulation, functional mobility, activities of daily living, and stroke severity.

Parkinsonian drug intervention may be beneficial for improving stroke severity.

The literature is mixed regarding Parkinsonian drug intervention for improving motor function and activities of daily living.

Parkinsonian drug intervention may not be beneficial for improving gait or functional ambulation.

The literature is mixed regarding nerve block agent intervention for improving spasticity.

Nerve block agent intervention may not be beneficial for improving motor function, range of motion or muscle strength.

Botulinum Toxin A is beneficial for improving activities of daily living, motor function, and spasticity.

The literature is mixed regarding the modalities, location and intensity of treatment of Botulinum Toxin A for improving other lower extremity outcomes after stroke.

Botulinum Toxin A may not be beneficial for improving gait.

Some antispastic drugs may be beneficial for improving spasticity.

The literature is mixed regarding antispastic drug intervention for improving activities of daily living.

Cerebrolysin may not be beneficial for improving motor function.

4-aminopyridine may be beneficial for improving functional ambulation.

Acupuncture may be beneficial for improving balance.

The literature is mixed regarding the use of acupuncture for improving motor function, gait and range of motion.

Acupuncture may not be helpful for improving functional ambulation, spasticity, activities of daily living, and stroke severity.

Electroacupuncture may be beneficial for improving motor function and stroke severity.

Electroacupuncture may not be beneficial for improving functional mobility, functional ambulation, spasticity, activities of daily living and muscle strength.

Meridian acupressure may be beneficial for improving balance and activities of daily living.

NeuroAid may not be beneficial for improving stroke severity.

Other herbal medications such as Dihuang Yinzi, Shaoyao, Gancao, Astragalus Membranaceus, and Tokishakuyakusan may be beneficial for improving motor function, functional mobility, spasticity and activities of daily living.

Modified Sakett Scale

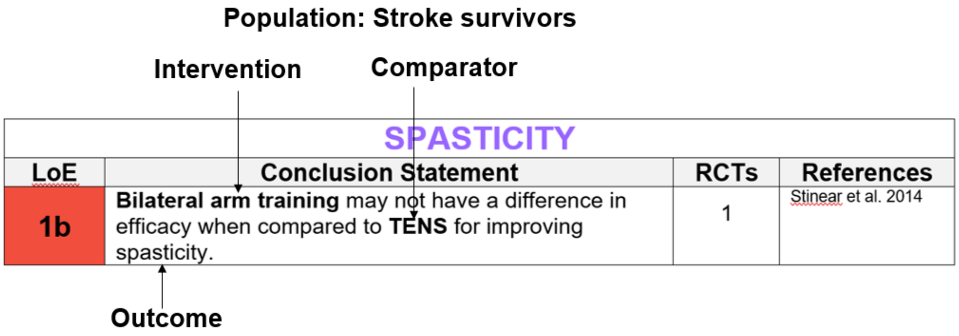
Level of evidence	**Study design**	**Description**
Level 1a	Randomized controlled trial (RCT)	More than 1 higher quality RCT (PEDro score ≥6).
Level 1b	RCT	1 higher quality RCT (PEDro score ≥6).
Level 2	RCT	Lower quality RCT (PEDro score <6).
	Prospective controlled trial (PCT)	PCT (not randomized).
	Cohort	Prospective longitudinal study using at least 2 similar groups with one exposed to a particular condition.
Level 3	Case Control	A retrospective study comparing conditions, including historical cohorts.
Level 4	Pre-Post	A prospective trial with a baseline measure, intervention, and a post-test using a single group of subjects.
	Post-test	A prospective post-test with two or more groups (intervention followed by post-test and no re-test or baseline measurement) using a single group of subjects
	Case Series	A retrospective study usually collecting variables from a chart review.
Level 5	Observational	Study using cross-sectional analysis to interpret relations. Expert opinion without explicit critical appraisal, or based on physiology, biomechanics or "first principles".
	Case Report	Pre-post or case series involving one subject.

New to the 19th edition of the Evidence-based Review of Stroke Rehabilitation

1) PICO conclusion statements

This edition of Chapter 9: Lower extremity motor rehabilitation interventions synthesizes study results from only randomized controlled trials (RCTs), all levels of evidence (LoE) and conclusion statements are now presented in the Population Intervention Comparator Outcome (PICO) format.

For example:



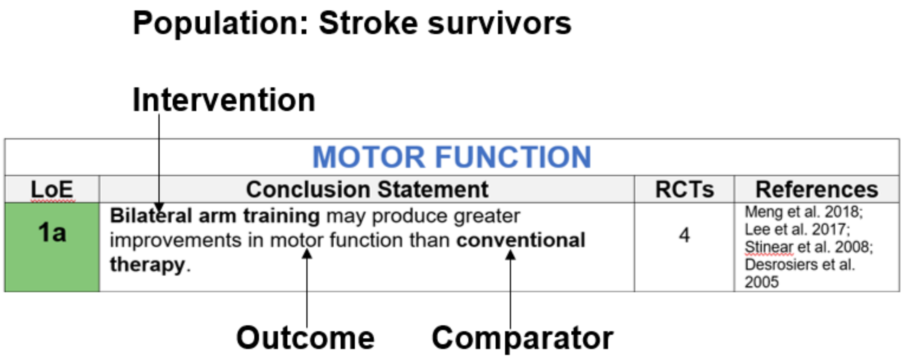
SPASTICITY			
LoE	Conclusion Statement	RCTs	References
1b	**Bilateral arm training** may not have a difference in efficacy when compared to **TENS** for improving spasticity.	1	Stinear et al. 2014

New to these statements is also the use of colours where the levels of evidence are written.

Red statements like above, indicate that the majority of study results when grouped together show no significant differences between intervention and comparator groups.

Green statements indicate that the majority of study results when grouped together show a significant between group difference in favour of the intervention group.

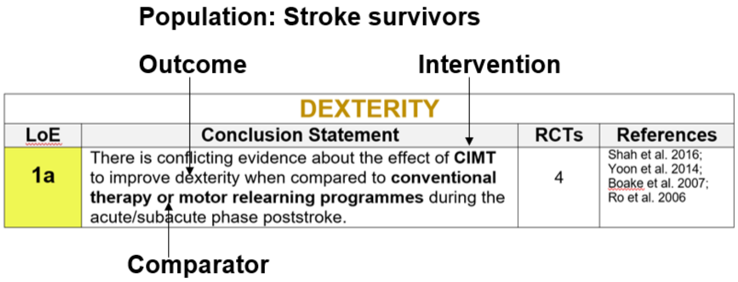
For example:



MOTOR FUNCTION			
LoE	Conclusion Statement	RCTs	References
1a	**Bilateral arm training** may produce greater improvements in motor function than **conventional therapy**.	4	Meng et al. 2018; Lee et al. 2017; Stinear et al. 2008; Desrosiers et al. 2005

Yellow statements indicate that the study results when grouped together are mixed or conflicting, some studies show benefit in favour of the intervention group, while others show no difference between groups.

For example:



DEXTERITY

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **CIMT** to improve dexterity when compared to **conventional therapy or motor relearning programmes** during the acute/subacute phase poststroke.	4	Shah et al. 2016; Yoon et al. 2014; Boake et al. 2007; Ro et al. 2006

2) Lower extremity rehabilitation outcome measures

Outcome measures were classified into the following broad categories:

Motor function: These outcome measures covered gross motor movements and a series of general impairment measures when using the upper extremities.

Activities of daily living: These outcome measures assessed performance and level of independence in various everyday tasks.

Spasticity: These outcome measures assessed changes in muscle tone, stiffness, and contractures.

Range of motion: These outcome measures assessed a patient's ability to freely move their upper extremity through flexion, abduction, and subluxation movements for instance, both passively and actively.

Proprioception: These outcome measures assessed sensory awareness about one's body and the location of limbs.

Stroke severity: These outcome measures assessed the severity of one's stroke through a global assessment of a multitude of deficits a stroke survivor may experience.

Muscle strength: These outcome measures assessed muscle power and strength during movements and tasks.

Functional ambulation: These outcomes measures assessed ambulatory abilities during distance-based or timed walking exercises commonly.

Balance: These outcome measures assessed postural stability, and both static and dynamic balance

Functional Mobility: These outcome measures assessed a person's ability to move around their environment, from one position or place to another, to complete everyday activities or tasks.

Gait: These outcome measures assessed various phases of the gait cycle.

Outcome measures that fit these categories are described in the next few pages.

Outcome measures definitions

Motor Function

Brunnstrom Recovery Stages (BRS): Is a measure of motor function and muscle spasticity in stroke survivors. The measure contains 35 functional movements which are done with the guidance of a clinician (e.g. should abduction, shoulder adduction, leg flexion/extension). These movements are evenly divided into 2 sections: upper extremity and lower extremity. Each movement is then rated on a 6-point scale (1=Flaccidity is present, and no movements of the limbs can be initiated, 2=Movement occurs haltingly and spasticity begins to develop, 3=Movement is almost impossible and spasticity is severe, 4=Movement starts to be regained and spasticity begins to decline, 5=More difficult movement combinations are possible as spasticity declines further. 6=Spasticity disappears, and individual joint movements become possible). This measure has been shown to have good reliability and concurrent validity (Naghdi et al. 2010; Safaz et al. 2009).

Chedoke McMaster Stroke Assessment Scale: Is a measure of motor impairment and consists of an impairment inventory as well as an activity inventory. The score for the impairment inventory ranges from a minimum of 6 to a maximum of 42, with a higher score corresponding to less impairment (Gowland et al. 1993). The maximum score for the activity inventory is 100, with a higher score corresponding to normal function (Gowland et al. 1993). The assessment has demonstrated excellent test-retest reliability, inter-rater reliability, internal consistency, and validity (Gowland et al.1993).

Fugl-Meyer Assessment (FMA): Is an impairment measure used to assess locomotor function and control of the upper and lower extremities, including balance, sensation, and joint pain in patients poststroke. It consists of 155 items, with each item rated on a three-point ordinal scale. The maximum motor performance score is 66 points for the upper extremity section, 34 points for the lower extremity section, 14 points for the balance section, 24 points for sensation section, and 44 points each for passive joint motion and joint pain section, for a maximum of 266 points that can be attained. The upper extremity section consists of four categories (Shoulder/Elbow/Forearm, Wrist, Hand/Finger, and Coordination) and includes 23 different movements which evaluate 33 items. The items are scored on a 3-point rating scale: 0=unable to perform, 1=partial ability to perform and 2=near normal ability to perform. The measure is shown to have good reliability and construct validity (Okuyama et al. 2018; Villian-Villian et al. 2018; Nillson et al. 2001; Sanford et al. 1993).

Lindmark Motor Assessment: Is an assessment of functional capacity, it investigates the domains of active selective movements (31 items), rapid movement (four items), mobility (eight items), balance (seven items), sensation (13 items), joint pain (nine items), and passive range of motion (26 items). The measure has both good intra-rater and inter-rater reliability within an acute stroke population (Kierkegaard & Tollback, 2005).

Lower Extremity Motor Coordination Test: The test consists of moving the lower extremity as fast as possible from one target to another for 20 seconds. The number of on target touches constitutes the score. The measure has good construct validity and test-retest reliability (Desrosiers et al. 2006).

Rivermead Motor Assessment (RMA): Is a multi-faced measure that assesses gross motor function, leg and trunk movements and arm movements in post-stroke patients. The arm movements section consists of 15 items ranging from specific isolated movements (e.g. protracting shoulder girdle in supine position) to complex tasks (e.g. placing a string around the head and tying a bow at the back). Patients perform all movements actively, and dichotomous scores indicate either success (score 1) or failure (score 0). The measure is shown to have good test-retest reliability, content validity, and construct validity (Dong et al. 2018, Van de Winckel et al. 2007).

Sodring Motor Evaluation Scale (SMES): Is a measure of motor function and activities in patients with stroke. It is comprised of 3 subscales that evaluate the motor function of the upper and lower limb, and gross motor function. The first 2 subscales assess simple voluntary movements, while the third evaluates functional tasks including trunk movements, balance, and gait. The scale is comprised of 32 different items scored using a 5-point scale. The measure is shown to have good concurrent and construct validity, as well as good inter-rater reliability (Gor-Garcia_Fogeda et al. 2014).

Upright Motor Control Test (UMCT): Is a measure of the functional strength for the lower extremities in stroke patients. This measure consists of 8 tasks which mainly consist of flexion and extension of the lower extremities (e.g. hip flexion/extension, knee flexion/extension, and ankle flexion/extension). These tasks are then evaluated on a 3-point ordinal scale (0=cannot complete task, 2=completes task as well as the unaffected side). This measure has been shown to have good reliability and validity (Gelisanga & Gorgon 2018; Lunar et al. 2017).

Functional Ambulation

10-Metre Walk Test: Is a measure used to assess walking speed, in which participants are asked to walk a distance of 10m in a straight line at maximum walking speed. The time taken to perform the task is recorded, and maximum walking speed is reported in m/s. The test is shown to have high interrater and intrarater reliability in stroke (Druzbicki et al. 2018).

25-Feet Walk Test: Is a measure of mobility and functional performance in which participants are timed while walking 25 feet as quickly as possible. The average of two trials is taken as the final score. The test has demonstrated excellent test/retest reliability and interrater/intrarater reliability in healthy controls (Phan-Ba et al. 2011).

2-Minute Walk Test: Is a measure of walking endurance in which participants are asked to walk at a comfortable pace between two defined points for two minutes. The walk is usually conducted along a straight path that is free of obstructions, and results are reported as a distance measure (in metres). The test is shown to have high inter- and intrarater reliability (Druzbicki et al. 2018; Hiengkaew et al. 2012).

30-Second Sit-to-Stand Test: Is a valid measure of lower extremity strength. Participants are asked to sit and stand out of a chair as fast as possible for 30 seconds with their arms crossed, and the number of complete repetitions performed in 30 seconds is reported. (Singh et al. 2013; Tveter et al. 2014).

3-Meter Backward Walk Test: Is an assessment of backward ambulation that has been used to predict fall risk. Participants are instructed to walk backwards for 3 meters and the average time of two trials is taken (Rose et al. 2018). The measure has demonstrated reasonable diagnostic accuracy in comparison to other common measures for assessing fall risk in healthy older adults (Carter et al. 2017).

3-Meter Walk Test: Is a less common measure of ambulation in which the time to walk 3 meters is recorded, with the average of two trials taken as the score. The measure can also be converted to a speed. This measure has demonstrated high test/retest reliability between trials, but low to moderate concordance in comparison to the 6-meter walk test based on a study in older adults by Lyons et al. (2015).

50-Meter Walk Test: Is a measure of physical fitness in which the time to walk 50 meters is recorded. This assessment is associated with quadriceps muscle strength and other outcome measures such as the timed up and go test (Hachiya et al.2014). This measure has been shown to be a valid and reliable assessment of walking ability in elderly participants (Hachiya et al. 2015).

5-Meter Walk Test: Is a measure of ambulation in which the time to walk five meters is taken. It has been shown to be more responsive than the 10-Meter Walk Test for assessing ambulation at a comfortable speed after stroke (Salbach et al. 2001).

6-Minute Walk Test: Is a measure of walking endurance, in which the distance walked by participants in a straight line within 6 minutes is reported. The test is proven to be valid and reliable in stroke (Kwong et al. 2019; Fulk et al. 2008).

EU Walking Scale: is a rating scale ranging from 0-5 that indicates an individual's ability to walk with, or without assistance. For example, 0 is a person who is wheelchair bound, a 3 corresponded to walking with a rollator, and a 6 would mean the individual is capable of walking completely unassisted (Wernig et al. 1995).

Functional Ambulation Category: Is a measure of functional mobility in which participants are ranked on their walking ability with categories ranging from zero, indicating the inability to walk or the requirement of two people assisting, to a 5, corresponding to the ability to walk anywhere independently. This measure has demonstrated excellent test-retest reliability, interrater reliability, and excellent concurrent validity in an acute stroke population (Mehrholz et al. 2007).

Gait Distance: Is a measure of endurance and can be used to assess hemiparesis or motor recovery post-stroke. Distances are usually measured in a fixed amount of time. As an individual recovers after injury, the distance they can cover in a fixed time should increase (Tanaka et al. 2019)

Gait Speed: Is a measure that is influenced by stride length and cadence and can be used to assess hemiparesis or motor recovery post-stroke. Often, an individual's "comfortable" gait speed, and/or "maximal" gait speed are recorded and used for assessment (Olney & Richards 1996).

Locomotion Ability for Adults with Lower Limb Impairments Assessment: Is an assessment of mobility for individuals with lower limb impairments that has been validated in a stroke population (Caty et al. 2007).

Modified Emory Functional Ambulation Profile: Is a modified measure of functional ambulation that assessed the time required to walk during 5 challenges. The modified version allows for manual assistance. The modified measure has demonstrated excellent test/retest reliability, inter/intra-rater reliability, and concurrent validity in both subacute and chronic stroke populations (Liaw et al. 2006; Baer et al. 2001; Wolf et al. 1999)

Walking Handicap Scale (WHS): Is a patient-reported measure that evaluates stroke patients on their overall gait and walking ability. This measure consists of a 19-item questionnaire that is mainly comprised of the myriad parts of walking (e.g. do you shuffle when you walk, do you feel fatigued quickly when you walk, do you feel any pain when you walk, etc.). These parts are then graded using a 4-point scale (0=frequently, 3=almost never). This measure has been shown to have good reliability and validity (Franceschini et al. 2013; Perry et al. 1995).

Walking Impairment Questionnaire: The Walking Impairment Questionnaire (WIQ) is a subjective measure of patient-perceived walking performance developed for individuals with peripheral arterial disease. This test has been shown to be a valid and reliable correlate of objective walking ability (Nead et al. 2013).

Walking Speed (WS): Is a measure that simply evaluates how quickly a stroke patient can walk and compares that to an age-matched baseline score. This measure consists of the patient walking a set distance (usually 10-15m) with a trained clinician timing them. The patient’s time is then compared to the average age-matched score in non-stroke patients. This measure has been shown to have good reliability and validity (Jordan et al. 2007; Himann et al. 1988).

Functional Mobility

Clinical Outcome Variable Scale: Is a measure of functional mobility consisting of 13 mobility tasks, each scored on a 7-point scale. Overall scores range of a 13 at the lowest to 91 at the highest, with a higher score corresponding to better functioning (Garland et al. 2003)

De Morton Mobility Index: Is a measure of mobility that has demonstrated reliability and validity within a sub-acute stroke population (Braun et al. 2018). The raw score of 19 is converted to the final score out of 100, with a higher score indicating better mobility.

Elderly Mobility Scale: Is a measure of function designed for the assessment of frail elderly adults. This assessment has demonstrated high inter-rater reliability, good intra-rater reliability, and high concurrent validity (Linder et al. 2006; Nolan et al. 2008; Smith 1994).

Functional Independence Measure: Is a measure of disability during activities of daily living that consists of 18 items, with 13 motor tasks and 5 cognitive tasks. The total score ranges from 18 to 126, with a higher score indicating greater independence. This measure has demonstrated excellent concurrent validity within an acute stroke population (Hsueh et al. 2002).

Life Space Assessment: Is a measure of mobility that assesses physical function, sociodemographic characteristics as well as psychological and cognitive aspects of daily functioning (Baker 2003).

Modified Rivermead Mobility Index (MRMI): is an assessment of functional tasks, such as getting out of bed. This measure is derived from the Rivermead Mobility Index but consists of 8, instead of 15 items. Each item is rated on a 6-point scale, as opposed to the binary outcome recorded in the original Rivermead Mobility Index. This measure has shown high reliability, validity and sensitivity (Lennon & Johnson, 2000)

Rivermead Mobility Index (RMI): Is a self-reported measure of the ability of a stroke patient to complete functional tasks. This measure consists of 15 functional tasks (e.g. turning over in bed, stairs, walking outside) which are then rated on 2-point scale completed by the patient in the form of a questionnaire (0=cannot complete task, 1=can complete task). This measure has been shown to have good reliability and validity (Lennon et al. 2000; Colleen et al. 1991).

Rivermead Motor Assessment (RMA): Is a measure that assesses functional mobility (e.g. gait, balance, and transfers) in stroke patients. It consists of 15 items ranging from specific isolated movements (e.g. protracting shoulder girdle in supine position) to complex tasks (e.g. placing a string around the head and tying a bow at the back).

Patients perform all movements actively, and dichotomous scores indicate either success (score 1) or failure (score 0). This measure is shown to have good test-retest reliability, content validity, and construct validity (Dong et al. 2018, Van de Winckel et al. 2007).

Short Physical Peformance Battery (SPPB): Is a group of measures that combines gait speed, chair stand and balance tests. The scores for this measure range from 0-12, with 0 being the worst performance, and 12 corresponding to the best performance. The SPPB has been shown to have good predictive validity (Freire et al. 2012).

Stroke Rehabilitation Assessment of Movement (SRAM): Is a measure of how well a stroke patient can perform functional tasks. This measure consists of 30 functional tasks which are then subdivided 5 subsections: supine, sitting, standing, standing (while gripping a stable support), and standing plus walking activities. These tasks are then evaluated on a 4-point scale. 0=unable to complete task, 1a=able to perform only part of the activity independently with marked deviation from normal motor pattern, 1b=able to perform only part of the activity independently in a manner that is comparable to the unaffected side, 1c=able to perform the full movement but with marked deviation from the unaffected side, 2=able to perform the full movement with grossly normal motor movement but with assistance, 3=able to complete the activity independently with grossly normal motor movement. This measure ha been shown to have s good reliability and validity (Ahmed et al. 2003; Daley 1999).

Balance

30-Second Sit-to-Stand Test: Is a valid measure of lower extremity strength. Participants are asked to sit and stand out of a chair as fast as possible for 30 seconds with their arms crossed, and the number of complete repetitions performed in 30 seconds is reported. (Singh et al. 2013; Tveter et al. 2014).

Activities-Specific Balance Confidence Scale: Is a measure of an individual's confidence, in percent, in performing various ambulatory activities without losing balance. It is a self-reported assessment with 16-items that is proven to have high interrater and test-retest reliability in stroke (Ng et al. 2018).

Anteroposterior Center of Pressure: Is a measure of acceptable validity and reliability to assess balance in the forward and backward direction (Zhen et al. 2016). A balance or force platform is used to calculate the center of pressure in three scenarios, including standing with eyes open, standing with eyes closed, and while sitting.

Balance Performance Monitor: Is a computerized system used to measure static and dynamic balance during gait. For static balance, participants are asked to stand on the footplates of the machine with an erect posture for 30 seconds, while for dynamic balance they are asked to shift their weight anteroposteriorly and mediolaterally. The BPM is shown to be reliable and valid in stroke (Kim et al. 2009).

Berg Balance Scale: Is a 14-item scale that measures balance ability and control while sitting and standing. Each item is ranked on a 4-point scale for a total score of 56. The measure is shown to have high interrater, intrarater, and test-retest reliability (Reinkensmeyer et al. 2019; Blum et al. 2008).

Biodex Balance System: Is a computerized posturography instrument that measures balance abilities in stroke patients. It focuses on proprioceptive neuromuscular functions that appear to affect dynamic joint and postural stability to assess standing balance. The instrument has been shown to be a reliable assessment tool for postural stability (Chaegil 2019; Chen et al. 2014; Dawson et al. 2018).

Brunel Balance Assessment: Is a measure of functional balance. It is a 10-point hierarchial ordinal scale that is found to be a reliable and valid measure of balance issues post stroke (Karthikbabu et al. 2018; Tyson & DeSouza 2004).

Burke Lateropulsion Scale: Is a measure of lateropulsion, or altered perception of body verticality, that may occur after a stroke. The scale consists of five items which assess the action or reaction of participants during supine, sitting, standing, transfers and walking positions. A therapist is required in scoring with a minimum score of 0 indicating no perceived lateropulsion, and a maximum score of 17. This scale has demonstrated excellent interrater and intrarater reliability in a stroke population (D'Aquila et al. 2004).

Community Balance and Mobility Scale: is a way to further assess mobility and balance in already ambulatory individuals. It was designed to examine an individual's ability to engage in their community. It consists of 13 tasks, such as hoping or crouching, each scored from 0-5, that take place over an 8 meter 'track', and a full flight of stairs. Scores on this measure range from 0-96, and each task is scored on the first trial. It is considered a reliable and valid measure and is a more sensitive assay for balance and mobility than others commonly used due to the difficulty of some tasks (Knorr, Brouwer & Garland, 2010).

Four Square Step Test: Is a measure of dynamic balance that assesses a participant's ability to step over objects when approaching from the front, the side, and from the back. The best time of two trials is taken as the score (Whitney et al. 2007)

Four Test Balance Scale: Is a measure of static balance in which four timed tasks of progressive difficulty are completed. They include the feet together stand, the semi-tandem stand, the tandem stand, and the one leg stand (Gardner et al. 2001).

Functional Reach Test: Is a measure of balance assessing the maximum distance a participant can reach forward while standing in a fixed position. The modified version assesses maximum reach while the participant is sitting. This measure has demonstrated excellent test-retest reliability, intrarater reliability, and high face validity within a stroke population (Katz-Leurer et al. 2009; Outermans et al. 2010).

Lateral Reach Test: Is a measure of medial-lateral postural stability that has demonstrated high inter-rater reliability within an elderly population (DeWaard et al. 2002).

Limit of Stability: Is an assessment of balance that measures the maximum distance the center of gravity can be displaced (Alfeeli et al. 2013). Reaction time, center of gravity movement velocity, directional control and excursion values are all recorded (Alfeeli et al. 2013).

Medial-Lateral Centre of Pressure: Is a measure of acceptable validity and reliability to assess balance in the side-to-side direction (Li et al. 2016). A balance or force platform is used to calculate the center of pressure in three scenarios, including standing with eyes open, standing with eyes closed, and while sitting.

Mini Balance Evaluation Systems Test: Is a shortened measure of balance, including assessments related to anticipatory postural adjustments, reactive postural control, sensory orientation, and dynamic gait. The maximum score is 28. This measure has demonstrated excellent test/retest reliability, inter/intra-rater reliability, and criterion validity within a chronic stroke population (Tsang et al. 2013).

Modified Clinical Test of Sensory Integration of Balance: The Modified Clinical Test of Sensory Integration of Balance is a timed test that systematically measures the influence of visual, vestibular, and somatosensory input on standing balance. In condition one, all sensory systems (i.e., vision, somatosensory, and vestibular) are available for maintaining balance. In condition two, vision has been removed and the older adult must rely on the somatosensory and vestibular systems to balance. In condition three, the somatosensory system has been compromised and the older adults must use vision and the vestibular system to balance. In condition four, vision has been removed and the somatosensory system has been compromised. The older adults must not rely primarily on the vestibular inputs to balance (Cohen, Blatchly, & Gombash, 1993).

Modified Functional Reach Tests: Is a modified measure of balance in which the maximum distance an individual can reach forward is measured. This measure is adapted for individuals who are unable to stand so that assessments can be performed in a sitting position. This assessment has demonstrated excellent test-retest reliability and criterion validity in a stroke population (Katz-Leurer et al. 2009).

Modified Stairs Test: is a longer version of the Timed Up and Go Test (TUG). The test is made up of the same tasks at TUG, but also includes ascending and descending 5 stairs. They are timed while they get out of a chair, walk a small distance to a stair set, ascend and descend the 5-stair set, and then return to the chair (Van De Port et al. 2009)

Overall Stability Test (OST): Is a measure of a stroke patient's static and dynamic balance. This test involves the patient standing on a force plate and moving slightly (anterior-posterior and medial-lateral) all while the force plate transmits information to a trained clinician. This measure has good test-retest reliability and validity (Goldbeck & Davies, 2000).

Pedaling Unbalance (PUn): Is a measure of how symmetrical a stroke patient's legs are working when they are pedaling on an exercise bicycle. This test involves the patient pedaling on a specialized bicycle which transmits information to a trained clinician. The patient's pedaling metrics (stroke power, stroke force, general leg asymmetry etc.) are then analyzed. This measure has good reliability and validity (Ambrosini et al. 2012).

Performance-Oriented Mobility Assessment (POMA) AKA Tinetti Balance Scale (TBS): Is a measure of how functionally mobile a stroke patient is. This test involves 9 different balancing tasks (e.g. standing balance, balance with eyes closed, sitting balance etc.). These tasks are measured using a 3-point scale (0=cannot complete task, 2=complete independence). This measure has been found to have good reliability and validity (Faber et al. 2006; Tinetti 1986).

Postural Assessment Stroke Scale (PASS): Is a measure of how well a stroke patient balances in both static and dynamic positions. This measure consists of 12 functional tasks (e.g. sitting without support, standing without support, sit-to stand etc.). These tasks are then divided into 2 distinct subscales (maintaining a posture and changing a posture). The tasks are scored on a 4-point scale (0=cannot complete task, 3=completes task and can hold position for an extended period of time). This measure has been shown to have good inter-rater reliability and validity (Chien et al. 2007; Benaim et al. 1999).

Postural Control (PC): Is a measure of how well a stroke patient can maintain a state of balance during a static posture and/or activity. This test consists of the patient standing on a force-plate and then the force plate analyzes the patient's level of control. The data from the force plate is then read and interpreted by a trained healthcare professional. This measure has been shown to have good reliability and validity (Gill et al. 2001; Nichols 1996).

Postural Sway (PS): Is a measure of how well a stroke patient can maintain a state of balance during a dynamic posture and/or activity. This test consists of the patient standing on a force-plate and then gently swaying. The force plate analyzes the patient's level of control and the data from the force plate is read and interpreted by a trained healthcare professional. This measure has been shown to have good reliability and validity (Lin et al. 2008; Hughes et al. 1996).

Rate of Falls (RoF): The number of falls that are recorded in a certain population. For example, stroke patients have a higher rate of falls than age matched healthy patients. This measure has been shown to have good reliability and validity (Nyberg & Gustafson 1995).

Scale for Contraversive Pushing (SCP): Is a measure of how well a stroke patient can maintain proper body posture while resisting pressure (contraversive pushing) applied by a trained clinician. This measure consists 3 different variables (spontaneous body posture, abduction and extension of the non-paretic extremities, resistance to passive correction of tilted posture). These variables are rated on a 3-point scale (0=no contraversive pushing, 2=maximum score). This measure has been shown to have good reliability and validity (Baccini et al. 2006; Karnath et al. 2000).

Sensory Organization Test: The Sensory Organization Test (SOT) describes a component of Computerized Dynamic Posturography. The SOT evaluates the impact of visual, vestibular, and somatosensory inputs, as well as sensory reweighting, under conditions of sensory conflict. This test is performed using six sensory stimulation conditions, during which visual stimuli are changed and a rotation of the foot support platform, or movements of the visual surround. It is sometimes divided into static and dynamic evaluations. (Benvenuti et al. 1999; Olchowik & Czwalik, 2020; Oliveira et al. 2011).

Sitting Balance (SB): Is a measure of how well a stroke patient can maintain their posture/stability when they are seated. This measure consists of 15 tasks (e.g. touch a clinician’s palm, touch the floor, reach to the ceiling). These tasks are then assessed on a 5-point scale (0=patient cannot complete task, 4=patient is functionally independent). This measure has been shown to have good reliability and validity (Betker et al. 2007; Nichols et al. 1996).

Sit-to-Stand Test (STS): Is a measure of how effectively and efficiently a stroke patient can rise from a seated position into a stable, standing position. This measure consists of 3 areas: rising power, transfer time and gravitational sway, which are then evaluated on a balance-specific balance program run by a trained clinician. This measure has been shown to have good reliability and validity (Whitney et al. 2005; Bohannon 1995).

Stabilometry Test (ST): Is a measure of the amount of postural equilibrium a stroke patient possesses. This measure is comprised of 2 distinct tests: unipedal (one foot) and bipedal (two feet). The evaluation begins once the patient steps onto a force plate and a trained clinician has them balance either on two feet or on one foot, and then the data is analyzed by said clinician. This measure has been shown to have good test-retest reliability and concurrent validity (Hsu et al. 2009; Ageberg et al. 1998).

Stair Climb Test (SCT): Is a measure of the amount of dynamic balance a stroke patient possesses, as well as their overall aerobic capacity. This measure is scored by having the patient ascend 4-9 stairs while they are being timed by a trained professional. The lower the time, the better the patient’s dynamic balance and aerobic capacity. This measure has been shown to have excellent inter-rater and test-retest reliability, as well as good validity (Hesse et al. 2012; Almeida et al. 2010).

Static Balance (SB): Is the ability of an object and/or person to maintain their stationary balance. This measure has been shown to have good reliability and validity. (Geuze 2003).

Timed Up & Go Test (TUG): Is a measure of the ability of a stroke patient to perform sequential motor tasks. This measure consists of 1 functional task which involves the patient standing up from a chair, walking 3 metres, turning around and sitting back down again. This task is then evaluated on a scale from 1 to 5 (1=normal function, 5=severely abnormal function). This measure has been shown to have good reliability and validity (Steffen et al. 2002; Shumway-Cook et al. 2000).

Tinetti Gait Scale (TGS): Is a measure of how efficient and effective the overall gait of a stroke patient is. The patient is evaluated in 8 different areas (e.g. indication of gait, foot clearance, step length and step symmetry). These areas are then evaluated on a 3-point scale (0=cannot complete activity, 1=completes activity with some difficulty, 2=can complete the activity as well as the unaffected side). This measure has been shown to have good reliability and validity. Please note that this test is sometimes combined with the POMA test in order to generate one score (Zimbelman et al. 2012).

Trunk Control Test (TCT): Is a measure that assesses the level of motor impairment a stroke patient has in the trunk/abdominal region. This measure consists of 4 functional tasks (e.g. roll to weak side, roll to strong side, balance on a sitting position at the edge of a bed, and sit up from lying down). For each task the patient receives points (0=cannot complete task, 12=completes task with some assistance, 25=completes task independently) for a maximum of 100 points. This measure has been shown to have good reliability and validity (Duarte et al. 2002; Franchignoni et al. 1997).

Trunk Impairment Scale (TIS): Is a measure of static and dynamic sitting balance as well as trunk coordination while a stroke patient is in a sitting position. This measure consists of 2 distinct subscales: static sitting balance and dynamic sitting balance. The static sitting balance subscale consists of 3 functional tasks (e.g. maintaining a sitting position, maintaining a sitting position with legs passively crossed and maintaining a sitting position with legs actively crossed). The dynamic sitting balance subscale consists of 1 functional task (e.g. rotating upper part of the trunk 6 times and then rotating the lower part of the trunk 6 times). These tasks are then graded on a 4-point ordinal scale (0=cannot complete task, 3=completes the task quickly and with ease). This measure has been shown to have good test-retest reliability and validity (Yu & Park 2013; Verheyden et al. 2004).

Trunk Reposition Error (TRE): Is a measure of how well a stroke patient can reproduce trunk flexion of approximately 30 degrees which is the normal amount of trunk flexion in age-matched non-stroke patients. This measure consists of the patient trying to reproduce this trunk angle under 3 distinct conditions (eyes opened on floor, eyes closed on floor, and eyes opened on foam). These tasks are then evaluated by having a trained clinician measure the patient’s actual trunk angle. This measure has been shown to have good to excellent test-retest reliability and good construct validity (Jung et al. 2014; Hidalgo et al. 2013).

Gait

Cadence: Is a gait pattern that varies and is assessed through gait analysis (Brandstater et al. 1983). Gait parameters after a stroke are associated with functional performance and recovery.

Double Limb Support Period: Is a measure of the time during which both feet are in contact with the ground during a gait cycle. Changes in this outcome may inform difficulty in balancing or in transferring body weight after stroke (Goldie et al. 2001).

Dynamic Gait Index: Is a measure of balance and gait in which participant's ability to adapt while walking around various obstacles is assessed. The assessment is performed over a distance of 20 feet and equipment required includes a shoe box, two obstacles, and stairs. The maximum score is 24 points with a higher score indicating less impairment. This measure has demonstrated excellent test/retest reliability, interrater reliability, and validity (Lin et al. 2010; Jonsdottir & Cattaneo, 2007).

Figure-8 Walk Test: Is a measure of mobility in older adults through an assessment of gait during a straight and curved path. This outcome has demonstrated excellent intra-rater, inter-rater and test-retest reliability in a stroke population (Wong et al. 2013).

Functional Gait Assessment: Is a measure of balance and gait that consists of 10 items, each scored from 0 to 3 for a maximum score of 30. A higher score indicates less impairment during ambulation. This measure has demonstrated excellent test/retest reliability, inter/intra-rater reliability, and validity within a stroke population (Thieme et al. 2009; Lin et al. 2010).

Gait Assessment and Intervention Tool: Is a measure of gait that includes 31 items. This measure has demonstrated good intra/inter-rater reliability (Daly et al. 2009).

Gait Cycle Time: Is the time it takes from the heel strike of one foot until the heel strike of the same foot before the next step. It allows for a quantifiable assessment of the ambulation pattern in participants with neurological impairments post-stroke (Nadeau et al. 2011).

Peak Propulsion: Propulsion is defined as the force used to propel the body forward. Peak propulsion is the maximum force generated during the propulsive phase and does not account for the duration of the propulsion. Improvements in peak propulsive force was correlated to long-term walking ability in individuals poststroke (Awad et al., 2014a; Hsiao, et al., 2016).

Single Limb Support Time: Is a measure of the amount of time that passes during the swing phase of one extremity in a gait cycle. This measure involves a trained clinician attaching a wearable device to a stroke patient and having them walk on a treadmill. The device then sends the clinician information which can be analyzed. This measure has been shown to have good reliability and validity (Jenkins et al. 2009; Hanke & Rogers 1992).

Stance Phase: Is the part of the gait cycle where a patient's one foot makes contact with the ground. It comprises approximately 60% of the gait cycle. This measure has been shown to have good reliability and validity. (Kozanek et al. 2009).

Stance Symmetry: Is the ability of a stroke patient to keep their centre of gravity in between their feet, instead of listing to one side or another. Most stroke patients list towards their unaffected side in order to compensate for a perceived lack of balance. This measure has been shown to have good reliability and validity (Rodriguez & Aruin 2002).

Step Length: Is the distance between the heel print of one foot to the heel print of the second foot. The higher the distance, the better the score. This measure has been shown to have good reliability and validity. (Kuo 2001).

Step Reaction Time: Is a measure that evaluates a stroke patient's reaction time with regards to their lower extremities. This measure consists of 1 functional task which involves the patient standing on the floor with four panels in front of them. When one of the panels light up the patient reaches their foot forward to touch it as quickly as possible. The patient is timed by the computer program and their time is compared to age-matched non-stroke patients. This measure has been shown to have good reliability and validity (Lord & Fitzpatrick, 2001).

Step Test: Is a test that measures aerobic capacity. Participants step on and off a raised step in a quick but controlled manner for 3 minutes straight. The more steps completed, the higher the score. This measure has been shown to have good reliability and validity. (Siconolfi et al. 1985).

Step Time: Is the time between successive foot-floor contact for both feet. Participants are timed by a trained professional. The lower the time, the better the score. This measure has been shown to have good reliability and validity. (Balasubramanian et al. 2009).

Stride Length: Is the distance between two successive placements of the same foot. One stride length is the equivalent of two step lengths. Unlike step lengths, stride lengths should be very similar for both the right and left leg. This measure has been shown to have good reliability and validity. (Danion et al. 2003; Lewis et al. 2000).

Stride Time: Is the time that elapses between the first contact of two consecutive footsteps of the same foot. It is measured in milliseconds (ms). This measure has been shown to have good test-retest reliability and validity (Beauchet et al. 2011).

Stride Width: Is the distance between your heels when each heel is at its lowest point. Stroke patients typically have a wider stride length compared to non-stroke patients due to weaker overall balance. This measure has been shown to have good reliability and validity (Heitmann et al. 1989; Kawamura et al. 1991).

Support Duration: Is a measure of how long a stroke patient can support themselves while standing up. This measure consists of the patient standing up from a chair and continuing to stand for as long as possible while being timed by a trained clinician. This measure has een shown to have good reliability and validity (Plummer et al. 2007).

Sway Area: Is a measure of the numerical amount a stroke patient's body deviates from a set point when they are standing still. Baseline (sample) points are laid down and then the patient-specific points are calculated once the test is complete. Stroke patients usually deviate from the sample points. This measure has been shown to have good reliability and validity (Wollseifen 2011).

Sway in Centre of Pressure: Is a measure of the change in the centre of pressure over time in stroke patients. This deviation is measured through the use of force plates which help trained clinicians analyze movement in the anterior-posterior and medial-lateral directions. Stroke patients typically deviate more from their centre of pressure compared to age-matched non-stroke patients. This measure has been shown to have good reliability and validity (Matsuda et al. 2008; Riach & Starkes 1994).

Sway Length: Measures the length of the path traversed by the sway pattern which is then measured in centimetres. This measure involves the patient walking on a treadmill while they are attached to a computer program. Their results are analyzed by a trained clinician. This measure has been shown to have good reliability and validity (Kincl et al. 2002).

Sway Velocity: Is the average horizontal area covered by the movement of the centre (anterior-posterior and medial-lateral directions) of force per second. This data is analyzed by a computer program which is in turn run by a trained clinician. This measure has been shown to have good reliability and validity (Cho et al. 2014).

Swing Power: Is the rate at which work is done in the swing phase (when the foot is NOT in contact with the ground) of the overall gait cycle. The patient has a wearable device attached to their affected side and the feedback is sent to a trained clinician for analysis. This measure has been shown to have good reliability and validity (Olney et al. 1991).

Swing Symmetry: Is a measure of how synchronised a stroke patient's affected and unaffected sides are. The measure consists of 2 parts: a wearable device being attached to the stroke patient's unaffected side and the data from this device is then analyzed by a trained clinician. Additionally, the patient also undergoes a 3-5min walking test, which is administered by the clinician, who then records their observations. This measure has been shown to have good reliability and validity (Patterson et al. 2010).

Symmetric Weight Bearing: Is a measure of how well a stroke patient keeps themselves centred, instead of tilting towards the unaffected side. This data is analyzed by having the stroke patient stand on a force plate and a trained clinician then interprets the results. This measure has been shown to have good reliability and construct validity (Combs et al. 2012; Cheng et al. 2001).

Tinetti Gait Scale: Is a measure of how efficient and effective the overall gait of a stroke patient is. The patient is evaluated in 8 different areas (e.g. indication of gait, foot clearance, step length and step symmetry). These areas are then evaluated on a 3-point scale (0=cannot complete activity, 1=completes activity with some difficulty, 2=can complete the activity as well as the unaffected side). This measure has been shown to have good reliability and validity. Please note that this test is sometimes combined with the POMA test in order to generate one score (Zimbelman et al. 2012).

Turn Speed: Is a measure of how quickly and effectively a stroke patient can turn and change directions while they are walking. This measure consists of 1 functional task which involves the patient being asked to walk and then being told to change directions. This task is then evaluated on a 3-point ordinal scale (0=cannot turn at all, 2=turns as well as the unaffected side). This measure has been shown to have good reliability and validity. Please note that this outcome measure is occasionally done in conjunction with the TUG Test (Son & Park 2019).

Wisconsin Gait Scale: Is a measure that evaluates the gait parameters and walking abilities of a stroke patient. This measure consists of 14 functional areas of walking (e.g. use of hand-held gait aid, hip hitching, stance width etc.). These areas are then graded on a 3-point scale (0=cannot complete task, 2=no discernible gait troubles). This measure has been shown to have good reliability and validity (Pizzi et al. 2007; Turani et al. 2004).

Activities of daily living

Ability for Basic Movement Scale Revised: Is a measure of functional ability, it assesses five basic movements (turning over from the supine position, sitting up, remaining in sitting position, standing up, remaining in standing position). Each item is scored from: 1=prohibition from moving, 2=total dependence, 3=partial dependence, 4=supervision, 5=independence in a special environment, 6=complete independence. It has demonstrated validity within a stroke population (Kinoshita et al. 2017; Tanaka et al. 2010).

Barthel Index (BI): Is a measure of how well a stroke survivor can function independently and how well they can perform activities of daily living (ADL). The measure consists of a 10-item scale (e.g. feeding, grooming, dressing, bowel control). Possible total scores range from 0 to 100. This measure has been shown to have good reliability and validity in its full form (Gonzalez et al. 2018; Park et al. 2018).

Frenchay Activities Index (FAI): Is a measure of activities that stroke survivors have participated in recently. The measure consists of 15 items that are in turn split up into 3 subscales (domestic chores, leisure/work and outdoor activities). These items include: preparing meals, washing clothes, light/heavy housework, social outings etc. Each task is then scored on a 4-point scale with 1 being the lowest score. This measure has been shown to have good reliability and concurrent validity in its full form (Schuling et al. 1993).

Functional Independence Measure (FIM): Is an 18-item outcome measure composed of both cognitive (5-items) and motor (13-items) subscales. Each item assesses the level of assistance required to complete an activity of daily living on a 7-point scale. The summation of all the item scores ranges from 18 to 126, with higher scores being indicative of greater functional independence. This measure has been shown to have excellent reliability and concurrent validity in its full form (Granger et al. 1998, Linacre et al. 1994; Granger et al. 1993).

Lower Extremity Functional Scale: Is an assessment of lower extremity impairment. The measure includes 20 items that measure a person’s ability to complete activities of daily living with a score range from 0 to 80. This outcome has demonstrated excellent test-retest reliability, and adequate to excellent validity (Verheijde et al. 2013).

Modified Barthel Index (MBI): Is a measure of how well a stroke survivor can function independently and how well they can perform activities of daily living (ADL). The measure consists of a 10-item scale (e.g. feeding, grooming, dressing, bowel control). Possible scores range from 0 to 20. This measure has been shown to have good reliability and validity in its full form. (MacIsaac et al. 2017; Ohura et al. 2017).

Motor Assessment Scale (MAS): Is a performance-based measure that assesses everyday motor function. The measure consists of 8 motor-function based tasks (e.g.

supine lying, balanced sitting, walking). Each task is then measured on a 7-point scale (0=suboptimal motor performance, 6=optimal motor performance). This measure has been shown to have good reliability and concurrent validity (Simondson et al. 2003).

Nottingham Extended Activities of Daily Life (NEADL): Is a measure of a stroke survivor's independence with regards to their performance on various activities of daily living. The measure consists of 22 functional tasks (e.g. walking, cooking, cleaning, participation in active hobbies). These tasks are then further divided into 4 distinct subscales (mobility, kitchen, domestic, and leisure activities). In turn, each task is measured on a 5-point (0=not at all, 4=on my own with no difficulty). This measure has been shown to have good reliability and validity (das Nair et al. 2011; Sahin et al. 2008).

Stroke Impact Scale (SIS): Is a patient-reported measure of multi-dimensional stroke outcomes. The measure consists of 59 functional tasks (e.g. dynamometer, reach and grab, walking, reading out loud, rating emotional regulation, word recall, number of tasks completed, and shoe tying). These tasks are then divided into 8 distinct subscales which include: strength, hand function, mobility, communication, emotion, memory, participation and activities of daily living (ADL). Each task is measured on a 5-point scale (1=an inability to complete the task, 5=not difficult at all). The measure has been shown to have good reliability and validity (Mulder et al. 2016; Richardson et al. 2016).

Sunnaas Index: Is a measure of functional activity limitation. The measure consists of 12 items (eating, indoor mobility, toilet-management, transfer, dressing-undressing, grooming, cooking, bath/shower, housework, outdoor mobility, communication). Each item is scored from: 0=total dependence; 1=needs some help from others; 2=can manage alone; 3=complete independence (Claesson & Svensson, 2001).

Range of motion

Active Range of Motion (AROM): Is a measure of the range of motion stroke survivors possess without receiving assistance. The measure consists of 20 functional movements for both the upper and lower extremity. The movements are evenly divided into 2 sections: upper extremity and lower extremity. These movements are then rated on a 4-point ordinal scale (0=cannot complete movement, 3=completes movement as well as the unaffected side). This measure has been shown to have good reliability and validity (Beebe & Lang 2009, Dickstein et al. 1986)

Maximal Elbow Extension Angle During Reach (MEEAR): Is a measure of the amount of elbow extension undergone by a stroke survivor while they are reaching for an object. The measure consists of 1 functional movement which is when a patient reaches for an object and their rate of elbow extension is measured (the higher the rate of extension, the better the outcome). This measure has been shown to have good inter/intra reliability and concurrent validity (Murphy et al. 2011; Cristea et al. 2003).

Passive Range of Motion (PROM): Is a measure of the range of motion stroke survivors possess while receiving assistance. The measure consists of 30 functional movements for both the upper and lower extremity. The movements are evenly divided into 2 sections: upper extremity and lower extremity. These movements are then rated on a 5-point ordinal scale (0=cannot complete movement, 4=completes movement as well as the unaffected side). This measure has been shown to have good test/retest reliability and validity (Lynch et al. 2005).

Muscle strength

Isokinetic Peak Torque (IPT): Is a measure of the work capacity of specific muscle groups of a stroke survivor. The measure consists of 1 functional task. The patient performs elbow flexion/extension while attached to a machine that measures force output. The process is then repeated for the leg. The output is then compared to healthy patients that are approximately the same age and build. This measure has been shown to have good test/retest reliability (Horvat et al. 1997).

Manual Muscle Strength Test (MMST): Is a measure of how well a stroke survivor can complete various upper extremity movements while resistance is applied by a trained clinician. The measure consists of 3 functional tasks: muscle contraction, total range of motion and resistance to applied pressure. Patients are scored on a 12-point scale (0=no movement, T=trace/barely discernable movement, 10=movement carried out as well as the unaffected side). This measure has been shown to have good reliability and validity (Kristensen et al. 2017; Ada et al. 2016)

Medical Research Council Scale (MRCS): Is a measure of overall muscle strength a stroke survivor possesses. The measure consists of 33 functional tasks (e.g. opening/shutting cupboards, screwing and unscrewing lids, lifting of light objects). Each task is then rated on a 4-point scale (0=cannot complete task, 3=completes task as well as the unaffected side). This measure has been shown to have good reliability and validity (Hsieh et al. 2011; Fasoli et al. 2004).

Spasticity

Composite Spasticity Index: Is a measure of spasticity and consists of three items assessing tendon jerk, resistance to passive flexion, and clonus. The total score is calculated by adding the individual scores from each item with a range of 0 to 16. A higher score is indicative of more severe spasticity (Chan 1986).

Modified Ashworth Scale (MAS): Is a measure of muscle spasticity for stroke survivors. The measure contains 20 functional movements which are done with the guidance of a trained clinician. These movements are evenly divided into 2 sections: upper extremity and lower extremity. Each movement is then rated on a 6-point scale (0=no increase in muscle tone, 1=barely discernible increase in muscle tone 1+=slight increase in muscle tone, 2=moderate increase in muscle tone 3=profound increase in muscle tone (movement of affected limb is difficult) 4=complete limb flexion/rigidity (nearly impossible to move affected limb)). This measure has been shown to have good reliability and validity (Merholz et al. 2005; Blackburn et al. 2002).

Modified Tardieu Scale (MTS): Assesses spasticity through measuring the quality and angle of muscle movements in response to stretches of different velocities. The velocities of muscle movement are as slow as possible (V1), speed of the limb falling from gravity (V2), and when the joint is moved as fast as possible (V3). The quality and angle of muscle reactions are recorded during these velocities. The quality of muscle reactions are scored as: 0 (no resistance throughout the duration of the stretch), 1 (slight resistance), 2 (clear catch occurring at a precise angle, followed by a release), 3 (fatigable clonus), 4 (infatigable clonus), 5 (joint is immovable) (Li et al. 2014b).

Spasm Frequency Scale (SFS): Is a measure of the amount of spasms experienced by stroke survivors in a day. The measure is only concerned with measuring the amount of spasms in a single day. The amount of spasms per day are rated based on a 5-point scale (0=No spasms, 1= One or fewer spasms per day, 2=Between 1 and 5 spasms per day, 3=Five to less than 10 spasms per day, 4=Ten or more spasms per day, or continuous contraction). This measure has been shown to have good reliability and validity (Santamato et al. 2013; Snow et al. 1990).

Proprioception

Joint Position Sense Test (JPST): Is a measure of how well stroke survivors can perceive the position of their joints in motion and standing still. The measure consists of 1 functional task repeated several times. This task involves the patient holding 2 different shaped objects that also weigh different from each other and then told to identify which one weighs more and which one has a stranger shape. The more times the patient (s) identifies which shape is heavier/unique, then the better the outcome. This measure has been shown to have good reliability and validity (Kattenstroth et al. 2013).

Kinesthetic Visual Imagery Questionnaire (KVIQ): Is the measure of the visual acuity and muscle movement that stroke survivors possess. The measure consists of 20 functional tasks (e.g. tying shoes, reading out loud, reaching for an object, peripheral vision testing). Each task is then measured on 3-point scale (0=cannot complete task, 2=completes task as well as the unaffected side). This measure has been shown to have good reliability and validity (Salles et al. 2017; Demanboro et al. 2018).

Revised Nottingham Sensory Assessment (RNSA): Is a measure of somatosensory perception in stroke survivors. The measure consists of 1 functional task repeated with 11 different objects. The task involves patients identifying 11 different objects with their eyes closed. The higher the rate of objects identified leads to a better overall outcome. This measure is shown to have good reliability and validity (Boccuni et al. 2018; Gorst et al. 2018).

Stroke severity

Hemispheric Stroke Scale (HSS): Is a predominantly neurologic examination for use after an acute hemispheric infarction (Adams et al. 1987). It assesses level of consciousness, language, cognitive function, motor function, and sensory outcomes post-stroke.

Modified Rankin Scale (MRS): Is a measure of functional independence for stroke survivors. The measure contains 1 item. This item is an interview that lasts approximately 30-45 minutes and is done by a trained clinician. The clinician asks the patient questions about their overall health, their ease in carrying out ADLs (cooking, eating, dressing) and other factors about their life. At the end of the interview the patient is assessed on a 6-point scale (0=bedridden, needs assistance with basic ADLs, 5=functioning at the same level as prior to stroke). This measure has been shown to have good reliability and validity (Quinn et al. 2009; Wilson et al. 2002).

National Institutes of Health Stroke Scale (NIHSS): Is a measure of somatosensory function in stroke survivors during the acute phase of stroke. This measure contains 11 items and 2 of the 11 items are passive range of motion (PROM) assessments delivered by a clinician to the upper and lower extremity of the patient. The other 9 items are visual exams conducted by the clinician (e.g. gaze, facial palsy dysarthria, level of consciousness). Each item is then scored on a 3-point scale (0=normal, 2=minimal function/awareness). This measure has been shown to have good reliability and validity (Heldner et al. 2013; Weimar et al. 2004).

Scandinavian Stroke Scale (SSS): Is a measure of somatosensory function in acute/subacute phase stroke patients. This measure consists of 10 functional tasks (e.g. speech, orientation in space, eye movement) which are rated on a 7-point (0=paralysis/no movement, 6=fully conscious/ as normal as unaffected side). This measure has been shown to have good reliability and validity (Askim et al. 2016; Christensen et al. 2005).

Therapy Based Interventions

Neurodevelopmental Techniques and Motor Relearning

Adopted from: http://www.bobathconcept.eu/en/main-site/

There are several approaches considered to be neurodevelopmental techniques including the Bobath concept. The Bobath concept is a comprehensive, problem-solving treatment approach that focuses on motor recovery (e.g. function, movement and tone) of an individual's affected side after a lesion in the central nervous system (Michielsen et al. 2017). Prior to its introduction in the 1950's, stroke rehabilitation largely assumed a compensatory approach towards the unaffected side for rehabilitation (Kollen et al. 2009). The Bobath concept like other neurodevelopmental techniques relies on the tenets of neuroplasticity, in that motor recovery of the affected side is possible through individualised treatment plans that focus on how tasks are completed, facilitation of movements through therapeutic handling, movement analysis, modification of the environment and appropriate use of verbal cues from therapists (Michielsen et al. 2017).

The motor relearning programme employs practice of task-specific activities to remediate specific motor skills needed to perform that task. Motor tasks are practiced in context relevant environments to enhance sensory input and modulate performance (Pandian 2012).

A total of 12 RCTs were found that evaluated neurodevelopmental techniques for lower extremity motor rehabilitation. Three RCTs compared the Bobath concept to conventional therapy (Kilinc et al. 2016; Wang et al. 2005; Gelber et al. 1995). One RCT compared early and late Bobath therapy (Tang et al. 2014). Two RCTs compared the Bobath concept with task specific-practice and task specific-practice alone (Brock et al. 2011.; Mudie et al. 2002). Two RCTs compared motor relearning programmes to conventional or sham therapies (Chan et al. 2006; Dean et al. 1997). Three RCTs compared motor relearning programmes to the Bobath concept approach (Van Vliet et al. 2005; Pollock et al. 2002; Langhammer & Stanghelle 2000). One RCT was found that was a follow-up to the Langhammer & Stanghelle 2000 study (Langhammer & Stanghelle 2003).

The methodological details and results of all 12 RCTs are presented in Table 1.

Table 1. RCTs Evaluating Neurodevelopmental Techniques for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Bobath Concept Approach vs Conventional Therapy		
Kilinc et al. (2016) RCT (6) N$_{start}$=22 N$_{end}$=22 TPS=Chronic	E: Bobath approach C: Conventional techniques (strengthening, stretching, weight transfer, range of motion) Duration: 1hr/d, 3d/wk for 12wk	• Stroke Rehabilitation Assessment of Movement (-) • 10-Metre Walk Test (-) • Berg Balance Scale (-) • Timed Up & Go Test (-)
Wang et al. (2005) RCT (7) N$_{start}$=44 N$_{end}$=44 TPS=Chronic	E: Bobath approach C: Conventional Techniques (strengthening, stretching, weight transfer, range of motion) Duration: 40min/d, 5d/wk for 4wk	• Motor Assessment Scale (+exp) • Stroke Impact Scale (+exp)
Gelber et al. (1995) RCT (5) N$_{start}$=20 N$_{end}$=20 TPS=Chronic	E: Bobath approach C: Conventional techniques (passive range of motion, resistive exercises, functional tasks with affected side) Duration: 1hr/wk, 5d/wk, for 4wk	• Functional Independence Measure (-)
Early vs Late Bobath Approaches		
Tang et al. (2014) RCT (9) N$_{start}$=48 N$_{end}$=48 TPS=Acute	E: Early Bobath emphasizing sitting, standing, and walking C: Conventional Bobath Approach Duration: *Not reported*	• Berg Balance Scale (+exp) • Stroke Rehabilitation Assessment of Movement (+exp)
Bobath Concept Approach with Task-Specific Training vs Task-Specific Training		
Brock et al. (2011) RCT (7) N$_{start}$=26 N$_{end}$=23 TPS=Chronic	E: Bobath approach + Task practice C: Task practice Duration: 1hr/d, 6d/wk for 2wk	• Gait Velocity (+exp) • 6-Minute Walk Test (-) • Berg Balance Scale (-)
Mudie et al. (2002) RCT (8) N$_{start}$=40 N$_{end}$=26 TPS=Chronic	E1: Bobath approach E2: Task-specific training E3: Balance performance monitor feedback training C: Conventional therapy Duration: 30min/d, 5d/wk for 2 wk	• Barthel Index total score (-) • Mobility subsection of Barthel Index (-)
Motor Relearning Programmes vs Conventional Therapy or Sham		
Chan et al. (2006) RCT (7) N$_{start}$=52 N$_{end}$=52 TPS=Chronic	E: Motor relearning C: Conventional therapy Duration: 2hr/d, 3d/wk for 6wk	• Berg Balance Scale (+exp) • Modified Lawson IADL (+exp) • Functional Independence Measure (+exp) • Timed Up & Go Test (-)

Dean et al. (1997) RCT (5) N_{start}=20 N_{end}=20 TPS=Chronic	E: Motor relearning C: Sham training Duration: *Not Specified*	• Functional Reach Test (+exp) • 10-Metre Walk Test (-) • Sit-to-Stand Test (-)
Motor Relearning vs Bobath Concept Approach		
Van Vliet et al. (2005) RCT (7) N_{start}=120 N_{end}=109 TPS=Chronic	E: Motor relearning C: Bobath approach Duration: 30min/d, 4d/wk for 8wk	• Rivermead Motor Assessment (-) • Motor Assessment Scale (-)
Langhammer & Stanghelle (2003) 1 and 4yr follow-up to Langhammer & Stanghelle (2000) RCT (8) N_{start}=61 N_{end}=61 TPS=Acute	E: Motor relearning C: Bobath approach Duration: 2hr/d, 7d/wk for 1wk	• Motor Assessment Scale (-) • Sodring Motor Evaluation Scale (-) • Barthel activities of daily living index (-) • Berg Balance Scale (-)
Pollock et al. (2002) RCT (5) N_{start}=28 N_{end}=21 TPS=Chronic	E: Motor relearning programme C: Bobath approach Duration 1hr/d, 4d/wk for 3wk	• Weight distribution during sitting, standing, rising to stand, sitting down, or reaching (-)
Langhammer & Stanghelle (2000) RCT (8) N_{start}=61 N_{end}=61 TPS=Acute	E: Motor relearning C: Bobath approach Duration: 2hr/d, 7d/wk for 1wk	• Motor Assessment Scale (+exp) • Sodring Motor Evaluation Scale (+exp) • Barthel activities of daily living index (-)

Abbreviations and table notes: ANOVA=analysis of variance; ANCOVA=analysis of covariance; C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.

+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group

+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group

+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group

- indicates no statistically significant between groups differences at α=0.05

Conclusions about Neurodevelopmental Techniques

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**

1a	There is conflicting evidence about the effect of **motor relearning programmes** when compared to the **Bobath concept approach** for producing greater improvements in motor function.	3	Van villet 2005; Langhammer & Stanghelle 2003; Langhammer & Stanghelle 2000

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	The **Bobath concept approach** may not have a difference in efficacy when compared to **conventional therapy** for improving functional ambulation.	1	Kilinc et al. 2016
1b	The **Bobath concept approach with task practice** may not have a difference in efficacy compared to **task practice alone** for improving functional ambulation.	1	Brock et al. 2011
2	There is conflicting evidence about the effect of **motor relearning programmes** when compared to **conventional therapy** for improving functional ambulation.	1	Dean et al. 1997

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	The **Bobath concept approach** may not have a difference in efficacy when compared to **conventional therapy** for improving functional mobility.	1	Mudie et al. 2002
1b	**Early Bobath concept approach** may produce greater improvements in functional mobility when compared to **late Bobath Approachs.**	1	Tang 2014

BALANCE

LoE	Conclusion Statement	RCTs	References
1b	The **Bobath concept approach** may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	1	Kilinc et al. 2016
1b	**Early Bobath concept approach** may produce greater improvements in balance when compared to **late Bobath Approachs.**	1	Tang 2014
1b	The **Bobath concept approach with task practice** may not have a difference in efficacy when compared to **task practice** for improving balance.	1	Brock et al. 2011
1b	There is conflicting evidence about the effect of **motor relearning programmes** when compared to **conventional therapy** for improving balance.	2	Chan et al. 2006; Dean et al. 1997
1b	**Motor relearning programmes** may not have a difference in efficacy when compared to the **Bobath concept approach** for improving balance.	2	Langhammer & Stanghelle 2003; Pollock et al. 2002

GAIT			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	The **Bobath concept approach with task practice** may produce greater improvements in gait than **task practice alone**.	1	Brock et al. 2011

ACTIVITIES OF DAILY LIVING			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	There is conflicting evidence about the effect of the **Bobath concept approach** to improve activities of daily living when compared to **conventional therapy**.	3	Wang et al. 2005; Mudie et al. 2002; Gelber et al. 1995
1b	**Motor relearning programmes** may produce greater improvements in activities of daily living than **conventional therapy**.	1	Chan et al. 2006
1a	**Motor relearning programmes** may not have a difference in efficacy for improving activities of daily living when compared to the **Bobath concept approach**.	3	Van Vliet et al. 2005; Langhammer & Stanghelle 2003; Langhammer & Stanghelle 2000

Key Points

The literature is mixed regarding motor relearning programmes for improving motor function.

The literature is mixed regarding the Bobath concept approach for improving activities of daily living.

Sit to Stand Training

Adopted from: https://www.theptdc.com/how-to-assess-older-clients

Standing from a seated position is considered the most frequently performed functional task and is necessary for mobility (Alexander 2000). Sit-to-stand training is a targeted and specific intervention aimed at improving this particular movement, as well as at improving balance and muscle strength (Tung et al. 2010). Sit-to-stand training may improve outcomes through restoration of impairment, compensation for impairment, or substitution for impairment (Pollock et al. 2014).

Sit-to-stand training can be modified through providing an unstable support surface or through adjusting the positioning of the nonparetic limb to an asymmetric position, which can improve the weight-bearing rate of the paretic limb when compared to the symmetric foot position (Laufer et al. 2000)

Six RCTs were found evaluating sit-to-stand training for lower extremity motor rehabilitation. One RCT compared sit-to-stand training to conventional therapy (Tung et al. 2010). One RCT compared sit to stand training with a swiss ball to a stool (Rasheeda & Sivakumar, 2017). One RCT compared unstable sit-to-stand support surface to stable sit-to-stand support surface (Mun et al. 2014). Two RCTs compared sit-to-stand training with asymmetrical foot position to sit-to-stand training with symmetrical foot position (Liu et al. 2016; Fargalit et al. 2013). One RCT compared sit to stand training with auditory feedback to training with no feedback (Engardt & Knutsson, 1994).

The methodological details and results of all six RCTs are presented in Table 2.

Table 2. RCTs Evaluating Sit-to-Stand Training Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Sit-to-Stand Training vs Conventional Therapy		
Tung et al. (2010) RCT (6) N$_{start}$=32 N$_{end}$=32 TPS=Chronic	E: Sit-to-stand training C: Conventional rehabilitation Duration: 45min/d, 3d/wk for 4wk	• Directional control (+exp) • Hip extensor strength (+exp) • Berg Balance Scale (-)
Sit-to-Stand Training with Various Tools		
Rasheeda & Sivakumar (2017) RCT (7) N$_{start}$=74 N$_{end}$=67 TPS=Acute	E: Sit to Stand Training (with Swiss ball) C: Sit to Stand Training (with stool) Duration: 40 min/d for 10 days	• 30-Second Sit to Stand Test (-) • Weight Bearing (+exp) • Brunnstrom Recovery Stage (+exp)
Unstable Sit-to-Stand Support Surface vs Stable Sit-to-Stand Support Surface		
Mun et al. (2014) RCT (3) N$_{start}$=30 N$_{end}$=30 TPS=Chronic	E: Unstable support surface sit-to-stand training C: stable support surface sit-to-stand training Duration: 1hr/d, 4d/wk for 8wk	• Step length (+exp) • Berg Balance Scale (-) • Timed Up & Go Test (-) • 10-Meter Walk Test (-) • 6-Minute Walk Test (-)
Sit-to-stand Training with Asymmetrical Foot Position vs Sit-to-stand Training with Symmetrical Foot Position		
Liu et al. (2016) RCT (7) N$_{start}$=50 N$_{end}$=50 TPS=Subacute	E: Sit-to-stand training with asymmetrical foot position C: Sit-to-stand training with symmetrical foot position Duration: 1hr/d, 3d/wk for 4wk	• Berg Balance Scale (+exp) • Dynamic balance (+exp) • Static balance (+exp)
Farqalit et al. (2013) RCT (8) N$_{start}$=40 N$_{end}$=40 TPS=Chronic	E: Sit-to-stand training with asymmetrical foot position C: Sit-to-stand training with symmetrical foot position Duration: 30min/d, 3d/wk for 4wk	• Berg Balance Scale (+exp) • Timed Up & Go Test (+exp) • Sit-to-stand repetitions (+exp)
Auditory Feedback During Sit-to-Stand Training		
Engardt & Knutsson, (1994) RCT (5) N$_{start}$=40 N$_{end}$=36 TPS=Subacute	E: Continuous Auditory Feedback During Sit to Stand Training C: No Feedback During Sit to Stand Training Duration: 15min, 3x/d, 5d/wk, 6wks	• Peak Torque • Knee Flexion (-) • Knee Extension (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Sit-to-Stand Training

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Sit-to-stand training with various tools** may produce greater improvements in motor function than **conventional sit-to-stand training.**	1	Rasheeda & Sivakumar, 2017

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
2	**Unstable support surface sit-to-stand training** may not have a difference in efficacy when compared to **stable support sit-to-stand training** for improving functional ambulation.	1	Mun et al. 2014
1b	**Sit-to-stand training with various tools** may not have a difference in efficacy when compared to **conventional sit-to-stand training** for improving functional ambulation.	1	Rasheeda & Sivakumar, 2017

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Sit-to-stand training with asymmetrical foot position** may produce greater improvements in balance than **sit-to-stand training with symmetrical foot position.**	2	Liu et al. 2016; Fargalit et al. 2013
1b	**Sit-to-stand training** may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	1	Tung et al. 2010
2	**Unstable support surface sit-to-stand training** may not have a difference in efficacy when compared to **stable support surface sit-to-stand training** for improving balance.	1	Mun et al. 2014

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Sit-to-stand training** may produce greater improvements in gait than **conventional therapy.**	1	Tung et al. 2010
1b	**Sit-to-stand training with various tools** may produce greater improvements in gait than **conventional sit-to-stand training.**	1	Rasheeda & Sivakumar, 2017
2	**Unstable support surface sit-to-stand training** may produce greater improvements in gait than **stable support surface sit-to-stand training.**	1	Mun et al. 2014

MUSCLE STRENGTH			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Sit-to-stand training** may produce greater improvements in muscle strength than **conventional therapy.**	1	Tung et al. 2010
2	**Sit-to-stand training with auditory feedback** may not have a difference in efficacy when compared to **no feedback** for improving muscle strength.	1	Engardt & Knutsson,1995

Key Points

Sit-to-stand training may be beneficial for improving gait and muscle strength, but not functional ambulation.

Sit-to-stand training with asymmetrical foot position may be beneficial for improving balance.

Wheelchair Use

Adopted from http://www.neater.co.uk/neater-uni-chair/

Following stroke, particularly when associated with hemiplegia, individuals often require use of a wheelchair. Wheelchairs are usually self-propelling, but can also be manually propelled (Blower, 1988). The Neater Uni-Chair is a wheelchair designed for those with hemiplegia and thus only requires one hand to propel and one foot to steer (Mandy et al. 2013). While patients view the temporary use of a wheelchair positively, there is a lack of consensus between clinicians about the benefits of wheelchair use in stroke rehabilitation, particularly in the acute phase (Ashburn & Lynch, 1988; Engstrom, 1995).

The main advantage for early use of wheelchairs is related to support for the hemiplegic sides and greater functional improvement and independence. The popular treatment regimen described by Bobath discourages early self-propulsion in a wheelchair because it is believed to cause poor posture and increased tone on the hemiplegic side, and may have an adverse impact on long-term recovery (Ashburn & Lynch, 1988). These postulated negative impacts include increasing spasticity, encouraging one-sidedness, and reducing motivation to walk (Blower, 1988). While the use of wheelchairs following stroke is widespread, there is limited research evaluating them as an intervention.

Two RCTs were found evaluating wheelchairs as an assistive device for lower extremity motor rehabilitation. One RCT compared the Neater Uni-wheelchair attachment to a standard wheelchair (Mandy et al. 2015). One RCT compared encouraging self-propelling to discouraging self-propelling (Barrett et al. 2001).

The methodological details and results of the two RCTs are presented in Table 3.

Table 3. RCTs Evaluating Wheelchair Use for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Neater Uni-Wheelchair Attachment vs Standard Wheelchair		
Mandy et al. (2015) RCT (7) N$_{start}$=4 N$_{end}$=4 TPS=Chronic	E: Neater Uni-wheelchair attachment C: Standard wheelchair Duration: 6hr/d, 5d/wk for 6wk	• Motor Skills (+exp) • Activities of Daily Living (+exp) • Process Skills (-)
Encouraging vs Discouraging Self-Propulsion		
Barrett et al. (2001) RCT (7) N$_{start}$=40 N$_{end}$=40 TPS=Chronic	E: Encouraged to self-propel C: Discouraged from self-propulsion Duration: *Not Specified*	• Barthel Index (-) • Nottingham Extended ADL Scale (-) • General Health Questionnaire (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Wheelchair Use

MOTOR FUNCTION			
LoE	Conclusion Statement	RCTs	References
1b	The **Neater Uni-wheelchair attachment** may produce greater improvements in motor function than a **standard wheelchair.**	1	Mandy et al. 2015

ACTIVITIES OF DAILY LIVING			
LoE	Conclusion Statement	RCTs	References
1b	The **Neater Uni-wheelchair attachment** may produce greater improvements in activities of daily living than a **standard wheelchair.**	1	Mandy et al. 2015
1b	**Encouraging self-propelling** may not have a difference in efficacy compared to **discouraging self-propelling** for improving activities of daily living.	1	Barrett et al. 2001

Key Points

The Neater Uni-wheelchair may be beneficial for improving motor function and activities of daily living.

Trunk Training

Adopted from https://www.flintrehab.com/2016/core-exercises-for-stroke-patients/

Trunk impairment is common after stroke and is directly associated with balance and gait (Jijimol et al. 2013; Verheyden et al. 2006). Additionally, trunk control and balance while sitting are well known predictors in functional outcome and hospital stay after a stroke (Verheyden et al. 2006; Franchignoni et al. 1997).

Trunk training targets the trunk or "core muscles", which include those supporting the lumbo-pelvic-hip complex (Hibbs et al. 2008). An example of a specific trunk stabilization method is the abdominal drawing-in maneuver, which involves selectively activating the transversus abdominis (Hides et al. 2004). Core stability training typically involves a combination of multiple exercises that encourage deep muscle movement and selective pelvic exercises to produce a comprehensive core stabilization rehabilitation program (Haruyama et al. 2017).

13 RCTs were found evaluating trunk training for lower extremity motor rehabilitation. Eight RCTs compared trunk training to conventional therapy (Tirupatamma et al. 2019; Dubey et al. 2018; Büyükavci et al. 2016; Jung et al. 2014; Chung et al. 2013; Saeys et al. 2012; Verheyden et al. 2009; Dean et al. 2007). Three RCTs compared different trunk training modalities to conventional trunk training (Fujino et al. 2016; Lim et al. 2012; Karthikbabu et al. 2011).One RCT compared trunk training with robotics to conventional therapy (Min et al. 2020). One RCT compared trunk training to cognitive training (Van Criekinge et al. 2020).

The methodological details and results of all 13 RCTs are presented in Table 4.

Table 4. RCTs Evaluating Trunk Training Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Trunk Training vs Conventional Therapy		
Tirupatamma et al. (2019) RCT (4) N$_{start}$=50 N$_{end}$=30 TPS=Not Reported	E: Rocker Board Trunk Control Training C: Conventional Trunk Exercises Duration: 20min, 6d/wk, 6wks	• Berg Balance Score (+exp) • Functional Reach Test (+exp) • Timed Walking Test (+exp)
Dubey et al. (2018) RCT (5) N$_{Start}$=34 N$_{End}$=26 TPS=Chronic	E: Pelvic control training C: Conventional physiotherapy Duration: determined based on individual participant performance	• Fugl Meyer Assessment-Lower Extremity (+exp) • Hip muscle strength (+exp) • Isometric strength of hip extensors (+exp) • Isometric strength of flexors (+exp) • Isometric strength of abductors (+exp) • Isometric strength of adductors (+exp) • Angle of lateral pelvic tilt(+exp) • Angle of anterior pelvic tilt (-) • 10-Meter Walk Test (+exp) • Modified Barthel Index (-) • Trunk Impairment Scale (+exp)
Büyükavci et al. (2016) RCT (5) N$_{start}$=65 N$_{end}$=61 TPS=Subacute	E: Trunk training C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 4wk	• Berg Balance Scale (+exp) • Rivermead Mobility Index (+exp) • Brunnstrom Recovery Stage (+exp) • Functional Independence Measure (+exp)
Jung et al. (2014) RCT (7) N$_{start}$=18 N$_{end}$=18 TPS=Chronic	E: Trunk training, unstable surface C: Conventional rehabilitation Duration: 1hr/d, 4d/wk for 3wk	• Timed Up & Go Test (+exp) • Trunk Impairment Scale (+exp) • Trunk Reposition Error (+exp)
Chung et al. (2013) RCT (5) N$_{start}$=16 N$_{end}$=16 TPS=Chronic	E: Trunk training C: Conventional rehabilitation Duration: 30min/d, 4d/wk for 3wk	• Gait velocity (+exp) • Step length (-) • Stride length (-) • Cadence (-) • Timed Up & Go Test (-)
Saeys et al. (2012) RCT (7) N$_{start}$=33 N$_{end}$=33 TPS=Chronic	E: Trunk training C: Conventional rehabilitation Duration: *Not Specified*	• Trunk Impairment Scale (+exp) • Tinetti Test (+exp) • Four Test Balance Scale (+exp) • Berg Balance Scale (+exp) • Rivermead Motor Assessment (+exp) • Dynamic Gait Index (+exp)
Verheyden et al. (2009) RCT (6) N$_{start}$=33 N$_{end}$=33 TPS=Chronic	E: Trunk training C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 4wk	Trunk Impairment Scale: • Dynamic balance subscale (+exp) • Static balance subscale (-) • Coordination subscale (-) • Total score (-)
Dean et al. (2007) RCT (7) N$_{start}$=12 N$_{end}$=9 TPS=Acute	E: Sitting Reach Training C: Sham Training Duration: 30min, 5x/wk, 2wks	• Maximum Sitting Reach Distance (+exp) • Reaching Time (+exp) • 10-Meter Walking Test (-)
Comparing Various Trunk Training Modalities to Each Other		

Fujino et al. (2016) RCT (6) N_{start}=43 N_{end}=43 TPS=Acute	E: Trunk training, tilted platform C: Trunk training, flat platform Duration: 45min/d, 6d/wk for 3wk	• Trunk Control Test (+exp)
Lim et al. (2012) RCT (4) N_{start}=21 N_{end}=21 TPS=Chronic	E: Trunk training, enhanced (draw-in + bridge) C: Trunk training, standard (bridge) Duration: 35min/d, 4d/wk for 8wk	• Sway velocity (+exp) • Sway area (+exp) • Sway length (+exp)
Karthikbabu et al. (2011) RCT (8) N_{start}=30 N_{end}=24 TPS=Subacute	E: Trunk training, unstable surface C: Trunk training, stable surface Duration: 20min/d, 6d/wk for 10wk	• Brunel Balance Assessment (+exp) • Trunk Impairment Scale (+exp)
Trunk Training Combined with Robotics vs Conventional Therapy		
Min et al. (2020) RCT (7) N_{start}=38 N_{end}=19 TPS=Chronic	E: Trunk Training Using Trunk Stability Rehabilitation Robot Trainer (3DBT-33) C: Conventional Therapy Duration: 30min/d, 5d/wk, 4wks conventional control, 30min/d, 5d/wk, 4wks robot trunk training in experimental group	• Fugl-Meyer Lower Extremity (+exp) • Modified Barthel index (+exp) • Functional Ambulation category (-) • Berg Balance Scale (+exp) • Timed Up-and-Go (-)
Trunk Training vs Cognitive Training		

Van Criekinge et al. (2020)
RCT (7)
N_{start}=39
N_{end}=39
TPS=Subacute
	E: Trunk Training
	C: Cognitive Training
	Duration: 60min, 4x/wk, 4wks
		• Tinetti Performance-Oriented Assessment (+exp)
		  • Balance (-)
		  • Gait (+exp)
		• Step Length (+exp)
		• Step Time (-)
		• Step Width (+exp)
		• Stance Time (-)
		• Walking Speed (+exp)
		• Center of Movement (+exp)
		• Gait Deviation Index (-)
		• Trunk Impairment Scale (+exp)
		  • Static (-)
		  • Dynamic (+exp)
		  • Coordination (+exp)
		• Range of Motion
		  • Pelvis (3/6)
		  • Thorax (3/6)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Trunk Training

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
2	**Trunk training** may produce greater improvements in motor function than **conventional therapy.**	2	Dubey et al. 2018; Büyükavci et al. 2016
1b	**Trunk training with robotics** may produce greater improvements in motor function than **conventional therapy.**	1	Min et al. 2020

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **trunk training** to improve functional ambulation when compared to **conventional therapy.**	3	Dubey et al. 2018; Chung 2013; Dean 2007
1b	**Trunk training using robotics** may not have a difference in efficacy for producing greater improvements in functional ambulation when compared to **conventional therapy.**	1	Min et al. 2020

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Trunk training** may produce greater improvements in functional mobility than **conventional therapy.**	2	Büyükavci et al. 2016; Saeys 2012

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Trunk training** may produce greater improvements in balance than **conventional therapy.**	7	Tirupatamma 2019; Dubey et al. 2018; Büyükavci et al. 2016; Jung et al. 2014; Chung et al. 2013; Saeys et al. 2012; Verheyden 2009
1a	**Trunk training on a tilted or unstable surface or with draw in bridge** may produce greater improvements in balance than **trunk training on a stable surface or conventional trunk training.**	3	Fujino et al. 2016; Lim et al. 2012; Karthikbabu et al. 2011
1b	**There is conflicting evidence about the effect of trunk training using robotics** when compared to **conventional therapy** for improving balance performance.	1	Min et al. 2020
1b	**Trunk training** may produce greater improvements in balance than **cognitive training.**	1	Van Criekinge et al. 2020

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Trunk training** may not have a difference in efficacy for producing greater improvements in gait when compared to **conventional therapy.**	3	Dubey 2018; Chung et al. 2013; Saeys et al. 2012
1b	There is conflicting evidence about the effect of **trunk training** to improve gait when compared to **cognitive trianing**.	1	Van Criekinge et al. 2020

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
2	There is conflicting evidence about the effect of **trunk training** to improve activities of daily living when compared to **conventional therapy**.	2	Dubey et al. 2018; Büyükavci et al. 2016
1b	**Trunk training with robotics** may produce greater improvements in performance of activities of daily living when compared to **conventional therapy.**	1	Min et al. 2020

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **trunk training** to improve range of motion when compared to **cognitive training.**	1	Van Criekinge et al. 2020

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
2	**Trunk training** may produce greater improvements in muscle strength than **conventional therapy.**	1	Dubey et al. 2018

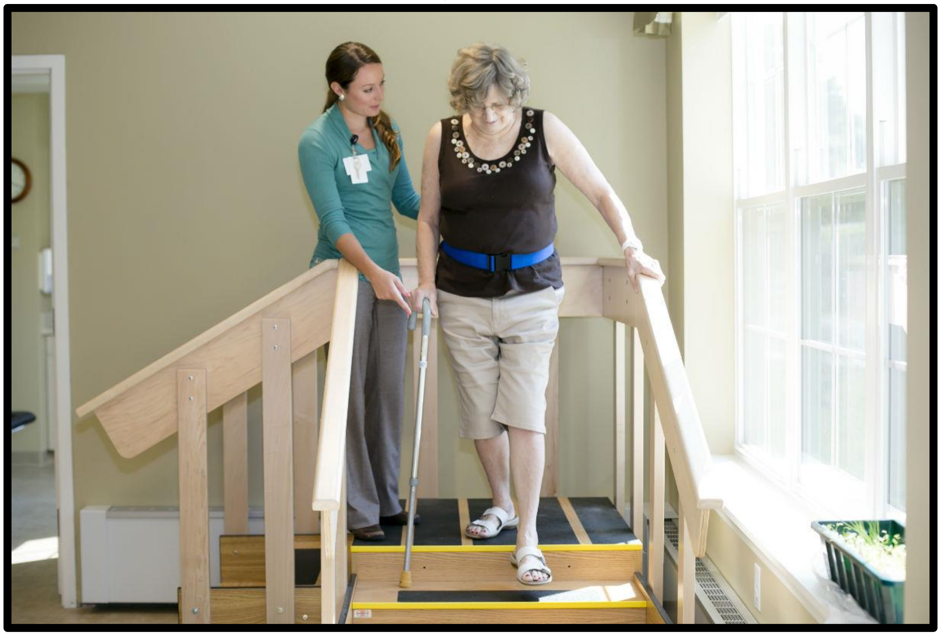
Key Points

Trunk training may be beneficial for improving balance of lower limb rehabilitation after stroke.

The literature is mixed concerning trunk training’s ability to improve functional ambulation.

Trunk training may not be beneficial for improving gait of lower limb rehabilitation after stroke.

Task-Specific Training



Adopted from: http://berkshireplace.com/programs-services/skilled-nursing-rehabilitation/

Task-specific training, also referred to as task-oriented, goal-directed, or functional task practice, involves therapy in which patients perform practical motor tasks that would be used in their everyday life, such as walking up the stairs. Tasks should be relevant, repetitive, and should be designed to progress towards performance of the whole task while being reinforced with feedback (Hubbard et al. 2009).

Task-specific circuit training is a tailored intervention program targeting balance, gait, strength, aerobic capacity, and range of movement. The training involves performing various exercises at different stations and is often performed in groups. In addition to lower limb recovery, benefits associated with circuit training include peer support and social interaction, as well as more efficient use of therapy staff.

21 RCTs were found evaluating task-specific training for lower extremity motor rehabilitation. Seven RCTs compared task-specific training to conventional therapy or education (Kuberan et al. 2017; Park & Won, 2017; Kim et al. 2016; Kwon et al. 2015; van de Port et al. 2012; Verma et al. 2011; Sherrington et al. 2008). Four RCTs compared stair or ramp training to flat surface training (Park et al. 2015; Seo & Kim 2015; Lee & Seo 2014; Seo et al. 2014). Five RCTs compared various task-specific training modalities (Yoon-Hae et al. 2020; Chat et al. 2016; Renner et al. 2016; Marin et al. 2013; Kluding et al. 2008). Two RCTs compared high and low task-specific training intensities (Outermans et al. 2010; Wellwood et al. 2004). Two RCTs compared task-oriented training with a tilt table to tilt table alone (Kim et al. 2015a; Kim et al. 2015b). One RCT compared task specific circuit training to group education and activities (Mudge et al. 2009).

The methodological details and results of all 21 RCTs are presented in in Table 5.

Table 5. RCTs Evaluating Task-Specific Training Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) **Study Design (PEDro Score)** **Sample Size$_{start}$** **Sample Size$_{end}$** **Time post stroke category**	**Interventions** **Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures** **Result (direction of effect)**
Task-Specific Training vs Conventional Therapy or Educational Classes		
Kuberan et al. (2017) RCT (5) N_{Start}=26 N_{End}=26 TPS=Chronic	E: Task-oriented training C: Conventional physical therapy Duration: 45-60min/d. 5d/wk for 3wk	• Dynamic Gait Index (-) • Timed Up and Go Test (+exp) • Fall Efficacy Scale (+exp)
Park & Won. (2017) RCT (5) N_{start}=28 N_{end}=26 TPS=Chronic	E: Conventional Physical Therapy + Task-Oriented Training (with altered sensory input) C: Conventional Physical Training Duration: Physical Therapy 5d/wk, 4wks + Task-oriented Training 1hr/d, 3d/wk, 4wks	• Berg Balance Scale (+exp) • Activities-Specific Balance Confidence Scale (-) • Limit of Stability (-)
Kim et al. (2016) RCT (7) N_{start}=20 N_{end}=20 TPS=Subacute	E: Task-specific circuit training C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 4wk	• Fugl-Meyer Assessment (-) • Berg Balance Scale (-) • 6-Minute Walk Test (-) • Modified Barthel Index (-)
Kwon et al. (2015) RCT (5) N_{start}=44 N_{end}=42 TPS=Subacute	E: Task-specific treadmill training C: Conventional treadmill training Duration: 30min/d, 5d/wk for 8wk	• Timed Up & Go Test (+exp) • 6-Minute Walk Test (+exp) • Gait (+exp)
van de Port et al. (2012) RCT (7) N_{start}=250 N_{end}=237 TPS=Chronic	E: Task-specific circuit training C: Conventional rehabilitation Duration: 90min/d, 2d/wk for 12 wk	• 6-Minute Walk Test (+exp) • 5-Metre Walk Test (+exp) • Modified Stairs Test (+exp) • Timed Up & Go Test (-) • Rivermead Mobility Index (-) • Functional Functional ambulation Category (-) • Stroke Impact Scale (-) • Nottingham Extended ADL (-)
Verma et al. (2011) RCT (8) N_{start}=30 N_{end}=30 TPS=Subacute	E: Task-specific circuit training C: Conventional rehabilitation Duration: 40min/d, 7d/wk for 2wk	• Functional Functional ambulation Category (+exp) • Rivermead Visual Gait Assessment (+exp) • Cadence (+exp) • Comfortable gait speed (+exp) • 6-minute Walk Test (+exp)

Sherrington et al. (2008)
RCT (7)
N_{start}=173
N_{end}=159
TPS=Not Reported
	E: Task-Specific Circuit-Style Exercise Training
	C: Sham
	Duration: 1 hr/d, 2 d/wk for 5 wks
		• Step Test (+exp)
		• Balance Scale
		    • Semi-tandem Stance (-)
		    • Tandem Stance (-)
		    • Sit-to-Stand
		    • Rate (+exp)
		    • Minimum Height (-)
		• 6-Metre Gait Velocity (+exp)
		• 6-Minute Distance (+exp)
		• Knee extension (-)
		• Knee flexion (-)

Stair or Ramp Training vs Flat Surface Gait Training		
Park et al. (2015) RCT (5) N_{start}=24	E: Stair gait training C: Flat surface gait training Duration: 15min/d, 3d/wk for 8wk	• Rectus Femoris Strength (+exp) • Tibialis Anterior Strength (+exp) • Gastrocnemius Strength (-)

N_{end}=24 TPS=Chronic		- Timed Up & Go Test (-) - Step Length (-)
Seo & Kim (2015) RCT (4) N_{start}=20 N_{end}=20 TPS=Chronic	E: Ramp gait training C: Flat surface gait training Duration: 1hr/d, 3d/wk for 4wk	- Berg Balance Scale (+exp) - Timed Up & Go Test (-) - Functional Reach Test (-)
Lee & Seo (2014) RCT (4) N_{start}=40 N_{end}=40 TPS=Chronic	E: Stair gait training C: Flat surface gait training Duration: 1hr/d, 5d/wk for 4wk	- Weight bearing (+exp) - Limit of stability (+exp) - Romberg Test (+exp)
Seo et al. (2014) RCT (5) N_{start}=30 N_{end}=28 TPS=Chronic	E: Stair gait training C: Flat surface gait training Duration: 30min/d, 5d/wk for 10wk	- Romberg Test (+exp) - Limit of stability (-) - Weight bearing (-)
Task-Specific Training Modalities		
Yoon-Hee et al. (2020) RCT (8) N_{start}=20 N_{end}=20 TPS=Chronic	E1: 15cm Stair Height Training E2: 10cm Stair Height Training nan Duration: 30min, 4x/wk 6wks	- Berg Balance Scale (-) - Timed Up and Go Test (-) - Muscle Activity (exp1)
Cha et al. (2016) RCT (5) N_{start}=25 N_{end}=20 TPS=Chronic	E: Mirror therapy + task-oriented training C: Task oriented training Duration: 30min/d, 2x/d, 5x/wk, 4wks	- Berg Balance Scale (+exp) - Timed Up-and-Go (+exp) - Balance Index (+exp) - Dynamic Limits of Stability (+exp)
Renner et al. (2016) RCT (7) N_{start}=73 N_{end}=68 TPS=Subacute	E: Group task-specific training C: Individual task-specific training Duration: 90min/d, 5d/wk for 6wk	- Stroke Impact Scale (-) - 6-Minute Walk Test (-) - 10-Metre Walk Test (-) - Timed Up & Go Test (-) - Stair Climb (-)
Marin et al. (2013) RCT (8) N_{start}=20 N_{end}=20 TPS=Chronic	E: Task-Specific Training + Whole-Body Vibration Treatment (With an increase in frequency, sets, and time) C: Task-Specific Training + Sham Vibration Duration: 1 session/wk, 7 wks & 2 sessions/wk, 5 wks	- Berg Balance Scale (-) - Muscle Strength (-)
Kluding et al. (2008) RCT (5) N_{start}=17 N_{end}=16 TPS=Subacute	E: Task-specific training + Ankle joint mobilizations C: Task-specific training Duration: 45min/d, 2d/wk for 8wk	- Weight-bearing symmetry (+exp) - Ankle range of motion (-) - Ankle kinematics (-) - Gait (-)
High Intensity Task-Specific Training vs Conventional Therapy or Low Intensity Training		
Outermans et al. (2010) RCT (7) Nstart=44 Nend=43 TPS=Subacute	E: High Intensity Task-Specific Training C: Conventional rehabilitation Duration: 45min/d, 5d/wk for 4wk	- 10-Metre Walk Test (+exp) - 6-Minute Walk Test (+exp) - Berg Balance Scale (-) - Functional Reach Test (-)

Wellwood et al. (2004) RCT (7) N_{start}=70 N_{end}=65 TPS=Chronic	E: Task-specific training, higher dosage C: Task-specific training, lower dosage Duration: 60-80min/d, 5d/wk for 4wk	• River Mobility Index (-) • Motricity Index (-) • Barthel Index (-) • Nottingham Extended ADL Index (-)
Task Oriented Training with Tilt Table vs Tilt Table Alone		
Kim et al. (2015) RCT (6) N_{start}=39 N_{end}=39 TPS=Acute	E1: Tilt Table with Task-Oriented Training E2: Tilt Table C: Conventional Control Duration: 20min/d, 3wks	E1 vs E2 • Barthel Index (+exp1) • National Institutes of Health Stroke Scale (-) • Fugl Meyer Assessment (+exp1) E1/E2 vs C • Barthel Index (+exp1,+exp2) • National Institutes of Health Stroke Scale (+exp1,+exp2) • Fugl Meyer Assessment (+exp1,+exp2)
Kim et al. (2015) RCT (5) N_{start}=37 N_{end}=30 TPS=Chronic	E1: Title Table with Task-Oriented Training (one leg fastened) E2: Tilt Table (one leg fastened) C: Standard Tilt Table (both legs fastened) Duration: 30 min/d, 5d/wk, 3wks routine therapy & 20 min/d tilt table	E1 vs E2 • Muscle Strength (+exp2) • Gait Velocity (+exp2) • Cadence (+exp2) • Stride Legnth (+exp2) • Gait Symmetry (+exp2) • Double Support Phase (+exp2) E1/E2 vs C • Muscle Strength (+exp1,+exp2) • Gait Velocity (+exp1,+exp2) • Cadence (+exp1,+exp2) • Stride Length (+exp2) • Gait Symmetry (+exp1,+exp2) • Double Support Phase (+exp1,+exp2)
Task-Specific Circuit Training vs Group Activities		
Mudge et al. (2009) RCT (7) N_{start}=60 N_{end}=50 TPS=Chronic	E: Task-specific circuit training C: Social and educational classes Duration: 1hr/d, 3d/wk for 4wk	• 6-Minute Walk Test(+exp) • 10-Metre Walk Test (-) • Rivermead Mobility Index (-) • Activities-Specific Balance Confidence Scale (-) • Physical Activity & Disability Scale (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Task-Specific Training

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Task-specific training** may not have a difference in efficacy compared to **conventional therapy** for improving motor function.	1	Kim et al. 2016
1b	**Task-specific training with tilt table** may produce greater improvements in motor function when compared to **tilt tables** alone.	1	Kim et al. 2015a

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Task-specific training** may produce greater improvements in functional ambulation when compared to **conventional therapy**.	5	Kim et al. 2015; Kim et al. 2015; Kwon et al. 2015; Van de Port et al. 2012; Verma et al. 2011
1b	A **higher intensity of task-specific training** may produce greater improvements in functional ambulation when compared to a **conventional therapy.**	1	Outermans et al. 2010
1b	**Group task-oriented training** may not have a difference in efficacy compared to **individual task-oriented training** for improving functional ambulation.	1	Renner et al. 2016
1b	There is conflicting evidence about the effect of **task-specific training** for improving functional ambulation when compared to **social education classes**.	1	Mudge et al. 2009

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Task-specific training** may not have a difference in efficacy compared to **conventional therapy or education** for improving functional mobility.	1	Van de Port et al. 2012
1b	A **higher dose of task-specific training** may not have a difference in efficacy compared to a **lower dose of task-specific training** for improving functional mobility.	1	Wellwood et al. 2004
1b	**Task-specific circuit training** may not have a difference in efficacy when compared to **social education classes** for improving functional mobility.	1	Mudge et al. 2009

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **task-specific training** to improve balance when compared to **conventional therapy.**	5	Kuberan et al. 2017; Park & Won 2017; Kim et al. 2016; Kwon et al. 2015; Van de Port et al. 2012

1b	**Upper limb task-specific training with symmetric abdominal muscle contraction** may produce greater improvements in balance than **general upper limb task-specific training**.	1	Lee & Choi 2017
2	**Task-oriented training with ankle joint mobilization** may produce greater improvements in balance than **task-oriented training.**	1	Kluding et al. 2008
2	**Task-oriented training mirror therapy** may produce greater improvements in balance than **task-oriented training.**	1	Cha et al. 2016
1b	**Task-oriented training with whole body vibration** may produce greater improvements in balance than **task-oriented training.**	1	Marin et al. 2013
2	There is conflicting evidence about the effect of **stair or ramp training** to improve balance when compared to **flat surface training.**	4	Park et al. 2015; Seo & Kim 2015; Lee & Seo 2014; Seo et al. 2014
1b	**Group task-oriented training** may not have a difference in efficacy compared to **individual task-oriented training** for improving balance.	1	Renner et al. 2016
1b	**High intensity task specific** training may not have a difference in efficacy compared to **conventional therapy** for improving balance.	1	Outermans et al. 2010
1b	**Task-specific circuit training** may not have a difference in efficacy when compared to **social education classes** for improving balance.	1	Mudge et al. 2009

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**Task-specific training** may produce greater improvements in gait than **conventional therapy.**	4	Kuberan et al. 2017; Kwon et al. 2015; Verma et al. 2011; Sherrington et al. 2008
2	**Stair training** may not have a difference in efficacy compared to **flat surface training** for improving gait.	1	Park et al. 2015
2	**Task-specific training with ankle joint mobilization** may not have a difference in efficacy compared to **task-specific training** for improving gait.	1	Kluding et al. 2008
1b	**Task-specific training with tilt table** may not have a difference in efficacy for improving gait when compared to **tilt tables.**	1	Kim et al. 2015b

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Task-specific training** may not have a difference in efficacy compared to **conventional therapy** for improving activities of daily living.	2	Kim et al. 2016; Van de Port et al. 2012;

1b	**A higher dose of task-specific training** may not have a difference in efficacy compared to a **lower dose of task-specific training** for improving activities of daily living.	1	Wellwood et al. 2004
1b	**Task-specific training with tilt table** may produce greater improvements in performance on activities if daily living when compared to **tilt tables** alone.	1	Kim et al. 2015a
1b	**Task-specific circuit training** may not have a difference in efficacy when compared to **social education classes** for improving performance on activities of daily living.	1	Mudge et al. 2009

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Task-specific training** may not have a difference in efficacy compared to **conventional therapy** for improving range of motion.	1	Kim et al. 2016
2	**Task-specific training with ankle joint mobilization** may not have a difference in efficacy compared to **task-specific training** for improving range of motion.	1	Kluding et al. 2008

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
2	There is conflicting evidence about the effect of **stair training** to improve muscle strength when compared to **flat surface training**.	1	Park et al. 2015
1b	A **higher dose of task-specific training** may not have a difference in efficacy compared to a **lower dose of task-specific training** for improving muscle strength.	1	Wellwood et al. 2004
1b	**Task-specific training with tilt table** may not have a difference in efficacy for improving muscle strength when compared to **tilt tables.**	1	Kim et al. 2015b

PROPRIOCEPTION

LoE	Conclusion Statement	RCTs	References
2	**Stair training** may produce greater improvements in proprioception than **flat surface training.**	2	Lee & Seo 2014; Seo et al. 2014

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1b	**Task-specific training** may not have a difference in efficacy compared to **conventional therapy** for improving stroke severity.	1	Van de Port et al. 2012

1b	**Group task-specific training** may not have a difference in efficacy compared to **individual task-specific training** for improving stroke severity.	1	Renner et al. 2016
1b	**Task-specific training with tilt table** may not have a difference in efficacy for improving stroke severity when compared to **tilt tables.**	1	Kim et al. 2015a

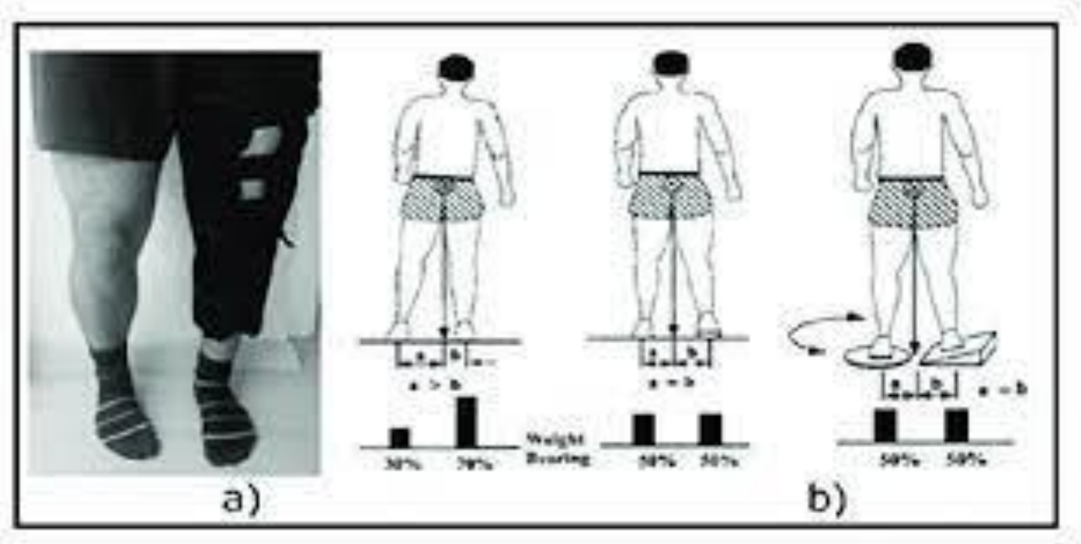
Key Points

Task-specific training may be beneficial for improving functional ambulation and gait.

The literature is mixed regarding the effectiveness of task-specific training for improving balance.

The literature is mixed regarding the effectiveness stair or ramp training to improve balance when compared to flat surface training.

Constraint-Induced Movement Therapy (CIMT)



Adopted from: https://www.researchgate.net/figure/Constraint-method-of-the-nonparetic-lower-limb-a-Whole-leg-orthosis-b-addition-of-a_fig1_320587918

CIMT of the lower extremity (CIMT-LE) draws many aspects of CIMT of the upper extremity. As in CIMT for the upper extremity, CIMT-LE is designed to overcome the tendency among hemiparetic patients to avoid the use of their paretic limb, a process termed “learned non-use”. Despite similarities of protocols used in CIMT such as motor activity logs, supervised training and shaping, there are key differences implemented in CIMT for the LE. Unique to the protocols used during CIMT-LE, is the omission of restraint of the stronger limb. This is rationalized by the risk of falls and related injuries. In addition, both lower limbs are required to produce a natural gait cycle and restraint of one limb may hinder shaping interventions aimed at promoting gait and functional ambulation (dos Anjos et al. 2020).

Six RCTs were found evaluating constraint-induced movement therapy for lower extremity motor rehabilitation. Three RCTs compared mCIMT to conventional therapy or neurodevelopmental techniques. (Candan & Livanelioglu, 2019; Candan et al. 2017; Zhu et al. 2016). One RCT compared mCIMT ro forced use therapy (Fuzaro et al 2012). One RCT compared virtual reality with CIMT to virtual reality or conventional therapy alone (Choi et al. 2017). One RCT compared robotic training with CIMT to robotic training alone (Bonnyaud et al. 2014).

The methodological details and results of all six RCTs are presented in Table 6.

Table 6. RCTs Evaluating CIMT Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Task-Specific Training vs Conventional Therapy or Educational Classes		

Candan & Livanelioglu. (2019)
RCT (6)
N_{start}=33
N_{end}=30
TPS=Chronic
	E: mCIMT
	C: Neurodevelopmental Techniques
	Duration: 120min/d, 5x/wk, 2wks
		• Motricity Index (-)
		• Stroke Specific Quality of Life (+exp)
		  • Mobility (+exp)
		  • Energy (-)
		  • Self Care (+exp)
		  • Vision (-)
		  • Language
		  • Work/Productivity (-)
		  • Upper Extremity Function (-)
		  • Thinking (+exp)
		  • Personality (-)
		  • Mood (+exp)
		  • Family (+exp)
		  • Social Roles (+exp)
		• Stroke Impact Scale (-)

Candan et al. (2017) RCT (7) N_{start}=33 N_{end}=30 TPS=Other: Chronic	E: mCIMT on paretic lower limb C: Neurodevelopmental Techniques Duration: 120min/day, 5d/wk, 2wks	• Berg Balance Scale (+exp) • Postural Symmetry Ratio (+exp) • Step Length Ratio (+exp) • Cadence (+exp) • Walking velocity (+exp) • Functional Ambulation Classification (+exp)
Zhu et al. (2016) RCT (5) N_{start}=22 N_{end}=22 TPS=Subacute	E: mCIMT C: Conventional Rehabilitation Duration: 45min conventional + 2hrs mCIMT, 5x/wk, 4wks	• Velocity (+exp) • Step Width (+exp) • Step Length (-) • Swing Time (-)
mCIMT vs Forced Use Therapy		
Fuzaro et al. (2012) RCT (6) N_{start}=37 N_{end}=37 TPS=Chronic	E: mCIMT C: Forced use therapy Duration: 23hr/day, 5d/wk, 4ks restraint in both FUT and mCIMT groups + 50min/d, 5d/wk, 4wks exercise training in mCIMT group	• Berg Balance Scale (-) • 10-meter walk test (-) • Timed Up-and-Go (-)
VR Combined with CIMT vs VR or Conventional Training		
Choi et al. (2017) RCT (6) N_{Start}=36 N_{End}=36 TPS=Chronic	E1: Game-based (Wii balance board) CIMT E2: General game-based training program C: Traditional physical therapy Duration: 30min/d. 3d/wk for 4wk	• Functional Reach Tests (-) • Timed Up and Go Test (-) • Sway Mean Velocity (-) E1/E2 vs C: • Modified Functional Reach Tests (+E1/E2) E1 vs. E2/C • Anteroposterior Center of Pressure (+E1) • Sway Area (+E1) • Symmetric Weight Bearing (+E1) E1 vs. C • Medial-Lateral Center of Pressure (+E1)
Robotic Training Combined with Restraint vs Robotic Training		
Bonnyaud et al. (2014) RCT (4) N_{start}=26 N_{end}=26 TPS=Chronic	E: Lokomat Gait Training + Restraint of Non-paretic Limb C: Lokomat Gait Training Duration: Single Session - 20min	• Spatiotemporal Gait Analysis (-) • Kinematic Gait analysis (-) • Kinetic Gait Analysis (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.

+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about CIMT

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**mCIMT** may not have a difference in efficacy compared to **conventional therapy** for improving motor function.	1	Candan & Livanelioglu 2019

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	**mCIMT** may not have a difference in efficacy for improving functional ambulation when compared to **forced-use therapy.**	1	Fuzaro et al. 2012

BALANCE

LoE	Conclusion Statement	RCTs	References
1b	**mCIMT** may produce greater improvements in balance than **conventional therapy.**	1	Candan et al. 2017
1b	**mCIMT** may not have a difference in efficacy for improving balance when compared to **forced-use therapy.**	1	Fuzaro et al. 2012
1b	**mCIMT with VR** may not have a difference in efficacy for improving balance when compared to **conventional therapy.**	1	Choi et al. 2017

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**mCIMT** may produce greater improvements in gait than **conventional therapy.**	2	Candan et al. 2017; Zhu et al. 2016
1b	**mCIMT with VR** may produce greater improvements in gait than **conventional therapy.**	1	Candan et al. 2017
2	**Lokomat training with restraint** may not have a difference in efficacy for improving gait when compared to **lokomat training** alone.	1	Bonnyaud et al. 2014

ACTIVITIES OF DAILY LIVING

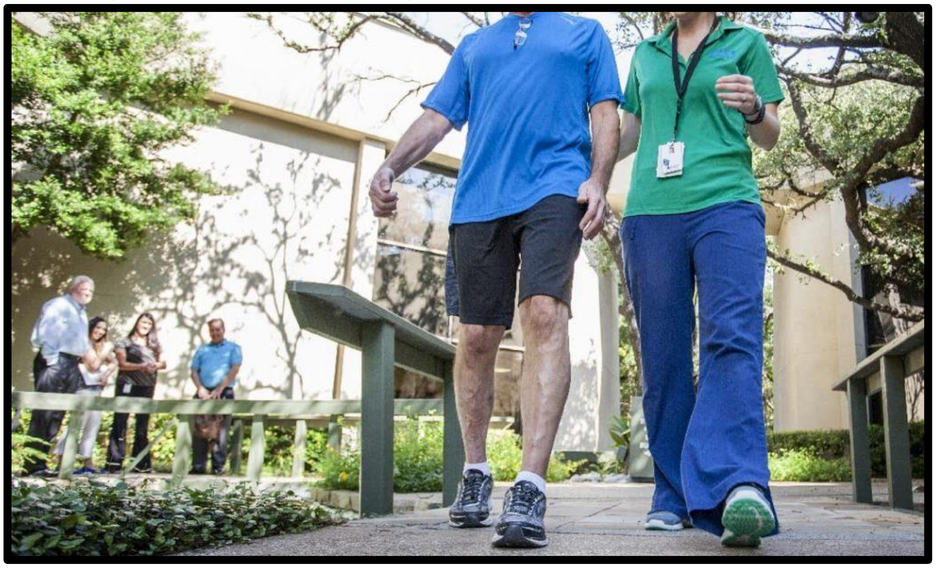
LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **mCIMT** to improve performance of activities of daily living when compared to **conventional therapy.**	1	Candan & Livanelioglu 2019

Key Points

mCIMT may be beneficial for improving gait and balance following stroke

More research is needed to draw conclusions about the effect of mCIMT on other aspects of post-stroke rehabilitation.

Overground Walking



Adopted from: https://www.paterehab.com/about-abi/traumatic-brain-injury-tbi/

Gait training is one of the most common interventions provided following a stroke (Jette et al. 2005). Overground gait training includes walking and related exercises with or without cueing from a physical therapist but does not include use of technology aids such as those used to administer body weight support (Pappas & Salem 2009).

10 RCTs were found evaluating overground walking for lower extremity motor rehabilitation. Six RCTs compared overground walking to conventional therapy or massage therapy (Bergmann et al, 2018; Shen et al. 2015; Kim et al. 2014; Gordon et al. 2013; Bonnyaud et al. 2013a; Bonnyaud et al. 2013b.). One RCT compared overground walking with home-based cycling (Mayo et al. 2013). One RCT compared bent knee gait training o conventional care (Dalal et al. 2018). Two RCTs compared backward walking training to standing practice or conventional care (Rose et al. 2017; Yang et al. 2005).

The methodological details and results of all 10 RCTs are presented in Table 7.

Table 7. RCTs Evaluating Overground Walking Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Overground Walking vs Conventional Therapy, Treadmill Training or Massage		
Bergmann et al. (2018) RCT (6) N$_{start}$=27 N$_{end}$=20 TPS=Subacute	E: Overground gait training C: Treadmill gait training Duration: 20min, single session	• Speed (-) • Cadence (-) • Percentage of single limb support phase, paretic and nonparetic sides (-) • Step length, paretic and nonparetic sides (-) • Peak hip flexion/extension (-) • Peak knee extension/flexion (-) • Peak ankle dorsi/plantar flexion (-) • Vertical ground reaction force (-) • Peak propulsion (-) • Breaking on paretic, nonparetic sides (-)
Shen et al. (2015) RCT (6) N$_{start}$=40 N$_{end}$=40 TPS=Subacute	E: Overground Walking (Intensified Walk Training) C: Conventional Therapy Duration: 40-60 min/d, 5-6 d/wk for 5 wks	• Fugl-Meyer Assessment (+exp) • Modified Barthel Index (+exp) • 6-minute Walking Distance (+exp)
Kim et al. (2014) RCT (8) N$_{start}$=26 N$_{end}$=26 TPS=Chronic	E: Community-based walking program C: Conventional rehabilitation Duration: 30min/d, 3d/wk for 8wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Community Gait Assessment (+exp)
Gordon et al. (2013) RCT (7) Nstart=128 Nend=116 TPS=Chronic	E: Aerobic training (overground walking) C: Massage Duration: 30min/d, 3d/wk for 12wk	• 6-Minute Walk Test (+exp) • Motricity Index (-)
Bonnyaud et al. (2013) RCT (4) N$_{start}$=26 N$_{end}$=26 TPS=Other: Chronic	E: Overground gait training C: Treadmill gait training Duration: 20min, single session	• Speed (-) • Cadence (-) • Percentage of single limb support phase, paretic and nonparetic sides (-) • Step length, paretic and nonparetic sides (-) • Peak hip flexion/extension (-) • Peak knee extension/flexion (-) • Peak ankle dorsi/plantar flexion (-) • Vertical ground reaction force (-) • Peak propulsion (-) • Breaking on paretic, nonparetic sides (-)
Bonnyaud et al. (2013) RCT (5) N$_{start}$=60 N$_{end}$=60 TPS=Subacute	E1: Overground gait training with mass E2: Treadmill gait training with mass C1: Overground gait training without mass C2: Treadmill gait training without mass Duration: 20min/d, 1 session	• Speed (-) • Cadence (-) • Step length paretic, nonparetic sides (-) • Peak hip flexion paretic, nonparetic sides (-) • Peak knee flexion paretic, nonparetic sides (-) • Peak ankle dorsiflexion paretic, nonparetic sides (-) • Vertical ground reaction force paretic, nonparetic sides (-) • Peak propulsion paretic, nonparetic sides (-) • Peak breaking paretic side (-)

		- Peak breaking nonparetic side (+exp2 vs con2)
Home Based Overground Walking vs Home based Cycling		
Mayo et al. (2013) RCT (6) N_{start}=87 N_{end}=65 TPS=Chronic	E1: Home-based exercise program (cycle ergometer) E2: Home-based exercise program (overground walking) Duration: 30min/d, 5d/wk for 3wk	- 6-Minute Walk Test (-)
Bent Knee (Prowling) Gait Training vs Conventional Therapy		
Dalal et al. (2018) RCT (8) N_{start}=32 N_{end}=29 TPS= Not reported	E: Bent Knee Gait training (prowling) with Proprioceptive Training C: Conventional Care Duration: 15-20min Prowling and Proprioceptive training, 60min Conventional Physiotherapy - 6 sessions	- Hyperextension (+exp) - Dorsifelxion (+exp) - Time taken (-) - Wisconsin Gait Scale (+exp)
Backward Walking Training vs Standing Practice or Conventional Therapy		
Rose et al. (2017) RCT (4) N_{start}=16 N_{end}=10 TPS=Acute	E: Backward walk training C: Standing balance training Duration: 30min/d for 8d	- Five-Meter Walk Test (+exp) - 3-Meter Backward Walk Test (+exp) - Activities-Specific Balance Confidence Scale (-) - Berg Balance Scale (-) - Sensory Organization Test (-) - Function Independence Measure-Mobility (-)
Yang et al. (2005) RCT (6) N_{start}=25 N_{end}=25 TPS=Acute	E: Backward Walking Training + Conventional Rehabilitation C: Conventional Rehabilitation Duration: rehab 40min, backwards walking 30min, 3x/wk, 3wks	- Velocity (+exp) - Cadence (-) - Stride Length (+exp) - Gait Cycle (-) - Symmetry Index (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Overground Walking

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Overground walking** may produce greater improvements in motor function when compared to **conventional therapy.**	1	Shen et al. 2015

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	**Overground walking** may produce greater improvements in functional ambulation when compared to **conventional therapy or massage.**	3	Shen et al. 2015; Kim et al. 2014; Gordon et al. 2013
1b	**Home-based overground walking** may not have a difference in efficacy in improving functional ambulation when compared to **home-based cycle ergometry.**	1	Mayo et a. 2013

2	**Backwards walking training** may produce greater improvements in functional ambulation when compared to **standing balance training**.	1	Rose et al., 2017

BALANCE

LoE	Conclusion Statement	RCTs	References
2	**Backwards walking training** may not have a difference in efficacy when compared to **standing balance training** for improving balance.	1	Rose et al. 2005

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**Overground gait training** may not have a difference in efficacy when compared to **conventional therapy** for improving gait.	4	Bergmann et al. 2018; Kim et al. 2014; Bonnyaud et al. 2013a; Bonnyaud et al. 2013b
1b	**Bent knee training** may produce greater improvements in gait when compared to **conventional therapy.**	1	Dalal et al. 2018
1b	**Backwards walking training** may not have a difference in efficacy when compared to **conventional rehabilitation** for improving gait.	1	Yang et al. 2005

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1b	**Overground gait training** may produce greater improvements in performance on activities of daily living than **conventional therapy.**	1	Shen et al. 2015
2	**Backwards walking training** may not have a difference in efficacy when compared to **standing balance training** for improving performance on activities of daily living.	1	Rose et al. 2005

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Overground gait training** may not have a difference in efficacy when compared to **conventional therapy** for range of motion.	3	Bergmann et al. 2018; Bonnyaud et al. 2013a; Bonnyaud et al. 2013b
1b	**Bent knee training** may produce greater improvements in range of motion when compared to **conventional therapy.**	1	Dalal et al. 2018

MUSCLE STRENGTH			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Overground gait training** may not have a difference in efficacy when compared to **massage therapy** for improving muscle strength.	1	Gordon et al. 2013

Key Points

Overground walking may be beneficial for improving motor function and functional ambulation.

Overground waking may not be beneficial for improving other aspects of stroke rehabilitation.

Cycle Ergometer Training

Adopted from: https://www.verywellfit.com/best-indoor-cycling-bikes-4160109

Use of a cycle ergometer for stationary cycling has been used as a safe form of exercise training in those with challenges in maintaining balance and independent gait (Brown et al. 1997). Cycling shares similar locomotor patterns with walking and is typically used for improving muscle strength, aerobic capacity, and to facilitate muscle control in the lower limbs (Raasch & Zajac 1999, Kautz & Brown 1998; Ozaki et al. 2015)

15 RCTs were found evaluating cycle ergometer training for lower extremity motor rehabilitation. Seven RCTs compared cycle ergometer training to conventional therapy (Vanroy et al. 2017; Wang et al. 2016; Kim et al. 2015; Jin et al. 2012; Letombe et al. 2010; Katz-Leurer et al. 2006; Katz-Leurer et al. 2003). One RCT examined early recumbent cycle ergometers (Wu et al. 2020). One RCT compared cycle ergometer and treadmill training to conventional therapy (Toledano-Zarhi et al. 2011). One RCT compared cycle ergometer training to overground walking (Mayo et al. 2013). One RCT compared cycle ergometers to sliding machines (Song et al. 2015). One RCT compared progressive resistance cycling to sham cycling (Lee et al. 2010). One RCT compared high intensity cycling with walking and streatching to conventional therapy (Sandberg et al. 2016). One RCT compared interlimb coupling to conventional therapy (Arya et al. 2020). One RCT compared cycle ergometer with virtual reality to cycle ergometer alone (Lee, 2019).

The methodological details and results of all 15 RCTs are presented in Table 8.

Table 8. RCTs Evaluating Cycle Ergometer Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Cycle Ergometer Training vs Conventional Therapy		
Vanroy et al. (2017) RCT Crossover (6) N$_{Start}$=59 N$_{End}$=53 TPS=Subacute	E: Active cycling + education program C: Passive mobilization therapy Duration: 30min/d, 3d/wk for 12wk	• Maximal knee extensional strength of paretic leg (-) • Maximal knee extensional strength of nonparetic leg (-) • functional ambulation category (-) • 10-min comfortable gait speed (-) • 10-min maximal gait speed (-)
Wang et al. (2016) RCT (5) N$_{start}$=42 N$_{end}$=NR TPS=Chronic	E: Aerobic training (cycle ergometer) C: Conventional rehabilitation Duration: 30min/d, 4d/wk for 6wk	• Functional Ambulation Category (+exp) • Fugl-Meyer Assessment (+exp) • Barthel Index (+exp)
Kim et al. (2015) RCT (7) N$_{start}$=32 N$_{end}$=30 TPS=Chronic	E: Aerobic training (cycle ergometer) C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 6wk	• 10-Metre Walk Test (+exp) • Timed Up & Go Test (+exp) • Berg Balance Scale (+exp)
Jin et al. (2012) RCT (4) N$_{start}$=133 N$_{end}$=122 TPS=Chronic	E: Aerobic training (cycle ergometer) C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 8wk	• 6-Minute Walk Test (+exp) • Muscle strength (+exp) • Rivermead Mobility Index (-) • Berg Balance Scale (-) • Modified Ashworth Scale (-)
Letombe et al. (2010) RCT (3) N$_{start}$=18 N$_{end}$=18 TPS=Subacute	E: Aerobic training (cycle ergometer) C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 4wk	• Barthel Index (+exp) • Katz ADL Scale (+exp)

Katz-Leurer (2006)
RCT (6)
N$_{start}$=24
N$_{end}$=24
TPS=Not Reported
	E: Cycle ergometer (Active Passive Trainer)
	C: Conventional therapy (Bobath Approach)
	Duration: 10-30min/d, 5d/wk, 3ks cycling & conventional therapy (not reported) experimental group, 3wks physical therapy control group
		• Postural Assessment Scale (+exp)
		  • Static (+exp)
		  • Dynamic (+exp)
		• Fugl-Meyer Assessment Lower Extremity (+exp)
		• Functional Independence Measure
		  • Total (-)
		  • Motor (+exp)

Katz-Leurer et al. (2003) RCT (5) N$_{start}$=92 N$_{end}$=92 TPS=Acute	E: Aerobic training (cycle ergometer) C: Conventional rehabilitation Duration: 1hr/d, 3d/wk for 8wk	• Stair climb (+exp) • Functional Independence Measure (-) • Walking distance (-) • Walking speed (-)
Early Recumbent Cycle Ergometer vs Conventional Therapy		
Wu et al. (2020) RCT (7) N$_{start}$=31 N$_{end}$=31 TPS=Acute	E: Conventional Physiotherapy + Early Intensive Rehabilitation (Recumbent Cycle Ergometer Training) C: Conventional Physiotherapy	• Fugl-Meyer Assessment (+exp) • Berg Balance Scale (-) • Barthel Index (-) • 50m Walking (-) • Modified Rankin Scale (-)

	Duration: 20 min/d, 5d/wk, 2wks recumbent cycle ergometer training & 5d/wk, conventional physiotherapy	
Cycle Ergometer and Treadmill Training vs Conventional Therapy		
Toledano-Zarhi et al. (2011) RCT (6) N_{start}=28 N_{end}=28 TPS=Acute	E: Aerobic training (treadmill and cycle ergometer) C: Conventional rehabilitation Duration: 90min/d, 2d/wk for 6wk	• 6-Minute Walk Test (+exp)
Cycle Ergometer Training vs Overground Walking		
Mayo et al. (2013) RCT (6) N_{start}=87 N_{end}=65 TPS=Chronic	E1: Home-based exercise program (cycle ergometer) E2: Home-based exercise program (overground walking) Duration: 30min/d, 5d/wk for 3wk	• 6-Minute Walk Test (-)
Cycle Ergometer vs Sliding Machine		
Song et al. (2015) RCT (5) N_{start}=40 N_{end}=39 TPS=Chronic	E1: Aerobic training (cycle ergometer) E2: Aerobic training (sliding machine) Duration: 30min/d, 5d/wk for 8wk	• 10-Metre Walk Test (-)
Progressive Resistance Cycling and Cycling vs Sham Progressive Resistance Cycling and Cycling		
Lee et al. (2010) RCT (8) N_{start}=48 N_{end}=41 TPS=Subacute	E1: Progressive resistance training + Cycling E2: Progressive resistance training + Sham cycling E3: Sham progressive resistance training + Cycling E4: Sham progressive resistance training + Sham cycling Duration: 1hr/d, 3d/wk for 10wk	E1/E2 vs E3/E4 • Muscle strength (+exp$_1$, +exp$_2$) • Muscle endurance (+exp$_1$, +exp$_2$) • Peak power (+exp$_1$, +exp$_2$) E1 vs E2 • Muscle strength (-) • Muscle endurance (-) Peak power (-) E3 vs E4 • Muscle strength (+exp$_3$) • Muscle endurance (+exp$_3$) • Peak power (+exp$_3$)
High Intensity Cycling with Walking and Stretching vs Conventional Therapy		
Sandberg et al. (2016) RCT (6) N_{start}=56 N_{end}=54 TPS=Subacute	E: Cycling + overground walking + Stretching C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 12wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Timed Up & Go Test (+exp)
Interlimb Coupling Training vs Conventional Therapy		
Arya et al. (2020) RCT (9) N_{start}=50 N_{end}=47 TPS=Chronic	E: Interlimb Coupling Training (cycle ergometer and elliptical) C: Conventional Control Duration: 60min/d, 3x/wk, 8wks	• Fugl-Meyer Assessment (+exp) • Rivermead Gait Assessment (+exp) • Functional Ambulation Category (+exp) • Modified Rankin Scale (-)
Cycle Ergometry with VR vs Cycle Ergometry Alone		

Lee, (2019)
RCT (7)
N_{start}=42
N_{end}=42
TPS=Chronic
	E: Speed-Interactive Pedaling Training + Virtual Reality
	C: Pedaling Training
	Duration: 40 min/d, 5d/wk, for 6wks
		• Fugl-Meyer Assessment - Lower Extremity (+exp)
		• Modified Functional Reach Test (+exp)
		• Gait Ability (+exp)
		  • Gait Velocity (+exp)
		  • Cadence (+exp)

		• Step Length (+exp) • Stride Length (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Cycle Ergometer Training

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Cycle ergometer training** may produce greater improvements in motor function than **conventional therapy.**	2	Wang et al. 2016; Katz-Leurer et al. 2006
1b	**Early recumbent cycle ergometry** may produce greater improvements in motor function than **conventional therapy.**	1	Wu et al. 2020
1b	There is conflicting evidence about the effect of **interlimb coupling training** when compared to **conventional** therapy for improving motor function.	1	Arya et al. 2020
1b	**Speed-interactive training with VR** may produce greater improvements in motor function than **peddling training**.	1	Lee et al. 2019

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Cycle ergometer training** may not have a difference in efficacy when compared to **conventional therapy for** improving functional ambulation.	6	Vanroy et al. 2017; Wang et al. 2016; Kim et al. 2015; Song et al. 2015; Jin et al. 2012; Katz-Leurer et al. 2003
1b	**Cycle ergometer and treadmill training** may produce greater improvements in functional ambulation than **conventional therapy.**	1	Toledano-Zarhi et al. 2011
1b	**Cycle ergometer training** may not have a difference in efficacy compared to **overground walking** for improving functional ambulation.	1	Mayo et al. 2013
2	**Cycle ergometer training** may not have a difference in efficacy when compared to **sliding machine** for improving functional ambulation.	1	Song et al. 2015
1b	**Interlimb coupling training** may produce greater improvements in functional ambulation than **conventional therapy.**	1	Arya et al. 2020

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
2	**Cycle ergometer training** may not have a difference in efficacy compared to **conventional therapy** for improving functional mobility.	1	Jin et al. 2012

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Cycle ergometer training** may produce greater improvements in balance than **conventional therapy.**	5	Kim et al. 2015; Jin et al. 2012; Kim et al. 2012; Katz-Leurer et al. 2006; Katz-Leurer et al. 2003
1b	**Early recumbent cycle ergometry** may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	1	Wu et al. 2020
1b	**Cycle ergometer with overground walking and stretching** may produce greater improvements in balance than **conventional therapy.**	1	Sandberg et al. 2016
1b	**Speed-interactive training with VR** may produce greater improvements in balance than **peddling training**.	1	Lee et al. 2019

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Early recumbent cycle ergometry** may not have a difference in efficacy when compared to **conventional therapy** for improving gait.	1	Wu et al. 2020
1b	**Cycle ergometer with overground walking and stretching** may produce greater improvements in gait than **conventional therapy.**	1	Sandberg et al. 2016
1b	**Interlimb coupling training** may produce greater improvements in gait than **conventional therapy.**	1	Arya et al. 2020
1b	**Speed-interactive training with VR** may produce greater improvements in gait than **peddling training**.	1	Lee et al. 2019

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1b	**Cycle ergometer training** may produce greater improvements in activities of daily living than **conventional therapy**	3	Wang et al. 2016; Letombe et al. 2010; Katz-Leurer et al. 2003
1b	**Early recumbent cycle ergometry** may not have a difference in efficacy when compared to **conventional therapy** for improving performance on activities of daily living.	1	Wu et al. 2020

MUSCLE STRENGTH			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Cycle ergometer** may not have a difference in efficacy compared to **conventional therapy** for improving muscle strength.	2	Vanroy et al. 2017; Jin et al. 2012
1b	**Cycle ergometer training with progressive resistance training** may produce greater improvements in muscle strength than **sham cycling or resistance.**	1	Lee et al. 2010

SPASTICITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**Cycle ergometer training** may not have a difference in efficacy compared to **conventional therapy** for improving spasticity.	1	Jin et al. 2012

STROKE SEVERITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Early recumbent cycle ergometry** may not have a difference in efficacy when compared to **conventional therapy** for improving stroke severity.	1	Wu et al. 2020

Key Points

Cycle ergometer training may be beneficial for improving motor function, balance, and activities of daily living.

Cycle ergometer training may not be beneficial for improving functional ambulation.

Treadmill Training

Adopted from: http://www.ptproductsonline.com/2016/01/accentuate-negative/

Treadmill walking is a common rehabilitation intervention used for patients with walking impairments after stroke. It has been shown to increase the total number of steps taken within a training session as compared to a conventional physiotherapy approach (Hesse et al. 2003). As such, treadmill training can be used to encourage intensive, repetitive, task-specific training, which is suggested to be an ideal form of gait training to optimize lower limb rehabilitation after stroke (French et al. 2016; Langhorne et al. 2009). Body weight support, provided through a harness above the treadmill, is an increasingly popular approach within rehabilitation programs that attempts to optimize locomotor-related sensory inputs to all neural regions involved in walking (Charalambous et al. 2013; Langhorne et al. 2009; Hassid et al. 1997).

Treadmill training can also be administered with support from nordic poles or handrails, and training can be modified through adding additional load, applying a horizontal force, encouraging walking sideways, or through changing the treadmill surface to make it unstable or inclined. Additionally, speed of the treadmill can be changed to increase or decrease intensity.

56 RCTs were found evaluating treadmill training for lower extremity motor rehabilitation.

Eight RCTs compared treadmill training to either conventional therapy, strength training, stretching, or neurodevelopmental techniques (Globas et al. 2012; Kuys et al. 2011; Lau & Mak 2011; Macko et al. 2005; Richards et al. 2004; Pohl et al. 2002; Laufer et al. 2001; Liston et al. 2000). Three RCTs compared treadmill training to overground walking (Gama et al. 2017; Park et al. 2013; Langhammer & Stanghelle 2010). Eight RCTs compared body weight support treadmill training to conventional therapy (Takao et al. 2015; MacKay-Lyons et al. 2013; Moore et al. 2010; Takami et al. 2010; Yang et al. 2010; Yen et al. 2008; Eich et al. 2004; Da Cunha et al. 2002). 10 RCTs compared body weight support treadmill training to overground walking (Srivastava et al. 2016; DePaul et al. 2015; Combs-Miller et al. 2014; Middleton et al. 2014; Hoyer et al. 2012; Ada et al. 2010; Franceschini et al. 2009; Suputtitada et al. 2004; Nilsson et al. 2001; Kosak & Reding 2000). Two RCTs compared boy weight supported treadmill training to treadmill training (Ullah et al. 2017; Visintin et al. 1998). Three RCTs compared body weight support treadmill training to other therapies (Ribeiro et al. 2013; Duncan et al. 2011; Sullivan et al. 2008). Two RCTs compared treadmill training with Nordic poles to treadmill training (Kang et al. 2016; Shin et al. 2015). Five RCTs compared treadmill training with load to treadmill training without load or conventional therapy (Kim et al. 2017; Ribeiro et al. 2017a; Ribeiro et al. 2017b; Silva et al. 2017; Park et al. 2014). Two RCTs compared treadmill training with an incine or decline (Gama et al. 2015; Carda et al. 2013). Nine RCTs compared other treadmill training modalities (Borderick et al. 2019; Kim & Kim 2018; Kang et al. 2016; Na et al. 2015; Bang et al. 2014; Chen et al. 2014; Kim et al. 2014a; Kim et al. 2014b; Richards et al. 1993). Two RCTs compared high intensity treadmill training to low intensity treadmill training (Holleran et al. 2015; Ivey et al. 2015). One RCT compared treadmill training and strength training (Kim et al. 2011). One RCT compared Treadmill training to stretching (Luft et al. 2008).

The methodological details and results of all 56 RCTs are presented in Table 9.

Table 9. RCTs Evaluating Treadmill Training Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Treadmill Training vs Conventional Therapy, Strength Training, Stretching, or Neurodevelopmental Techniques		
Globas et al. (2012) RCT Crossover (6) N$_{start}$=38 N$_{end}$=32 TPS=Chronic	E: Treadmill training C: Conventional therapy Duration: 30-50min, 3d/wk for 12wk	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (+exp) • Five times sit to stand test (-) • Berg Balance Scale (+exp) • Rivermead Mobility Index (+exp)
Kuys et al. (2011) RCT (8) N$_{start}$=30 N$_{end}$=30 TPS=Chronic	E: Treadmill training C: Conventional rehabilitation Duration: 30min/d, 3d/wk for 6wk	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (+exp) • Walking pattern (-)
Lau & Mak (2011) RCT (6) N$_{start}$=30 N$_{end}$=26 TPS=Acute	E: Treadmill training C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 2wk	• Gait speed (+exp) • Stride length (+exp) • Berg Balance Scale (-) • Cadence (-)
Macko et al. (2005) RCT (5) N$_{start}$=61 N$_{end}$=45 TPS=Chronic	E: Treadmill training C: Conventional rehabilitation Duration: 40min/d, 3d/wk for 24wk	• 6-Minute Walk Test (+exp) • 30-ft timed walk (-) • Walking Impairment Questionnaire (-) • Rivermead Mobility Index (-)

Richards et al. (2004) RCT (6) N_{start}=63 N_{end}=51 TPS=Chronic	E: Treadmill training C: Conventional rehabilitation Duration: 1h, 5d/wk for 8wk	• Gait speed (-) • Fugl-Meyer Assessment (-) • Timed Up and Go test (-) • Barthel Index (-) • Berg Balance Scale (-)
Pohl et al. (2002) RCT (6) N_{start}=69 N_{end}=60 TPS=Subacute	E1: Speed dependent treadmill training E2: Treadmill training C: Neurodevelopmental techniques Duration: 6d/wk for 30min sessions over 2wk	E1 vs C: • 10-Metre Walk Test (+exp) • Cadence (+exp) • Stride length (+exp) • Functional Ambulation Category (+exp) E2 vs C: • 10-Metre Walk Test (+exp$_2$) • Cadence (+exp$_2$) • Stride length (-) • Functional Ambulation Category (+exp$_2$) E1 vs E2: • 10-Metre Walk Test (+exp) • Cadence (+exp) • Stride length (+exp) • Functional Ambulation Category (+exp)
Laufer et al. (2001) RCT (5) N_{start}=25 N_{end}=22 TPS=Subacute	E: Treadmill training C: Conventional rehabilitation Duration: 15min/d, 5d/wk for 5wk	• Functional Ambulation Category (+exp) • Gait speed (+exp) • Stride length (+exp) • Muscular activity (+exp) • Gait kinematics (+exp)
Liston et al. (2000) RCT (7) N_{start}=18 N_{end}=18 TPS=Chronic	E: Treadmill training C: Conventional rehabilitation Duration: 45min/d, 5d/wk for 12wk	• 10-Metre Walk Test (-) • Sit-to-Stand Test (-)
Treadmill Training vs Overground Training		
Gama et al. (2017) RCT (6) N_{start}=32 N_{end}=28 TPS=Chronic	E: Overground training C: Treadmill Duration: 45min/d, 3d/wk for 6wk	• 10-Meter Walk Test (-) • 6-Minute Walk Test (6MWT) (-) • Functional Independence (-) • Fugl-Meyer Assessment – LE (-) • Step length (+exp) • Step length symmetry ratio (+exp) • Single limb support duration (-)
Park et al. 2013 RCT (8) N_{start}= 40 N_{end}=40	E: Treadmill training C: Overground gait training Duration: 30min, 2/d for 5d	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Berg Balance Scale (-)
Langhammer & Stanghelle (2010) RCT (8) N_{start}=39 N_{end}=34 TPS=Chronic	E1: Treadmill training E2: Overground gait training Duration: 2hr/d, 5d/wk for 3wk	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (+exp) • Stride length (+exp) • Step width (+exp)
Body Weight Support Treadmill Training vs Conventional Therapy		
Takao et al. (2015) RCT (4) N_{start}=18 N_{end}=18 TPS=Chronic	E: Treadmill training + Body weight support C: Conventional rehabilitation Duration: 45min/d, 3d/wk for 8wk	• Gait speed (+exp) • Step length (-) • Cadence (-)
MacKay-Lyons et al. (2013) RCT (8) N_{start}=50	E: Treadmill training + Body weight support C: Conventional rehabilitation	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (-) • Berg Balance Scale (-)

N_{end}=47 TPS=Chronic	Duration: 1hr/d, 5d/wk for 6wk	• Chedoke-McMaster Recovery Stages (-)
Moore et al. (2010) RCT (5) N_{start}=20 N_{end}=20 TPS=Subacute	E: Treadmill training + Body weight support C: Conventional rehabilitation Duration: 2hr/d, 5d/wk for 2wk	• Fastest gait speed (+exp) • Self-selected gait speed (-) • 12-Minute Walk Test (-) • Berg Balance Scale (-) • Timed Up & Go Test (-)
Takami et al. (2010) RCT (4) N_{start}=36 N_{end}=33 TPS=Acute	E1: Partial body weight support treadmill walking backwards E2: Partial body weight support treadmill walking forwards C: Conventional rehabilitation Duration: 40min, 6d/wk for 3wk	E1 vs C: • Berg Balance Scale (-) • Rivermead Mobility Index (+exp) • 10-Metre Walk Test (+exp) • Cadence (-) • Step length (+exp) E2 vs C: • Berg Balance Scale (-) • Rivermead Mobility Index (+exp$_2$) • 10-Metre Walk Test (+exp$_2$) • Cadence (-) • Step length (-) E1 vs E2: • Berg Balance Scale (-) • Rivermead Mobility Index (+exp) • 10-Metre Walk Test (-) • Cadence (-) • Step length (-)
Yang et al. (2010) RCT (7) N_{start}=18 N_{end}=18 TPS=Chronic	E: Treadmill training + Body weight support C: Conventional rehabilitation Duration: 50min/d, 3d/wk for 12wk	• Fugl-Meyer Assessment (+exp) • Abductor hallucis size (+exp)
Yen et al. (2008) RCT (7) N_{start}=14 N_{end}=14 TPS=Chronic	E: Treadmill training + Body weight support C: Conventional rehabilitation Duration: *Not Specified*	• Gait speed (+exp) • Step length (+exp) • Berg Balance Scale (-)
Eich et al. (2004) RCT (8) N_{start}=50 N_{end}=49 TPS=Subacute	E: Treadmill training + Body weight support C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 4wk	• Walking velocity (+exp) • Walking capacity (+exp) • Walking ability (-) • Walking quality (-)
Da Cunha et al. (2002) RCT (4) N_{start}=13 N_{end}=13 TPS=Chronic	E: Treadmill training + Body weight support C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 3wk	• Functional Ambulation Category (-) • Walking distance (-) • Gait speed (-) • Gait energy (-)
Body Weight Support Treadmill Training vs Overground Walking		
Srivastava et al. (2016) RCT (6) N_{start}=45 N_{end}=42 TPS=Chronic	E: Treadmill training + Body weight support E2: Treadmill training C: Overground gait training Duration: 1hr/d, 3d/wk for 4wk	• Functional Ambulation Category (-) • Scandinavian Stroke Scale (-) • Gait speed (-) • Gait endurance (-)
DePaul et al. (2015) RCT (8) N_{start}=71 N_{end}=68 TPS=Chronic	E: Treadmill training + Body weight support C: Overground gait training Duration: 90min/d, 2d/wk for 6wk	• Gait speed (-) • 6-Minute Walk Test (-) • Functional Balance Test (-) • Activities-Specific Balance Confidence Scale (-) • Stroke Impact Scale (-) • Life Space Assessment (-)

Combs-Miller et al. (2014) RCT (6) N_{start}=20 N_{end}=20 TPS=Chronic	E: Body-weight supported treadmill training C: Overground walking training Duration: 30min, 5d/wk for 2wk	• 10-Metre Walk Test comfortable walk subscale (+con) • 10-Metre Walk Test fast walk subscale (-) • 6-Minute Walk Test (-) • Step length (-) • Swing time (-) • Stance time (-)
Middleton et al. (2014) RCT (6) N_{start}=50 N_{end}=50 TPS=Chronic	E: Treadmill training + Body weight support C: Overground gait training Duration: 1hr/d, 5d/wk for 6wk	• Gait speed (-) • 6-Minute Walk Test (-) • Dynamic Gait Index (-) • Berg Balance Scale (-) • Timed Up & Go Test (-) • Activities-Specific Balance Confidence Scale (-) • Single limb stance (-) • Step length differential (-) • Fugl-Meyer Assessment (-) • Stroke Impact Scale (-)
Hoyer et al. (2012) RCT (7) N_{start}=60 N_{end}=60 TPS=Chronic	E: Treadmill training + Body weight support C: Overground gait training Duration: 1hr/d, 5d/wk for 4wk	• Functional Ambulation Category (-) • 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Functional Independence Measure (-)
Ada et al. (2010) RCT (8) N_{start}=126 N_{end}=120 TPS=Acute	E: Treadmill training + Body weight support C: Overground gait training Duration: 45min/d, 5d/wk for 4wk	• Independent walking (+exp)
Franceschini et al. (2009) RCT (6) N_{start}=97 N_{end}=97 TPS=Subacute	E: Treadmill training + Body weight support C: Overground gait training Duration: 30min/d, 5d/wk for 4wk	• Functional Ambulation Category (-) • 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Trunk Control Test (-) • Motricity Index (-) • Walking Handicap Scale (-) • Barthel Index (-)
Suputtitada et al. (2004) RCT (5) N_{start}=48 N_{end}=48 TPS=Chronic	E: Treadmill training + Body weight support C: Overground gait training Duration: 25min/d, 5d/wk for 4wk	• Gait speed (-) • Berg Balance Scale (-)
Nilsson et al. (2001) RCT (7) N_{start}=73 N_{end}=73 TPS=Subacute	E: Treadmill training + Body weight support C: Overground gait training Duration: 30min/d, 5d/wk for 4wk	• 10-Metre Walk Test (-) • Berg Balance Scale (-) • Functional Ambulation Categories (-) • Fugl-Meyer Assessment (-) • Functional Independence Measure (-)
Kosak & Reding (2000) RCT (4) N_{start}=56 N_{end}=52 TPS=Chronic	E: Treadmill training + Body weight support C: Overground gait training + Ankle foot orthosis Duration: 45min/d, 5d/wk for 8wk	• Gait speed (-) • Gait endurance (-)
Body Weight Support Treadmill Training vs Treadmill Training		
Ullah et al. (2017) RCT (3) N_{start}=50 N_{end}=50 TPS=Not Reported	E: Body Weight Supported Treadmill Training C: Treadmill Training Duration: 15min/d, 4d/wk, 6wks	• 10-Meter Walk Test (+exp) • Dynamic Gait Index (+exp) • Timed Up and Go Test (+exp)
Visintin et al. 1998 RCT (5) N_{start}=100	E: Treadmill training with body weight support C: Treadmill training	• Berg Balance Scale (+exp) • Stroke Rehabilitation Assessment of Movement (+exp)

N_{end}=79 TPS=Subacute	Duration: Not reported	- Walking speed (+exp)
Body Weight Support Treadmill Training vs Other Therapies		
Ribeiro et al. (2013) RCT (5) N_{start}=25 N_{end}=25 TPS=Chronic	E: Treadmill training + Body weight support C: Proprioceptive neuromuscular facilitation training Duration: 30min/d, 3d/wk for 4wk	- Stroke Rehabilitation Assessment of Movement (-) - Functional Ambulation Category (-) - Functional Independence Measure (-) - Gait kinematics (-)
Duncan et al. (2011) RCT (7) N_{start}=408 N_{end}=NR TPS=Chronic	E1: Treadmill training + Body weight support, Early E2: Treadmill training + Body weight support, Late E3: Home-based exercise program Duration 90min/d, 3d/wk for 14wk	- Gait speed (-) - Walking independence (-) - Fugl-Meyer Assessment (-) - Berg Balance Scale (-) - Stroke Impact Scale (-)
Sullivan et al. (2008) RCT (7) N_{start}=80 N_{end}=71 TPS=Chronic	E1: Body-weight supported treadmill with upper extremity ergometry training E2: Resistive leg cycling with upper extremity ergometry training E3: Body-weight supported treadmill with resistive leg cycling training E4: Body-weight supported treadmill with lower extremity progressive resistive exercise Duration: 1h, 4d/wk for 6wk	E1 vs E2: - 10-Metre Walk Test (+exp$_1$) - 6-Minute Walk Test (-) E1 vs E3/E4: - 10-Metre Walk Test (-) - 6-Minute Walk Test (-)
Treadmill Training with Nordic Poles vs Treadmill Training		
Kang et al. (2016) RCT (4) N_{start}=30 N_{end}=30 TPS=Chronic	E: Treadmill training + Nordic poles C: Treadmill training Duration: 30min/d, 5d/wk for 6wk	- 6-Minute Walk Test (+exp) - Berg Balance Scale (+exp) - Timed Up & Go Test (+exp) - Modified Barthel Index (+exp) - 10-Metre Walk Test (-)
Shin et al. (2015) RCT (5) N_{start}=20 N_{end}=20	E: Treadmill training + Nordic poles C: Treadmill training Duration: 30min/d, 3d/wk for 4wk	- 6-Minute Walk Test (+exp) - Dynamic Gait Index (+exp) - Timed Up & Go Test (-)
Treadmill Training with Load vs Treadmill Training without Load or Conventional Therapy		
Kim et al. (2017) RCT (5) N_{start}=30 N_{end}=29 TPS=Chronic	E: Power web hand exerciser and treadmill-based weight loading C: Conventional therapy Duration: 30min/d, 3d/wk for 6wk	- 10-meter walk test (+exp) - Timed Up and Go Test (+exp)
Ribeiro et al. (2017a) RCT (7) N_{Start}=38 N_{End}=38 TPS=Subacute	E: Treadmill training with a mass attached around non-paretic ankle C: Treadmill training with no mass Duration: 30min/d for 9d	- Gait speed (-) - Symmetry ratio of swing time (-) - Ankle range of motion (ROM) of non-paretic limb in the sagittal plane (-)
Ribeiro et al. (2017b) RCT (5) N_{start}=38 N_{end}=38 TPS=Subacute	E: Treadmill Training with Weight on Non-Paretic Lower Limb C: Treadmill Training Without Weight Duration: 30min/d, 7d/wk, 9d	- Distance Covered (-) - Treadmill Gait Speed (-)

Silva et al. (2017) RCT (8) N_{Start}=38 N_{End}=33 TPS=Subacute	E: Treadmill training with load C: Treadmill training without load Duration: 30min/d for 9d	• Berg Balance Scale (-) • Timed Up and Go Test (-) • Turn speed (-) • Stride length (-) • Stride time (-) • Stride width (-) • Symmetry ratio of swing time (-)
Park et al. (2014) RCT (4) N_{start}=30 N_{end}=30 TPS=Chronic	E: Treadmill training + Incremental leg loading C: Treadmill training Duration: 1hr/d, 3d/wk for 6wk	• Center of pressure (-)
Treadmill Training with Incline or Decline		
Gama et al. (2015) RCT (6) N_{start}=28 N_{end}=28 TPS=Chronic	E: Treadmill training on incline C: Treadmill training Duration: 1hr/d, 3d/wk for 4wk	• Gait speed (+exp) • Stride length (-) • Fugl-Meyer Assessment (-) • Berg Balance Scale (-) • Functional Independence Measure (-)
Carda et al. (2013) RCT (5) N_{start}=38 N_{end}=30 TPS=Chronic	E: Treadmill training on incline C: Treadmill training on decline Duration: 75min/d, 5d/wk for 6wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp)
Treadmill Training with Other Modalities		

Broderick et al. (2019)
RCT (6)
N_{start}=30
N_{end}=23
TPS=Chronic
	E: Treadmill Training + Mirror Therapy
	C: Treadmill Training + Sham
	Duration: 30min, 3d/wk, 4wks
		• 10-Meter Wak Test (-)
		• 6-Minute Walk Test (-)
		• Modified Ashworth Scale
		  • Hip (-)
		  • Knee (-)
		  • Ankle (+exp)
		• Fugl-Meyer Assessment (-)

Kim & Kim. (2018) RCT (6) N_{start}=23 N_{end}=23 TPS=Chronic	E: Treadmill Training + Proprioceptive Neuromuscular Facilitation C: Treadmill Training Duration: 40min/d, 5d/wk, 6wks	• Timed Up & Go Test (+exp) • 10-Meter Walking Test (+exp) • 6-Minute Walking Test (+exp)
Kang et al. (2015) RCT (5) N_{start}=30 N_{end}=30 TPS=Chronic	E1: Treadmill training + Front handrail E2: Treadmill training + Bilateral handrail C: Treadmill training Duration: 30min/d, 5d/wk for 8wk	E1/E2 vs C • Gait quality: (+exp$_1$, +exp$_2$)
Na et al. (2015) RCT (4) N_{start}=24 N_{end}=21 TPS=Subacute	E: Treadmill training + Horizontal force C: Treadmill training Duration: 20min/d, 3d/wk for 8wk	• Constant gait speed (+exp) • Maximum gait speed (+exp) • Berg Balance Scale (+exp) • Timed Up & Go Test (+exp) • Cadence (+exp) • Step length (+exp) • Functional Reach Test (-)
Bang et al. (2014) RCT (5) N_{start}=12 N_{end}=12 TPS=Chronic	E: Treadmill training + Unstable surface C: Treadmill training Duration: 30min/d, 5d/wk for 4wk	• 6-Minute Walk Test (+exp) • Timed Up & Go Test (+exp)

Chen et al. (2014) RCT (7) N_{start}=31 N_{end}=27 TPS=Chronic	E: Treadmill training with turning C: Treadmill training Duration: 30min/d, 3d/wk for 4wk	• Gait speed (+exp) • Berg Balance Scale (+exp) • Limits of stability (+exp) • Muscle strength (+exp) • Walking pattern (-) • Angular kinematics (-)
Kim et al. (2014) RCT (5) N_{start}=24 N_{end}=24 TPS=Chronic	E: Treadmill training sideway + Visual deprivation C: Treadmill training sideways Duration: 20min/d, 3d/wk for 6wk	• Gait speed (+exp) • Stance time (+exp) • Walking distance (-) • Step length (-) • Timed Up & Go (-) • Sit-to-Stand Test (-)
Kim et al. (2014) RCT (4) N_{start}=36 N_{end}=36 TPS=Chronic	E1: Treadmill training, backward and forward E2: Treadmill training, forward E3: Treadmill training, backward Duration: 30min/d, 6d/wk for 3wk	E1vs E2/E3 • Walking ability: (+exp$_1$) • Step time: (+exp$_1$) • Step length: (+exp$_1$) • Stance phase: (+exp$_1$) • Swing phase: (+exp$_1$) • Single support: (+exp$_1$)
Richards et al. (1993) RCT (6) N_{start}=27 N_{end}=27 TPS=Acute	E: Task-specific training using a treadmill C1: Early and intensive conventional therapy C2: Conventional therapy Duration: *Not Specified*	• Fugl-Meyer Assessment (-) • Barthel Index (-) • Berg Balance Scale (-) • Gait velocity (-)
High vs Low Intensity Treadmill Training		
Holleran et al. (2015) RCT (4) N_{start}=14 N_{end}=14 TPS=Chronic	E: Aerobic training (treadmill, high intensity) C: Aerobic training (treadmill, low intensity) Duration: 45min/d, 3d/wk for 4wk	• 6-Minute Walk Test (+exp)
Ivey et al. (2015) RCT (5) N_{start}=34 N_{end}=34 TPS=Chronic	E: Aerobic training (treadmill, high intensity) C: Aerobic training (treadmill, low intensity) Duration: 30min/d, 5d/wk for 3wk	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • 48-Hour Step Count (-)
Treadmill Training vs Strength Training		
Kim et al. (2011) RCT (5) N_{start}=44 N_{end}=44 TPS=Chronic	E: Treadmill training C: Strength training Duration: 30min/d, 3d/wk for 6wk	• 10-Metre Walk Test (-) • Timed Up and Go Test (-) • Berg Balance Scale (-)
Treadmill Training vs Stretching		
Luft et al. (2008) RCT (5) N_{start}=113 N_{end}=71 TPS=Chronic	E: Treadmill training C: Stretching program Duration: 40min, 3d/wk for 12wk	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Treadmill Training

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Treadmill training** may produce greater improvements in motor function than **conventional therapy.**	1	Richards et al. 2004
1b	**Treadmill training** may not have a difference in efficacy compared to **overground walking** for improving motor function.	1	Gama et al. 2017
1a	There is conflicting evidence about the effect of **treadmill training with body weight support** to improve motor function when compared to **conventional therapy.**	2	Mckay-Lyons et al. 2013; Yang et al. 2010
1b	There is conflicting evidence about the effect of **treadmill training with body weight support** to improve motor function when compared to **home-based exercise**.	1	Duncan et al. 2011
1a	**Treadmill training with body weight support** may not have a difference in efficacy compared to **overground walking** for improving motor function.	3	Middleton et al. 2014; Franceschini et al. 2009; Nilsson et al. 2001
1b	**Treadmill training** may not have a difference in efficacy compared to **conventional therapy or overground walking** for improving motor function.	2	Gama et al. 2017; Richards et al. 2004
1b	**Treadmill training on incline** may not have a difference in efficacy compared to **level treadmill training** for improving motor function.	1	Gama et al. 2015
1b	**Treadmill task-specific training** may not have a difference in efficacy compared to **early and intensive conventional therapy** for improving motor function.	1	Richards et al. 1993
1b	**Treadmill training with mirror therapy** may not have a difference in efficacy compared to **treadmill training and sham mirror therapy** for improving motor function.	1	Broderick et al. 2019

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Treadmill training** may produce greater improvements in functional ambulation than **conventional therapy, stretching, or neurodevelopmental therapy.**	6	Globas et al. 2012; Kuys et al. 2011; Macko et al. 2005; Pohl et al. 2002; Laufer et al. 2001; Liston et al. 2000
1b	**Treadmill training** may not have a difference in efficacy compared to **overground walking** for improving functional ambulation.	3	Gama et al. 2017; Park et al. 2013; Langhammer & Stanghelle 2010
2	**Treadmill training with body weight support** may produce greater improvements in functional ambulation than **treadmill training.**	2	Ullah et al. 2017; Visintin et al 1998

2	**Treadmill training with body weight** support may not have a difference in efficacy compared to **proprioceptive neuromuscular facilitation** for improving functional ambulation.	1	Ribeiro et al. 2013
1b	**Early Treadmill training with body weight** support may not have a difference in efficacy compared to **late Treadmill training with body weight** for improving functional ambulation.	1	Duncan et al. 2011
1b	**Treadmill training with body weight support** and leg cycling may not have a difference in efficacy when compared to **treadmill training with body weight support and progressive resistance** for improving functional ambulation.	1	Sullivan et al. 2008
2	There is conflicting evidence about the effect of **treadmill training with load** when compared to **treadmill training** alone for improving functional ambulation.	2	Kim et al. 2017; Ribeiro 2017b
2	**Treadmill unstable surface training** may produce greater improvements in functional ambulation than **conventional treadmill training.**	1	Bang et al. 2014
2	**Treadmill incline training** may produce greater improvements in functional ambulation than **treadmill decline training.**	1	Carda et al. 2013
1a	There is conflicting evidence about the effect of **treadmill training** to improve functional ambulation when compared to **overground walking**.	4	Ada et al. 2003; Gama et al. 2017; Langhammer & Stanghelle 2010; Park et al. 2013
1b	There is conflicting evidence about the effect of **treadmill training with body weight support** to improve functional ambulation when compared to **conventional therapy**.	5	MacKay-Lyons et al. 2013; Moore et al. 2010; Takami et al. 2010; Eich et al. 2004; Da Cunha et al. 2002
2	T**readmill training with nordic poles may produce greater improvements in** functional ambulation when compared to **treadmill training.**	2	Kang et al. 2016; Shin et al. 2015
1b	**Treadmill training with mirror therapy** may not have a difference in efficacy compared to **treadmill training and sham mirror therapy** for improving functional ambulation.	1	Broderick et al. 2019
2	**Treadmill training sideways with visual deprivation** may not have a difference in efficacy compared to **treadmill training sideways** for improving functional ambulation.	1	Kim et al. 2014
2	There is conflicting evidence about the effect of **high intensity treadmill training** to improve functional ambulation when compared to **low intensity treadmill training.**	2	Holleran et al. 2015; Ivey et al. 2015
1a	**Treadmill training with body weight support** may not have a difference in efficacy compared to**, overground walking** for improving functional ambulation.	11	Srisvastava et al, 2016; DePaul et al. 2015; Ribeiro et al. 2013; Duncan et al. 2011; Sullivan et al. 2008; Hoyer et al. 2012; Ada et al. 2010; Franceschini et al. 2009; Nilsson et al. 2001; Combs-Miller et al. 2014; Middleton et al. 2014

1b	**Treadmill training with proprioceptive neuromuscular** facilitation may produce greater improvements in functional ambulation when compared to **treadmill training.**	1	Kim & Kim 2018
2	**Treadmill training** may not have a difference in efficacy compared to **strength training** for improving functional ambulation.	1	Kim et al. 2011
2	**Treadmill training** may produce greater improvements in functional ambulation when compared to **stretching.**	1	Luft et al. 2008

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Treadmill training** may not have a difference in efficacy when compared to conventional therapy for improving functional mobility.	2	Globas et al. 2012; Macko et al. 2005
2	**Treadmill training with partial body weight support** may produce greater improvements in functional mobility than **conventional therapy**	1	Takami et al. 2010
1b	There is conflicting evidence about the effect of **treadmill training** to improve functional mobility when compared to **conventional therapy**.	2	Globas et al. 2012; Macko et al. 2005
1b	**Treadmill training with body weight support** may not have a difference in efficacy compared to **overground walking** for improving functional mobility.	1	DePaul et al. 2015

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Treadmill training** may not have a difference in efficacy in improving balance when compared to **overground walking** or **conventional therapy**.	4	Globas et al. 2012; Kim et al. 2011; Lau & Mak, 2011; Richards et al. 2004
1b	**Treadmill training** may not have a difference in efficacy compared to **overground walking** for improving balance.	1	Park et al. 2013
1a	**Treadmill training with body weight support** may not have a difference in efficacy when compared to **overground walking** or **conventional therapy** for improving balance.	4	MacKay-Lyons et al. 2013; Moore et al. 2010; Takami et al. 2010; Yen et al. 2008;
1a	**Treadmill training** may not have a difference in efficacy compared to **overground walking** for improving balance.	5	DePaul et al. 2015; Middleton et al. 2014; Franceschini et al. 2009; Suputtitada et al. 2004; Nilsson et al. 2001
2	**Treadmill training with body weight support** may produce greater improvements in balance than **treadmill training.**	2	Ullah et al. 2017; Visintin et al 1998
2	**Treadmill incline training** may not have a difference in efficacy when compared to **treadmill decline**	1	Gama et al. 2015

	training for producing greater improvements in balance.		
1b	**Treadmill training with turning** may produce greater improvements in balance than **treadmill training.**	1	Chen et al. 2014
2	**Treadmill training on an unstable surface** may produce greater improvements in balance than **treadmill training on a stable surface.**	1	Bang et al. 2014
1b	There is conflicting evidence about the effect of **treadmill training with body weight support** to improve balance when compared to **treadmill training or home-based exercise**.	2	Duncan et al. 2011; Visintin et al. 1998
2	**Treadmill training with Nordic poles** may produce greater improvements in balance when compared to **treadmill training**.	2	Kang et al. 2016; Shin et al. 2015;
1b	**Treadmill training with load or on incline** may not have a difference in efficacy compared to **level treadmill training without a load** for improving balance.	1	Silva et al. 2017; Gama et al. 2015
1b	**Treadmill training with task-specific training** may not have a difference in efficacy compared to **early and intensive conventional therapy** for improving balance**.**	1	Richards et al. 1993
2	**Treadmill training with horizontal force** may produce greater improvements in balance than **conventional treadmill training.**	1	Na et al. 2015
1b	**Treadmill training with proprioceptive neuromuscular** facilitation may produce greater improvements in balance when compared to **treadmill training.**	1	Kim & Kim 2018
2	**Treadmill training** may not have a difference in efficacy compared to **strength training** for improving balance.	1	Kim et al. 2011
2	**Treadmill training sideway with visual deprivation** may not have a difference in efficacy compared to **treadmill training sideways** for improving balance.	1	Kim et al. 2014
2	**Treadmill training with incremental leg loading** may not have a difference in efficacy compared to **treadmill training** for improving balance.	2	Silva et al. 2017; Park et al. 2014

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **treadmill training** to improve gait when compared to **conventional therapy or neurodevelopmental therapy**.	6	Kuys et al. 2011; Lau & Mak 2011; Laufer et al. 2001; Macko et al. 2005; Pohl et al. 2002; Richards et al. 2004
1a	**Treadmill training** may produce greater improvements in gait than **overground walking**	2	Gama et al. 2017; Langhammer & Stangelle 2010

1a	**Treadmill training with body weight support** may not have a difference when compared to **conventional therapy for** improving gait.	5	Takao et al. 2015; Moore et al. 2010; Takami et al. 2010; Yen et al. 2008; Da Cumba et al 2002
1a	**Overground training** may produce greater improvements in gait than **treadmill training.**	2	Gama et al. 2017; Langhammer & Stanghelle 2010
2	**Treadmill training with body weight support** may produce greater improvements in gait than **treadmill training.**	2	Ullah et al. 2017; Visintin et al 1998
2	**Treadmill training with use of Nordic poles** may produce greater improvements in gait than **treadmill training.**	1	Kang et al. 2015;
2	**Treadmill training with horizontal force** may produce greater improvements in gait than **conventional treadmill training.**	1	Na et al. 2015
2	**Treadmill training forward and backwards** may produce greater improvements in gait than **treadmill training while only walking forwards or only walking backwards.**	1	Kim et al. 2014
1b	There is conflicting evidence about the effect of **treadmill training with body weight support** to improve gait when compared to **neuromuscular facilitation training, treadmill training, or exercise-based exercise**.	3	Ribeiro et al. 2013; Duncan et al. 2011; Visintin et al. 1998
1b	There is conflicting evidence about the effect of **treadmill training on incline** to improve gait when compared to **level treadmill training**.	1	Gama et al. 2015
1b	There is conflicting evidence about the effect of **treadmill training with turning** to improve gait when compared to **conventional treadmill training.**	1	Chen et al. 2014
2	There is conflicting evidence about the effect of **treadmill training sideways with visual deprivation** to improve gait when compared to **treadmill training sideways.**	1	Kim et al. 2014
1a	**Treadmill training** may not have a difference in efficacy compared to **overground walking** for improving gait.	7	Srivastava et al. 2016; Middleton et al. 2014; Kosak & Reding 2000; DePaul et al. 2015; Combs-Miller et al. 2014; Middleton et al. 2014; Suputtitada et al. 2004
1a	**Treadmill training with load** may not have a difference in efficacy compared to **treadmill training without load** for improving gait.	2	Ribeiro et al. 2017; Silva et al. 2017
1b	**Treadmill task-specific training** may not have a difference in efficacy compared to **early and intensive conventional therapy** for improving gait.	1	Richards et al. 1993
2	**Treadmill training with handrails** may produce greater improvements in gait when compared to **treadmill training alone.**	1	Kang et al. 2015
2	**High intensity treadmill training** may not have a difference in efficacy in improving gait compared to **low intensity treadmill training.**	1	Ivey et al. 2015

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1b	**Treadmill training** may not have a difference in efficacy compared to **conventional therapy** for improving activities of daily living.	1	Richards et al. 2004
1b	**Treadmill training** may not have a difference in efficacy compared to **overground walking** for improving performance on activities of daily living.	1	Gama et al. 2017
1b	**Treadmill training with body weight** support may not have a difference in efficacy compared to **proprioceptive neuromuscular facilitation** for improving performance on activities of daily living.	1	Duncan et al. 2011
2	**Early Treadmill training with body weight support** may not have a difference in efficacy compared to **late Treadmill training with body weight** for improving performance on activities of daily living.	1	Ribeiro et al. 2013
2	**Treadmill training with Nordic poles** may produce greater improvements in activities of daily living than **treadmill training.**	1	Kang et al. 2016
1a	**Treadmill training with body weight support** may not have a difference in efficacy compared to **overground walking** for improving activities of daily living.	4	DePaul et al. 2015; Hoyer et al. 2012; Franceschini et al. 2009; Nilsson et al. 2001
1b	**Treadmill training** may not have a difference in efficacy compared to **conventional therapy or overground walking** for improving activities of daily living.	1	Richards et al. 2004; Gama et al. 2017
1b	**Treadmill training on incline** may not have a difference in efficacy compared to **level treadmill training** for improving activities of daily living.	1	Gama et al. 2015
1b	**Task-specific treadmill training** may not have a difference in efficacy compared to **early and intensive conventional therapy** for improving activities of daily living.	1	Richards et al. 1993
2	**Treadmill training with body weight support** may not have a difference in efficacy compared to **neuromuscular facilitation training** for improving activities of daily living.	1	Ribeiro et al. 2013

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Treadmill training with load** may not have a difference in efficacy compared to **conventional treadmill training** for improving range of motion.	1	Ribeiro et al. 2017

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Treadmill training with body weight support** may produce greater improvements in muscle strength than **conventional therapy.**	1	Yang et al. 2010
1b	**Treadmill training with turning** may produce greater improvements in muscle strength than **treadmill training.**	1	Chen et al. 2014
1b	**Treadmill training with body weight support** may not have a difference in efficacy compared to **overground walking** for improving muscle strength.	1	Franceschini et al. 2009

SPASTICITY

LoE	Conclusion Statement	RCTs	References
2	**Treadmill training with mirror therapy** may not have a difference in efficacy compared to **treadmill training and sham mirror therapy** for improving spasticity.	1	Broderick et al. 2019

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1a	**Treadmill training with body weight support** may not have a difference in efficacy compared to **overground walking** for improving stroke severity.	2	Srivastava et al. 2016; DePaul et al. 2015
1b	**Treadmill training with body weight support** may not have a difference in efficacy compared to **conventional therapy or home-based exercise** for improving stroke severity.	2	MacKay-Lyons et al. 2013; Duncan et al. 2011

Key Points

Treadmill training may be beneficial specifically for improving functional ambulation and balance.

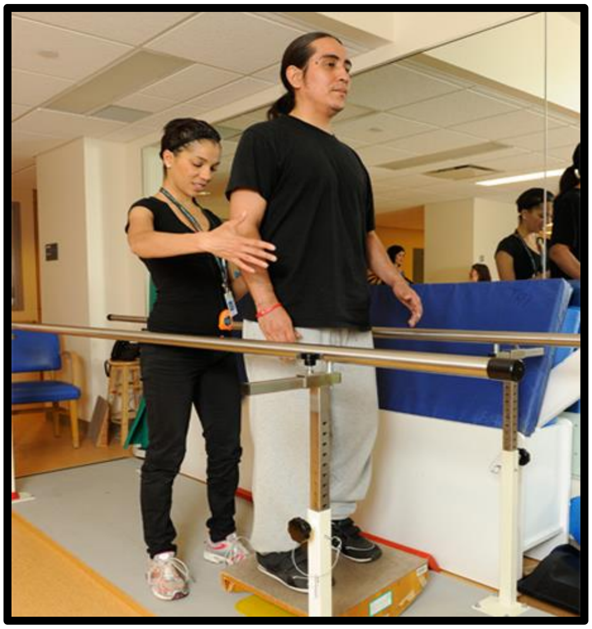
The literature is mixed regarding treadmill training for improving gait.

Treadmill training with body weight support may not be beneficial specifically for improving motor function, balance, gait, and activities of daily living.

Treadmill training with body weight support may not be beneficial specifically for improving functional ambulation compared to overground walking.

The literature is mixed regarding treadmill training with body weight support for improving functional ambulation compared to conventional therapy.

Physiotherapy and Exercise Programs



Adopted from: https://www.kliniknoridah.com/stroke-physiotherapy-treatment/

Exercise can be defined as planned physical activity that is structured and repetitive and is performed deliberately with the intention of improving physical fitness. Major factors of physical fitness are cardiovascular fitness, strength and power. After a stroke, individuals are impaired on all three of these attributes, to significant but varying degrees (Saunders, Greig & Mead, 2014). Physiotherapy and exercise are the primary method for regaining any of these deficits experienced after the injury. Although it is well known that physiotherapy and exercise are effective for rehabilitation, it is still not clear as to what type is most effective (Langhorne, Wagenaar & Patridge, 1996; Cho & Cha, 2016). Therefore, there is always an effort to identify when, where and how physiotherapy should be applied to maximize its benefit to the patient's recovery. Besides the more obvious physical benefits associated with exercise, psycho-social benefits also exist, and attempts are made to maximize these residual benefits as well (Saunders, Greig & Mead, 2014).

A total of 19 RCTs were found that looked at physiotherapy and exercise programs for lower extremity motor rehabilitation. Four RCTs compared body weight shifting techniques to conventional therapy or perturbation balance training (Handelzalts et al. 2019; Krishna et al. 2018; Allison et al. 2007; Howe et al. 2005). Six RCTs compared alternative exercise programs to other exercise regimes (Park et al. 2020; Swank et al. 2020; Liu et al. 2014; Olney et al. 2006; Marigold et al. 2005; Green et al. 2002). Three RCTs compared aerobic exercise to other physiotherapy programs (Wu et al. 2020; Hornby et al. 2016; Lee et al. 2015). Two RCTs investigated high intensity interval training (Boyne et al. 2019; Hesse et al. 2011). Two RCTs compared open to closed chain kinetic exercises (Krawczyk et al. 2014; Lee et al. 2013). Two RCTs compared sling exercise therapy to conventional therapy (Liu et al. 2020; Lou et al. 2019).

The methodological details and results of all 19 RCTs are presented in Table 10.

Table 10. RCTs Evaluating Physiotherapy-Based Interventions and Exercise Programs for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Body Weight Shift Technique vs Conventional Therapy or Perturbation-Based Training		
Handelzalts et al. (2019) RCT (6) N_{start}=34 N_{end}=32 TPS=Subacute	E: Perturbation-Based Balance Training C: Weight Shifting and Gait Training Duration: 30 min/session, 12 sessions in 2.5 wks	• Fugl-Meyer Assessment (-) • 6-Minute Walk Test (-) • 10-Meter Walk Test (-) • Activity-Specific Balance Confidence Scale (+exp) • Berg Balance Scale (-)
Krishna et al. (2018) RCT (8) N_{Start}=30 N_{End}=30 TPS=NA	E: Body weight shift technique induced by shoe lift on unaffected side C: No shoe lift technique Duration: 2wk	• Fugl Meyer Assessment (-) • Weight Bearing on affected side (+exp) • 10-Meter Walk Test (+exp) • Berg Balance Scale (+exp) • Lower extremity functional performance (+exp)
Allison et al. (2007) RCT (8) N_{start}=17 N_{end}=17 TPS=Subacute	E: Standing practice C: Conventional rehabilitation Duration: 1hr/d, 6d/wk for 6wk	• Berg Balance Scale (+exp) • Rivermead Motor Assessment (-) • Trunk Control Test (-)
Howe et al. (2005) RCT (7) N_{start}=35 N_{end}=35 TPS=Acute	E: Lateral weight shift training during sitting and standing physiotherapy C: Conventional rehabilitation Duration: 40min/d, 4d/wk for 3wk	• Lateral Reach Test (-) • Dynamic balance (-) • Static balance (-)
Alternative Exercise Programs vs a Different Exercise Regime		
Park et al. (2020) RCT (6) N_{start}=60 N_{end}=52 TPS=Chronic	E1: Direct Cross-Training Group (affected limb) E2: Indirect Cross-Training Group (unaffected limb) C: Conventional Care Duration: 30min, 3x/wk, 4wks	E1 Vs C • Timed Up and Go Test (-) • 10-Meter Walking Test (-) • Limit of Stability (-) E2 Vs C • Timed Up and Go Test (-) • 10-Meter Walking Test (-) • Limit of Stability (-) E1 Vs E2 • Timed Up and Go Test (-) • 10-Meter Walking Test (-) • Limit of Stability (-)
Swank et al. (2020) RCT (7) N_{start}=73 N_{end}=72 TPS=Acute	E: Patient Directed Activity Program (PDAP) with Conventional Care C: Conventional Care Alone Duration: 3hrs/d conventional, PDAP 30min, 2x/d	• Functional Independence Measure (-) • Stroke Rehabilitation Assessment of Movement Measure (-) • Stroke Impact Scale (-) • Midline Stability (-)

Liu et al. (2014)
RCT (6)
N_{start}=46
N_{end}=44
TPS=Acute
	E: Self-regulation While Performing Daily Tasks
	C: Conventional Therapy
	Duration: 60min/d, 5d/wk, 1wk
		• Functional Independence Measure
		  • Motor (+exp)
		  • Cognitive (-)
		• Fugl-Meyer Assessment
		  • Upper Extremity (-)
		  • Lower Extremity (-)
		• Activities of Daily living (+exp)
		  • Put Clothes on Hanger (+exp)
		  • Fold Laundry (+exp)
		  • Prepare a Cup of Tea (-)

		• Wash the Dishes (+exp) • Carry out Monetary Transaction (+exp)
Olney et al. (2006) RCT (7) N_{start}=72 N_{end}=72 TPS=Chronic	E: Supervised exercise program C: Unsupervised exercise program Duration: 90min/d, 3d/wk for 10wk	• 6-Minute Walk Test (-) • Physiological Cost Index (-) • Muscle strength (-)
Marigold et al. (2005) RCT (6) N_{start}=61 N_{end}=58 TPS=Chronic	E: Agility exercise program involving dynamic balance C: Stretching and weight-shifting exercise program Duration: 1hr/d, 3d/wk for 10wk	• Step Reaction Time (+exp) • Berg Balance Scale (-) • Timed Up & Go Test (-)
Green et al. (2002) RCT (8) N_{start}=170 N_{end}=146 TPS=Chronic	E: Community exercise program C: Usual care Duration: 30min/d, 5d/wk for 6wk	• Rivermead Mobility Index (+exp)
Aerobic Exercise and Physiotherapy Programs		
Wu et al. (2020) RCT (7) N_{start}=31 N_{end}=31 TPS=Acute	E: Early and Intensive Physiotherapy C: Conventional Care Duration: conventional 72hrs post CVA, early 24-48hrs, 30min/d, 5d/wk, 4wks	• Berg Balance Scale (-) • Barthel Index (-) • Fugl Meyer Assessment (+exp) • 50-Meter Walking (-) • Modified Rankin Scale (-)
Hornby et al. (2016) RCT (7) N_{start}=33 N_{end}=32 TPS=Chronic	E: Aerobic training (overground walking) C: Conventional rehabilitation Duration: 1hr/d, 3d/wk for 10wk	• 6-Minute Walk Test (+exp) • Self-Selected Speed (+exp) • Fastest Speed (+exp) • Activities-Specific Balance Coordination (-) • Berg Balance Scale (-) • Sit-to-Stand (-)
Lee et al. (2015) RCT (6) N_{start}=30 N_{end}=27 TPS=Chronic	E: Aerobic training (overground walking) + Resistance training C: Conventional rehabilitation Duration: 20min/d, 6d/wk for 4wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Timed Up & Go Test (-) • 30-Second Chair Test (-)
High Intensity Interval Training		
Boyne et al. (2019) RCT crossover (5) N_{start}=16 N_{end}=16 TPS=Chronic	E1: High-Intensity Interval Training – Treadmill E2: High-Intensity Interval Training - Stepper C: Moderate-intensity Continuous Exercise - Treadmill Duration: 20min Single session/Condition, ~ 1wk washout	• Walking Speed (-) • Step Count (-)
Hesse et al. (2011) RCT (6) N_{start}=50 N_{end}=50 TPS=Subacute	E: Intermittent High-Intensity Physiotherapy C: Conventional Care Duration: experimental - three two-month blocks, 30-45min, 4x/wk, Control, 30-45min, 2x/wk, 12mos	• Rivermead Mobility Index (-) • Rivermead Motor Assessment - Leg (-) • Walking Velocity (-) • Stair Climbing Velocity (-) • Timed up and Go Test (-) • Modified Ashworth Scale (- • Rivermead Activities of Daily Living (-)
Open vs Closed Chain Exercise		
Krawczyk et al. (2014) RCT (3) N_{start}=51 N_{end}=51 TPS=Subacute	E: “Closed” chain exercises involving whole paretic side of the body while sitting or standing. C: “Open chain” exercises involving isolated movements of the extremities with trunk stabilization while laying down.	• Berg-Balance Scale (-) • Rivermead Motor Assessment (-) • Fugl-Meyer Assessment (-) • Gait speed (-) • Cadence (-) • Stance phase (-) • Step length (-)

	Duration: 1hr/d, 5d/wk for 12wk	• Step width (-) • Hip and knee range (-) • Pelvic tilt (-)
Lee et al. (2013) RCT (3) N_{start}=33 N_{end}=33 TPS=Chronic	E1: Closed Chain Kinetics E2 Open Chain Kinetics C: Conventional Care Duration: 5x/wk, 6wks	E1 vs E2 • Anterior-posterior Sway (+exp2) • Medio-lateral Sway (exp2) E1/E2 vs C • Anterior-posterior Sway (+exp2) • Medio-lateral Sway (exp2)
Sling Exercise Therapy vs Conventional Therapy		
Liu et al. (2020) RCT (7) N_{start}=50 N_{end}=25 TPS=Subacute	E: Sling Exercise Therapy on Lower Limbs C: Conventional Therapy Duration: 30min/d,5d/wk, 4wks	• Berg Balance Scale (+exp) • Barthel Index (+exp) • Fugl-Meyer Lower Extremity (+exp) • Visual Analogue Scale Pain (+exp) • Overall Short-Form 36 (-)
Lou et al. (2019) RCT (5) N_{start}=56 N_{end}=56 TPS=Subacute	E: TheraSling Therapy with Neuromuscular Facilitation C: Conventional Care Duration: 45min, 6x/wk, 6wks	• Functional Ambulation Category (+exp) • Barthel Index (+exp) • Fugl Meyer Assessment (+exp) • Berg Balance Scale (+exp) • 10-Meter Walk Test (+exp) • Step Length (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Physiotherapy-Based Interventions and Exercise Programs

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	**Bodyweight shift techniques** may not have a difference in efficacy when compared to **conventional rehabilitation or perturbation training** for improving motor function.	4	Handelzalts et al. 2019; Krishna et al., 2018; Allison et al. 2007; Howe et al. 2005
1b	**Self-regulation** may not have a difference in efficacy when compared to **conventional therapy** for improving motor function.	1	Liu et al. 2014
1b	**Early intensive physiotherapy** may produce greater improvements in motor function when compared to conventional therapy.	1	Wu et al. 2020
1b	**High intensity interval training** may not have a difference in efficacy when compared to **conventional therapy** for improving motor function.	1	Hesse et al. 2011
2	The **"open-chain" exercises** used may not have a difference in efficacy when compared to **"closed-chain" exercises** they were compared against for improving motor function.	1	Krawczyk et al., 2014
1b	**Sling exercise therapy** may produce greater improvements in motor function when compared to **conventional therapy.**	2	Liu et al. 2020; Lou et al. 2019

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Bodyweight shift techniques** may not have a difference in efficacy when compared to **conventional rehabilitation or perturbation training** for improving functional ambulation.	2	Handelzalts et al. 2019; Krishna et al. 2018
1b	**Supervised activity programs** may not have a difference in efficacy when compared to **unsupervised activities** for improving functional ambulation.	1	Olney et al., 2006
1b	**Direct cross training** may not have a difference in efficacy when compared to **indirect cross training** for improving functional ambulation.	1	Park et al. 2020
1b	**Early intensive physiotherapy and aerobic exercise** may produce greater improvements in functional ambulation when compared to **conventional therapy.**	1	Wu et al. 2020; Hornby et al. 2016; Lee et al. 2015
2	**High intensity interval training** may not have a difference in efficacy when compared to **moderate intensity training or conventional therapy** for improving functional ambulation.	1	Boyne et al. 2019;

1b	**Sling exercise therapy** may produce greater improvements in functional ambulation when compared to **conventional therapy.**	2	Liu et al. 2020; Lou et al. 2019

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Patient directed activities program and self-regulation** may not have a difference in efficacy when compared to **conventional therapy** for improving functional mobility.	1	Swank et al. 2020
1b	**A community exercise program** may produce greater improvements in functional mobility when compared to **usual care.**	1	Greene et al. 2002

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Bodyweight shift techniques** may not have a difference in efficacy when compared to **conventional rehabilitation or perturbation training** for improving balance.	4	Handelzalts et al. 2019; Krishna et al. 2018; Allison et al. 2007; Howe et al. 2005
1b	**Agility-focused exercise** may not have a difference in efficacy when compared **to body-weight shift exercises** for improving balance.	1	Marigold et al., 2005
1b	**Patient directed activities program and self-regulation** may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	1	Swank et al. 2020
1b	**Direct cross training** may not have a difference in efficacy when compared to **indirect cross training** for improving balance.	1	Park et al. 2020
2	There is conflicting evidence about the effect of **open-chain" exercises** when compared to **"closed-chain" exercises** for improving balance.	1	Krawczyk et al., 2014;
1a	**Early intensive physiotherapy and aerobic exercise** may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	3	Wu et al. 2020; Hornby et al. 2016; Lee et al. 2015
1b	**High intensity interval training** may not have a difference in efficacy when compared to **moderate intensity training or conventional therapy** for improving balance.	1	Hesse et al. 2011
1b	**Sling exercise therapy** may produce greater improvements in balance when compared to **conventional therapy.**	2	Liu et al. 2020; Lou et al. 2019

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Bodyweight shift techniques** may not have a difference in efficacy when compared to **conventional rehabilitation or perturbation training** for improving gait.	1	Krishna et al. 2018
1b	**Agility-focused exercise** may produce greater improvements in gait than the **other exercise programs** they were compared against.	1	Marigold et al., 2005
1b	**Aerobic exercise** may produce greater improvements in gait when compared to **conventional therapy.**	1	Hornby et al. 2016
2	The **"open-chain" exercises** used may not have a difference in efficacy when compared to **"closed-chain" exercises** they were compared against for improving gait.	1	Krawczyk et al., 2014
1b	**High intensity interval training** may not have a difference in efficacy when compared to **moderate intensity training or conventional therapy** for improving gait.	1	Hesse et al. 2011
1b	**Sling exercise therapy** may produce greater improvements in gait when compared to **conventional therapy.**	2	Liu et al. 2020; Lou et al. 2019

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Patient directed activities program and self-regulation** may not have a difference in efficacy when compared to **conventional therapy** for improving performance on activities of daily living.	2	Swank et al. 2020; Liu et al. 2014
1b	**Early intensive physiotherapy** may not have a difference in efficacy when compared to **conventional therapy** for improving performance on activities of daily living.	1	Wu et al. 2020;
1b	**High intensity interval training** may not have a difference in efficacy when compared to **moderate intensity training or conventional therapy f**or improving performance on activities of daily living.	1	Hesse et al. 2011
1b	**Sling exercise therapy** may produce greater improvements in performance on activities of daily living when compared to **conventional therapy.**	2	Liu et al. 2020; Lou et al. 2019

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
2	The **"open-chain" exercises** used may not have a difference in efficacy when compared to **"closed-chain" exercises** they were compared against for improving range of motion.	1	Krawczyk et al., 2014

MUSCLE STRENGTH			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Supervised activity programs** may not have a difference in efficacy when compared to **unsupervised activities** for improving muscle strength.	1	Olney et al., 2006
1b	**High intensity interval training** may not have a difference in efficacy when compared to **moderate intensity training or conventional therapy** for improving muscle strength.	1	Hesse et al. 2011

SPASTICITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**High intensity interval training** may not have a difference in efficacy when compared to **moderate intensity training or conventional therapy** for improving spasticity.	1	Hesse et al. 2011

STROKE SEVERITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Patient directed activities program** may not have a difference in efficacy when compared to **conventional therapy** for improving stroke severity.	1	Swank et al. 2020
1b	**Early intensive physiotherapy** may not have a difference in efficacy when compared to **conventional therapy** for improving stroke severity.	1	Wu et al. 2020;

Key Points

Bodyweight shift techniques may not be beneficial for improving multiple measures of stroke rehabilitation.

Balanced-focused exercise, early intensive physiotherapy, and aerobic exercise may not be beneficial for improving balance or other areas of stroke rehabilitation.

Balance Training

Adapted from: https://www.flintrehab.com/regaining-balance-after-stroke/

Balance impairment is a common early symptom after stroke and is strongly associated with future recovery. Likewise, balance problems are the strongest predictors for future falls and related injuries (Lubetzky-Vilnai & Kartin 2010). Multiple interventions have aimed to improve balance in multi-faceted approaches. Many balance-focused rehabilitations strategies employ visual feedback to facilitate improvements in symmetrical weight bearing and posture. Recently, technological approaches have expanded the quantity and quality of real-time feedback on balance performance. Feedback driven interventions for balance training include bodyweight supported training, fixed, supportive and perturbation-based balance platforms and trunk training.

A total of 24 RCTs were found evaluating balance training interventions for lower extremity motor rehabilitation. Three RCTs were found evaluating balance training vs conventional therapy (Puckree et al. 2014; Batchelor et al. 2012; Yelnik et al. 2008). Four RCTs compared SMART Balance Master training to conventional rehabilitation (Rao et al. 2013; Chen et al. 2002; Geiger et al. 2001; Walker et al. 2000). Eight RCTs investigated non-supportive balance training (Ghomaschi 2016; De Nunzio et al. 2014; Lee et al. 2013b; Yoon et al. 2013; Varogui et al. 2011; Alptekin et al. 2008; Eser et al. 2008; Sackley & Lincoln et al. 1997). Five RCTs compared perturbation balance training with feedback to conventional therapy (An et al. 2020; Yadav et al. 2019; Ordahan et al. 2015; Ko et al. 2015; Goliar et al. 2010). Two RCTs compared fixed supportive balance training to conventional therapy (Chen et al. 2001; Wong et al. 1997). One RCT compared trunk training with visual feedback (Shin & Song 2016). One RCT compared sitting balance training with feedback to conventional therapy (De Seze et al. 2001).

The methodological details and results of all 24 RCTs are presented in Table 11.

Table 11. RCTs Evaluating Balance Training for Lower Extremity Motor Rehabilitation

Authors (Year) **Study Design (PEDro Score)** **Sample Size$_{start}$** **Sample Size$_{end}$** **Time post stroke category**	**Interventions** **Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures** **Result (direction of effect)**
Balance-Focused Exercise Programs vs Conventional Rehabilitation		
Puckree et al. (2014) RCT (6) N_{start}=50 N_{end}=43 TPS=Acute	E: Balance and stability focused physiotherapy rehabilitation C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 4wk	• Postural Assessment Scale for Stroke (+exp) • Berg Balance Scale (+exp)
Batchelor et al. (2012) RCT (8) N_{start}=156 N_{end}=148 TPS=Chronic	E: Falls prevention program including home exercise, implementation of falls and injury risk minimization as well as education. C: Usual care Duration: 1hr/d, 3d/wk for 12mo	• Falls rate (-) • Falls risk (-) • Falls efficacy (-) • Balance (-) • Gait (-) • Strength (-) • Participation (-) • Activity (-)
Yelnik et al. (2008) RCT (7) N_{start}=68 N_{end}=67 TPS=Chronic	E: Balance training + Visual deprivation C: Conventional rehabilitation Duration: 45min/d, 5d/wk for 4wk	• Functional Independence Measure (+exp) • Berg Balance Scale (-) • Double stance phase (-) • Gait speed (-) • Step climbing (-) • Daily walking (-)
Balance Training Using SMART Balance Master vs Conventional Rehabilitation		
Rao et al. (2013) RCT (5) N_{start}=28 N_{end}=28 TPS=Acute	E: Balance training + postural control visual biofeedback (SMART Balance master) C: Conventional rehabilitation Duration: 1hr/d, 3d/wk for 4wk	• Fugl-Meyer Assessment (-) • Functional Independence Measure (-)
Chen et al. (2002) RCT (4) N_{start}=41 N_{end}=38 TPS=Subacute	E: Balance training + postural control visual biofeedback (SMART Balance master) C: Conventional rehabilitation Duration: *Not Specified*	• Dynamic balance (+exp) • Static balance (-) • Functional Independence Measure (-)
Geiger et al. (2001) RCT (5) N_{start}=13 N_{end}=13 TPS=Chronic	E: Balance training + postural control visual biofeedback (SMART Balance master) C: Conventional rehabilitation Duration: 50min/d, 3d/wk for 4wk	• Berg Balance Scale (-) • Timed Up & Go Test (-)
Walker et al. (2000) RCT (4) N_{start}=54 N_{end}=54 TPS=Chronic	E1: Balance training + postural control visual biofeedback (SMART Balance master) E2: Balance training C: Conventional rehabilitation Duration: 2hr/d, 5d/wk for 8wk	• Berg Balance Scale (-) • Timed Up & Go Test (-) • Gait speed (-)
Non-Supportive Balance Trainers with Feedback vs Conventional Therapy or Balance Training		
Ghomashchi (2016) RCT (3) N_{start}=31 N_{end}=27 TPS=Chronic	E: Balance training + postural control visual biofeedback C: Balance training Duration: 1hr/d, 3d/wk for 4wk	• Postural balance (-) • Centre of pressure (-)
De Nunzio et al. (2014) RCT (7)	E: Balance Platform Training with Audio-visual Feedback	• Standing Balance Score (-) • Unified Balance Scale (-)

N_{start}=37 N_{end}=37 TPS=Not Reported	C: Conventional Physiotherapy Duration: 30min, 6d/wk, 2wks	• Functional Independence Measure (-) • Center of Pressure (-)
Lee et al. (2013b) RCT (4) N_{start}=22 N_{end}=22 TPS=Chronic	E: Balance training + postural control visual biofeedback C: Balance training Duration: 60min/d, 5d/wk for 4wk	• Static balance (+exp) • Dynamic balance (+exp)
Yoon et al. (2013) RCT (2) N_{start}=24 N_{end}=24 TPS=Chronic	E1: Balance training + self-controlled postural control visual biofeedback E2: Balance training + no control over postural control visual biofeedback C: Balance training Duration: 45min/d, 5d/wk for 6wk	E1/E2 vs C: • Postural sway:(+exp, +exp$_2$) E1 vs E2: • Postural Sway (-)
Varoqui et al. (2011) RCT (6) N_{start}=24 N_{end}=24 TPS=Subacute	E1: Balance training + postural control visual biofeedback from unaffected side E2: Balance training + postural control visual biofeedback from affected side C: Balance training Duration: *Not Specified*	E1/E2 vs C • Functional Independence Measure: (+exp, +exp$_2$) • Berg Balance Scale (-)
Alptekin et al. (2008) RCT (7) N_{start}=30 N_{end}=30 TPS=Chronic	E: Balance training + postural control visual biofeedback C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 4wk	• Dynamic balance (+exp) • Static balance (+exp) • Fugl-Meyer Assessment – Balance (+exp) • Fugl-Meyer Assessment – Total (-) • Functional Independence Measure (-)
Eser et al. (2008) RCT (5) N_{start}=41 N_{end}=41 TPS=Chronic	E: Balance training + postural control visual biofeedback C: Conventional rehabilitation Duration: 15min/d, 5d/wk for 3wk	• Brunnstrom Recovery Stage (-) • Rivermead Mobility Index (-) • Functional Independence Measure (-)
Sackley & Lincoln et al. (1997) RCT (6) N_{start}=26 N_{end}=26 TPS=Chronic	E: Balance training + postural control visual biofeedback C: Balance training with sham feedback Duration: 30min/d, 3d/wk for 6wk	• Postural sway (+exp) • Stance symmetry (+exp) • Rivermead Motor Assessment (+exp) • Nottingham ADL Scale (+exp)
Perturbation Balance Trainers with Feedback vs Conventional Therapy or Balance Training		
An et al. (2020) RCT (8) N_{start}=30 N_{end}=30 TPS=Acute	E: Whole-Body Tilt Table Postural Training + Visual feedback C: General Postural Training Duration: 30min, 2x/d, 5d/wk, 3wks	• Burke Lateropulsion Scale (+exp) • Postural Assessment Scale for Stroke (+exp) • Berg Balance Scale (+exp) • Modified Barthel Index (+exp) • Fugl-Meyer Assessment (+exp)

Yadav et al. (2019)
RCT (4)
N_{start}=133
N_{end}=110
TPS=Acute
	E1: Haemorrhagic Stroke Erigo Robotic Tilt Table
	E2: Ischemic Stroke Erigo Robotic Tilt Table
	C1: Haemorrhagic Stroke Conventional Care
	C2: Ischemic Stroke Conventional Care
	Duration: 50-60min, 6d/wk, 30d
		• Heamorrhagic Group
		  • Manual Muscle Score (-)
		  • National Institutes of Health Stroke Scale (+exp)
		  • Modified Ashworth Scale (+exp)
		• Ischemic Group
		  • Manual Muscle Score (-)
		  • National Institutes of Health Stroke Scale (-)
		• Modified Ashworth Scale (-)

Ordahan et al. (2015) RCT (5) N_{start}=50 N_{end}=44	E: Balance training + postural control visual biofeedback C: Conventional rehabilitation Duration: 20min/d, 5d/wk for 6wk	• Berg Balance Scale (+exp) • Timed Up & Go Test (+exp) • Functional Independence Measure (-)

TPS=Chronic		
Ko et al. (2015) RCT (4) N_{start}=52 N_{end}=52 TPS=Acute	E: Balance training + postural control visual biofeedback C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 3wk	• Berg Balance Scale (-) • Timed Up & Go Test (-) • Postural Assessment Scale for Stroke (-)
Goljar et al. (2010) RCT (6) N_{start}=50 N_{end}=39 TPS=Subacute	E: Balance training + postural control visual biofeedback C: Conventional balance training Duration: 45min/d, 5d/wk for 4wk	• Berg Balance Scale (-) • Timed Up & Go Test (-) • 10-Metre Walk Test (-)
Fixed Supportive Balance Trainers vs Conventional Therapy or Balance Training		
Cheng et al. (2001) RCT (5) N_{start}=54 N_{end}=48 TPS=Subacute	E: Balance training + postural control visual biofeedback C: Conventional rehabilitation Duration: 20min/d, 5d/wk for 3wk	• Sit-to-stand performance (-) • Rate of rise in force (-) • Sway in center of pressure (-)
Wong et al. (1997) RCT (5) N_{start}=60 N_{end}=52 TPS=Subacute	E: Balance training + postural control visual biofeedback C: Balance training Duration: Not Specified	• Postural symmetry (+exp)
Trunk Training with Visual Feedback vs Conventional Therapy		
Shin & Song (2016) RCT (6) N_{start}=24 N_{end}=24 TPS=Chronic	E: Trunk training + postural control smartphone-based visual feedback C: Conventional rehabilitation Duration: 20min/d, 3d/wk for 4wk	• Static Balance (+exp) • Timed Up & Go Test (+exp) • Trunk Impairment Scale (+exp) Modified Functional Reach Test (+exp)
Sitting Balance Training with Feedback (Bon Saint Come Device) vs Conventional Therapy		
De Seze et al. (2001) RCT (6) N_{start}=20 N_{end}=20 TPS=Acute	E: Balance training + postural control visual biofeedback C: Conventional rehabilitation Duration: 2hr/d, 5d/wk for 8wk	• Trunk Control Test (+exp) • Upright Equilibrium Index (+exp) • Functional Ambulation Category (+exp) • Sitting Equilibrium Index (-) • Motricity Index (-) • Functional Independence Measure (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Balance Training

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**SMART Balance Trainers with feedback** does not have a difference in efficacy when compared to **conventional therapy** for improving motor function.	1	Rao et al. 2013
1a	**Non-supportive balance trainers with feedback** may not have a difference in efficacy when compared to **conventional therapy or balance training** for improving motor function.	3	Alptekin et al. 2008; Eser et al. 2008; Sackley & Lincoln 1997

1b	**Perturbation-based balance trainers with feedback** may produce greater improvements in motor function when compared to **balance training or conventional therapy.**	1	Ko et al. 2015; Goljar et al. 2010
1b	**Sitting balance training with feedback** may not have a difference in efficacy when compared to **conventional therapy** for producing greater improvements in motor function.	1	De Seze et al. 2001

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	**Balance-focused programs** may not have a difference in efficacy when compared to **conventional rehabilitation** for improving functional ambulation.	1	Yelnik et al., 2008
1b	**Perturbation-based balance trainers with feedback** does not have a difference in efficacy when compared to **balance training or conventional therapy** for improving functional ambulation.	2	Ko et al. 2015; Goljar et al. 2010
1b	**Sitting balance training with feedback** may produce greater improvements in functional ambulation when compared to **conventional therapy.**	1	De Seze et al. 2001

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**Balanced-focused exercise** may not have a difference in efficacy when compared to **conventional rehabilitation** for improving gait.	2	Batchelor et al., 2012; Yelnik et al., 2008;
2	**SMART Balance Trainers with feedback** does not have a difference in efficacy when compared to **conventional therapy** for improving gait.	1	Walker et al. 2000
1b	**Non-supportive balance trainers with feedback** may not have a difference in efficacy when compared to **conventional therapy or balance training** for improving gait.	1	Sackley & Lincoln 1997

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Balanced-focused exercise** may not have a difference in efficacy when compared to **conventional rehabilitation** for improving balance.	3	Puckree et al., 2014; Batchelor et al., 2012; Yelnik et al., 2008;
2	**SMART Balance Trainers with feedback** may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	3	Chen et al. 2002; Geiger et al. 2001; Walker et al. 2000
1a	**Non-supportive balance trainers with feedback** may not have a difference in efficacy when compared	6	De Nunzio et al. 2014; Ghomashchi et al. 2013; Lee et al. 2013; Varoqui et al. 2011; Alptekin et al.

	to **conventional therapy or balance training** for improving balance.		2008; Sackley & Lincoln 1997
1a	There is conflicting evidence about the effect of **perturbation-based balance training with feedback** when compared to **balance training or conventional therapy for** improving balance.	4	An et al. 2020; Ko et al. 2015; Ordahan et al. 2015; Goljar et al. 2010
2	**Fixed balance trainers with feedback** may not have a difference in efficacy when compared to **conventional therapy or balance training** for improving balance.	2	Cheng et al. 2001; Wong et al. 1997
1b	**Trunk training with visual feedback** may produce greater improvements in balance when compared to **conventional therapy.**	1	Shin & Song 2016
1b	There is conflicting evidence about the effect of **Sitting balance training with feedback** when compared to **conventional therapy for** producing greater improvements in balance.	1	De Seze et al. 2001

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of the b**alanced-focused exercise programs** when compared to **conventional rehabilitation.** For improving performance on activities of daily living.	2	Yelnik et al, 2008; Batchelor et al. 2012
2	**SMART Balance Trainers with feedback** does not have a difference in efficacy when compared to **conventional therapy** for improving performance on activities of daily living.	2	Rao et al. 2013; Chen et al. 2002
1a	**Non-supportive balance trainers with feedback** may not have a difference in efficacy when compared to **conventional therapy or balance training** for improving performance on activities of daily living.	4	De Nunzio et al. 2014; Varoqui et al. 2011; Alptekin et al. 2008; Eser et al. 2008
1b	There is conflicting evidence about the effect of **perturbation-based balance training with feedback** when compared to **balance training or conventional therapy** for improving performance on activities of daily living.	2	An et al. 2020; Ordahan et al. 2015

SPASTICITY

LoE	Conclusion Statement	RCTs	References
2	**Perturbation-based balance trainers with feedback** may not have a difference in efficacy when compared to **balance training or conventional therapy** for improving spasticity.	1	Yadav et al. 2019

MUSCLE STRENGTH			
LoE	Conclusion Statement	RCTs	References
1b	**Balanced-focused exercise** may not have a difference in efficacy when compared to **conventional rehabilitation** for improving muscle strength.	1	Batchelor et al. 2012
2	**Perturbation-based balance trainers with feedback** may not have a difference in efficacy when compared to **balance training or conventional therapy** for improving muscle strength.	1	Yadav et al. 2019
2	**Fixed balance trainers with feedback** may not have a difference in efficacy when compared to **conventional therapy or balance training** for improving muscle strength.	1	Cheng et al. 2001

STROKE SEVERITY			
LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **perturbation-based balance training with feedback** when compared to **balance training or conventional therapy** for improving stroke severity.	2	An et al. 2020; Yadav et al. 2019

Key points

Balance focused exercise training may be beneficial for activities of daily living

Balance training with feedback may not be beneficial for post-stroke rehabilitation in improving motor function, ambulation, or balance

The literature is mixed concerning the effect of perturbation-based balance training with feedback in improving balance.

Dynamic Stretching (Pilates, Tai Chi, Yoga)

Adopted from: https://www.medicalnewstoday.com/articles/318160.php

Stretching exercise performed during dynamic activities such as pilates, yoga, and tai chi or during proprioceptive neuromuscular facilitation aims to reduce hypertonicity post-stroke. Prevention of hypertonicity may reduce the risk for development of contracture while improving the range of motion of the joint and stability of the whole-body. Most stretching activities are of relatively low physical impact and low cost. From a fitness standpoint, they focus on flexibility, balance, coordination and muscle endurance (Donahoe-Fillmore & Grant, 2019). Given these attributes, dynamic stretching could provide an alternative therapy to improve lower extremity rehabilitation. In addition, these practices have non-physical benefits. It has been reported that yoga can increase mental health outcomes, and contribute to a higher overall quality of life (Büssing et al., 2012). Stretching activities are also benefiting from the addition of technology as evidenced by the use of VR and ankle stretching robotics.

A total of 15 RCTs were found evaluating stretching and mobilization interventions for lower extremity motor rehabilitation. Four RCTs were found evaluating functional stretching or mobilization programs compared to conventional or no therapy (Pardines et al. 2019; Ghasemi et al. 2018a; Ghasemi et al. 2018b; An et al. 2017). One RCT compared mobilization with tilt table to conventional mobilization (Park et al. 2018). Five RCTs compared dynamic stretching programs to conventional or no therapy (Lim et al., 2016; Kim et al., 2015; Immink et al., 2014; Schmid et al., 2012; Au-Yeung et al., 2009). One RCT compared body weight supported tai chi to conventional care (Huang et al. 2019). One RCT compared early and late proprioceptive neuromuscular facilitation (Morreale et al. 2016). One RCT compared proprioceptive neuromuscular facilitation with virtual reality to virtual reality of PNF alone (dos Santos Junior et al. 2019). One RCT compared proprioceptive neuromuscular facilitation with treadmill training to treadmill alone (Kim & Kim, 2018). One RCT compared an ankle stretching robotic device to ankle stretching with a board (Yoo et al. 2018).

The methodological details and results of all 15 RCTs are presented in Table 12.

Table 12. RCTs Evaluating Stretching or Mobilization Exercises for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Functional Stretching or Mobilization vs Conventional Therapy		
Pradines et al. (2019) RCT (6) N$_{start}$=23 N$_{end}$=23 TPS=Chronic	E: Guided Self-rehabilitation Stretching Program C: Conventional Care Duration: 1 year (prescribed daily stretch, weekly home visit)	• Ambulation Speed (+exp)
Ghasemi et al. (2018a) RCT (5) N$_{start}$=45 N$_{end}$=45 TPS=Chronic	E: Functional Stretching Training C: Conventional Care Duration: 3x/wk, 4wks	• Modified Modified Ashworth Scale (+exp) • Ankle Range of Motion - Ankle (+exp)
Ghasemi et al. (2018b) RCT (6) N$_{start}$=30 N$_{end}$=28 TPS=Chronic	E: Functional stretch training C: Conventional physiotherapy Duration: 5min/d, 3d/wk, 4wks	• Modified Ashworth Scale (-) • Ankle Range of Motion (-) • Ten Meter Walk Test (-) • Timed Up-and Go (-)

An et al. (2017)
RCT (6)
N$_{start}$=26
N$_{end}$=26
TPS=Chronic
	E: Talocrural Mobilization
	C: Conventional Care
	Duration: Therapy 30min, 3x/wk, 5wks, + mobilization 30min, 3x/wk, 5wks
		• Dynamometer
		  • Plantar Flexion (+exp)
		  • Dorsiflexion (-)
		• Passive Range of Motion (+exp)
		• Limit of Stability (+exp)
		• Gait Kinematics
		  • Plantar Flexion (+exp)
		  • Swing Phase (-)
		  • Single Limb Support Phase (-)
		• Double Limb Support Phase (-)

Mobilization with Incline Board vs Conventional Therapy		
Park et al. (2018) RCT (6) N$_{start}$=28 N$_{end}$=28 TPS=Chronic	E: Mobilization with Movement On 10 Incline Board C: Conventional Mobilization with Movement Duration: 3x/wk, 4wks	• Ankle Passive Range of Motion (+exp) • Static Balance Ability (+exp) • Berg Balance Scale (-) • Gait Speed (+exp) • Cadence (+exp) • Step Length (+exp) • Barthel Index (-)
Dynamic Stretching vs Conventional or No Therapy		
Lim et al. (2016) RCT (5) N$_{start}$=19 N$_{end}$=19 TPS=Chronic	E: Pilates C: No therapy Duration: 30min/d, 3d/wk for 8wk	• Centre of pressure sway (+exp) • Centre of pressure velocity (+exp)
Kim et al. (2015) RCT (5) N$_{start}$=22 N$_{end}$=20 TPS=Chronic	E: Tai Chi C: Conventional rehabilitation Duration: 30min (2x/d) for 6wk	• Sway velocity (+exp) • Sway length (+exp) • Timed Up & Go Test (+exp) • Functional Reach Test (+exp) • 10-Metre Walk Test (+exp) • Dynamic Gait Index (+exp)
Immink et al. (2014) RCT (6) N$_{start}$=22 N$_{end}$=22	E: Yoga C: No therapy Duration: 1hr/d, 2d/wk for 10wk	• Berg Balance Scale (-)

TPS=Chronic		
Schmid et al. (2012) RCT (6) $N_{start}=47$ $N_{end}=39$ TPS=Chronic	E: Yoga C: No therapy Duration: 1hr/d, 2d/wk (biweekly) for 8wk	• Berg Balance Scale (-) • Activities-Specific Balance Confidence Scale (-) • Fear of falling (-)
Au-Yeung et al. (2009) RCT (6) $N_{start}=136$ $N_{end}=109$ TPS=Chronic	E: Tai Chi C: Conventional exercises Duration: 45min/d, 3d/wk for 12wk	• Dynamic balance (+exp) • Standing equilibrium (-) • Timed Up & Go Test (-)
Body Weight Supported Dynamic Stretching vs Conventional Therapy		
Huang et al. (2019) RCT (8) $N_{start}=28$ $N_{end}=25$ TPS=Chronic	E: Body Weight Supported Tai Chi C: Conventional Care Duration: 40min, 3x/wk, 12wks	• Limit of Stability (-) • Modified Clinical Test of Sensory Integration of Balance (+exp) • Falls Risk Index (+exp) • Fugl-Meyer Assessment (+exp)
Early vs late Proprioceptive Neuromuscular Facilitation (PNF)		
Morreale et al. (2016) RCT (7) $N_{start}=340$ $N_{end}=293$ TPS=Acute	E1: Early (<24hrs post-admission) Proprioceptive Neuromuscular Facilitation E2: Early (<24hrs post-admission) Cognitive Therapeutic Exercises C1: Delayed (4 days post-admission) Proprioceptive Neuromuscular Facilitation C2: Delayed (4 days post-admission) Cognitive Therapeutic Exercises Duration: 12mos (2.15hrs/d inpatient, 1.3hrs, 5x/wk outpatient)	E1/E2 vs C1/C2 • Modified Rankin Scale (-) • Barthel Index (-) • 6-Minute Walk Test (+exp1,+exp2) • Motricity Index (+exp1,+exp2) E1/C1 vs E2/C2 • Modified Rankin Scale (-) • Barthel Index (-) • 6-Minute Walk Test (-) • Motricity Index (-)
Proprioceptive Neuromuscular Facilitation (PNF) with VR vs PNF or VR Alone		

dos Santos Junior et al. (2019)
RCT (6)
$N_{start}=48$
$N_{end}=40$
TPS=Chronic
	E1: Virtual Reality
	E2: Virtual Reality + Proprioceptive Neuromuscular Facilitation
	C: Proprioceptive Neuromuscular Facilitation
	Duration: 50min/d, 2d/wk, 8wks
		E1/E2 vs C
		• Fugl-Meyer Assessment (-)
		  • Sensory Assessment (-)
		  • Balance (-)
		E1 vs E2
		• Fugl-Meyer Assessment (-)
		  • Sensory Assessment (-)
		  • Balance (-)

Proprioceptive Neuromuscular Facilitation (PNF) with Treadmill Training vs Treadmill Training		
Kim & Kim. (2018) RCT (6) $N_{start}=23$ $N_{end}=23$ TPS=Chronic	E: Treadmill Training + Proprioceptive Neuromuscular Facilitation C: Treadmill Training Duration: 40min/d, 5d/wk, 6wks	• Timed Up & Go Test (+exp) • 10-Meter Walking Test (+exp) • 6-Minute Walking Test (+exp)
Ankle Stretching Robotics vs Ankle Stretcher Exercises		
Yoo et al. (2018) RCT (4) $N_{start}=16$ $N_{end}=16$ TPS=Chronic	E: Motorized Ankle Stretcher C: Ankle Stretching with Board Duration: 30min, 2x/wk, 7 sessions (3.5wks)	• Ankle Range of Motion (+exp) • Walking Speed (-) • Walking Cadence (-) • Step Length (-) • Sensory Organization Test (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
$+exp_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group

+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Dynamic Stretching

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Body weight supported dynamic stretching** may produce greater improvements in motor function than **conventional rehabilitation**	1	Huang et al. 2019
1b	**Early proprioceptive neuromuscular facilitation** may produce greater improvements in motor function when compared to **late proprioceptive neuromuscular facilitation.**	1	Morreale et al. 2016
1b	**Proprioceptive neuromuscular facilitation and VR** may not have a difference in efficacy in improving motor function when compared to **Proprioceptive neuromuscular facilitation or VR alone.**	1	Do Santos Junior et al. 2019

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **dynamic stretching** when compared to **conventional rehabilitation** for functional ambulation.	3	Pradines et al. 2019; Ghasemi et al. 2018b; Kim et al., 2015
1b	**Early proprioceptive neuromuscular facilitation** may produce greater improvements in functional ambulation when compared to **late proprioceptive neuromuscular facilitation.**	1	Morreale et al. 2016
1b	**Proprioceptive neuromuscular facilitation with treadmill training** may produce greater improvements in functional ambulation when compared to **treadmill training alone**.	1	Kim & Kim 2018

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **dynamic stretching** when compared to **conventional rehabilitation** for improving balance.	9	Huang et al. 2019; Ghasemi et al. 2018b; Park et al. 2018; An et al. 2017; Lim et al. 2016; Kim et al., 2015; Immink et al., 2014; Schmid et al., 2012; Au-Yeung et al., 2009
1b	**Body weight supported dynamic** stretching may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	1	Huang et al. 2019
1b	**Proprioceptive neuromuscular facilitation with treadmill training** may produce greater improvements in balance when compared to **treadmill training alone**.	1	Kim & Kim 2018

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**Dynamic stretching** may produce greater improvements in gait than **conventional rehabilitation**	3	Park et al. 2018; An et al. 2017; Kim et al., 2015
2	**Motorized ankle stretching** may not have a difference in efficacy when compared to **ankle stretching boards** for improving gait.	1	Yoo et al. 2018

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1b	**Dynamic stretching programs** may not have a difference in efficacy for improving performance on activities of daily living when compared to **conventional therapy**.	1	Park et al. 2018
1b	**Early proprioceptive neuromuscular facilitation** may not have a difference in efficacy when compared to **late proprioceptive neuromuscular facilitation for** producing greater improvements in performance on activities of daily living.	1	Morreale et al. 2016

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1a	**There is conflicting evidence about the effect of dynamic stretching programs** for improving range of motion when compared to **conventional therapy.**	4	Ghasemi et al. 2018a; Ghasemi et al. 2018b; Park et al. 2018; An et al. 2017
2	**Motorized ankle stretching** produce greater improvements in range of motion when compared to ankle stretching boards.	1	Yoo et al. 2018

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **dynamic stretching programs** for improving muscle strength when compared to **conventional therapy**.	1	An et al. 2017

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Functional stretching programs** may not have a difference in efficacy for improving spasticity when compared to **conventional therapy.**	2	Ghasemi et al. 2018a; Ghasemi et al. 2018b

STROKE SEVERITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Early proprioceptive neuromuscular facilitation** may not have a difference in efficacy when compared to **late proprioceptive neuromuscular facilitation** for producing greater improvements stroke severity.	1	Morreale et al. 2016

Key points

The literature is mixed concerning the effect of dynamic stretching in improving functional ambulation, range of motion, and balance.

Dynamic stretching may be beneficial for improving gait.

Orthotics

Adopted from: http://www.acor.com/orthotic-devices.php

Orthotics are defined as medical devices used to improve the function and mobility of the body. Commonly used orthotics used in post-stroke rehabilitation of the lower extremity include ankle foot orthoses and shoe lifts. Shoe lifts or wedges alter biomechanical positioning by compelling a weight shift to the paretic side and consequently redistribute weight more symmetrically. This has the potential to improve the ability for functional ambulation and quality gait cycles. Ankle-foot orthotics (also known as foot-drop splints) aim to stabilize the foot and ankle and during weight-bearing and lift the toes while stepping, in effect reducing foot drop. (Tyson et al. 2013) Other assistive devices including taping and canes are also reviewed below.

A total of 16 RCTs were found evaluating orthotic devices for lower extremity motor rehabilitation. One RCT compared ankle taping to placebo or no tape (Shin et al. 2019). Three RCTs compared shoe insole orthotics to conventional therapy or overground walking (Fortes et al. 2020; Aruin et al. 2012; Forghany et al. 2010). Eight RCTs compared ankle foot orthotic devices to no orthotic devices (Yamamoto et al. 2018; Pomeroy et al. 2016; Zissimopoulos et al. 2015; Zollo et al. 2015; Lee et al. 2014; de Seze et al. 2011; Chen et al. 2010; de Wit et al. 2014). One RCT compared the timing of instituting an ankle foot orthosis (Nikamp et al. 2017). Three RCTs compared other orthotic devices (Chiong et al. 2013; DeMeyer et al. 2015; Lauffer et al. 2002).

The methodological details and results of all 16 RCTs are presented in Table 13.

Table 13. RCTs Evaluating Orthotic Devices for Upper Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Ankle Taping vs Placebo or No Tape		
Shin et al. (2019) RCT crossover (8) N_{start}=15 N_{end}=15 TPS=Chronic	E: Orthotics (Ankle Taping) C1: Placebo Taping C2: No taping Duration: single session, 10 min washout period	E vs C1 • Gait • Velocity (+exp) • Step Length (+exp) • Stride Length (+exp) • Cadence (+exp) E vs C2 • Gait • Velocity (+exp) • Step Length (+exp) • Stride Length (+exp) • Cadence (+exp)
Shoe Insole Orthotics During Walking vs Overground Walking or Conventional Therapy		
Fortes et al. (2020) RCT (6) N_{start}=42 N_{end}=42 TPS=Chronic	E: Shoe orthotic (shoe lift) 1.5cm C: Overground walking Duration: single session	• Ten Minute Walk Test (+exp) • Timed Up-and-Go (+exp)
Aruin et al. (2012) RCT (3) N_{start}=18 N_{end}=18 TPS=Chronic	E: Shoe insole orthotic (0.6cm) C: Conventional therapy Duration: 60min/d, 6d/wk, 6wks home exercises + 60min/d, 1d/wk, 6wks physical therapy or physical therapy + using insole	• Weight bearing (-) • Gait Velocity (-) • Berg Balance Scale (-) • Fugl-Meyer Assessment (-)
Forghany et al. (2010) RCT crossover (6) N_{start}=8 N_{end}=8 TPS=Not Reported	E1: 5-degree lateral wedge orthotic E2: 8.5-degree lateral wedge orthotic C: Overground walking Duration: 10 trials of each condition sequentially, no washout period	E1 Vs C • Walking speed (-) • Ankle plane of motion (+exp) E2 Vs C • Walking speed (-) • Ankle plane of motion (+exp) E1 Vs E2 • Walking speed (-) • Ankle plane of motion (+exp2)
Ankle-Foot Orthosis vs No Ankle-Foot Orthosis		
Yamamoto et al. (2018) RCT (7) N_{start}=42 N_{end}=40 TPS=Subacute	E: Ankle foot Orthosis with Plantar Stoop C: Ankle Foot Orthosis with Plantar Flexion Resistance Duration: 60min/d, 7d/wk, 2wks of physiotherapy while wearing device	• Temporal and Distance Factors (-) • Ground Reaction Forces (-) • Center of Pressure (-) • Ankle Joint Angle (-) • Ankle Joint Moment and Power (-) • Knee Joint Angle (-) • Knee Joint Moment (-) • Hip Joint Angle (-) • Hip Joint Moment (-) • Pelvic Tilt (-) • Thoracic Tilt (-)
Pomeroy et al. (2016) RCT (7) N_{start}=105	E: Ankle-Foot Orthosis (SWIFT cast) C: Conventional Care	• Walking Speed (-) • 3-Meter Independent Walk Test (-) • Functional Ambulation Category (-)

N_{end}=78 TPS=Acute	Duration: 6wks	• Modified Rivermead Mobility Index (-)
Zissimopoulos et al. (2015) RCT crossover (6) N_{start}=13 N_{end}=13 TPS=Chronic	E: Ankle Foot Orthoses (participants own, non-rigid articulated, dorsiflexion, plantar flexion, posterior leaf spring types) C: No Orthotic Duration: 1 session	• Mid-swing Plantar Flexion (+exp) • Hip hiking (-) • Circumduction (-) • Coronal Plane Hip Range of Motion (-) • Mediolateral Foot-Placement Ability (-)

Zollo et al. (2015)
RCT crossover (6)
N_{start}=10
N_{end}=10
TPS=Chronic
	E1: Solid Ankle Foot Orthosis
	E2: Dynamic Ankle Foot Orthosis
	C: No Ankle Foot Orthosis
	Duration: 5 walking trials/condition, no washout period
		E1 Vs C
		• Spatiotemporal Gait Analysis (-)
		• Kinematic Data
		    • Ankle (-)
		    • Knee (-)
		    • Hip (-)
		E2 Vs C
		• Spatiotemporal Gait Analysis (-)
		• Kinematic Data
		    • Ankle (-)
		    • Knee (-)
		    • Hip (-)
		E1 Vs E2
		• Spatiotemporal Gait Analysis (-)
		• Kinematic Data
		    • Ankle (-)
		    • Knee (-)
		    • Hip (-)

Lee et al. (2014) RCT (5) N_{start}=25 N_{end}=25 TPS=Chronic	E: Ankle Foot Orthosis (Joint type) C: No Orthotic Duration: 20min/, 2x/d, 5d/wk,6wks	• Overall Stability Index (-)

de Seze et al. (2011)
RCT (6)
N_{start}=28
N_{end}=28
TPS=Acute
	E: Chignon Ankle-Foot Orthosis
	C: Standard Ankle-Foot Orthosis
	Duration: 90d
		• 10-Meter Walk Test
		    • With Orthosis (+exp)
		    • Without Orthosis (+con)
		• Functional Ambulation Category (+con)
		• Postural Assessment Structural Scale (-)
		• Functional Independence Measure (-)
		• Motricity Index (-)
		• Ashworth Scale (-)

Chen et al. (2010)
RCT crossover (3)
N_{start}=14
N_{end}=14
TPS=Chronic
	E1: Posterior Ankle-Foot Orthosis
	E2: Anterior Ankle-Foot Orthosis
	C: No Ankle-Foot Orthosis
	Duration: single session, 5min washout
		E1 vs E2
		• Sagittal Plane
		    • Initial Contact (+exp1)
		    • Stance Phase (+exp1)
		    • Swing Phase (+exp1)
		    • Coronal Plane
		    • Initial Contact (-)
		    • Stance Phase (-)
		    • Swing Phase (-)
		• Transverse Plane
		    • Initial Contact (-)
		    • Stance Phase (-)
		    • Swing Phase (-)
		E1/E2 vs C

		• Sagittal Plane
		  • Initial Contact (+exp1
		  • Stance Phase (+exp1)
		  • Swing Phase (+exp1)
		  • Coronal Plane
		  • Initial Contact (-)
		  • Stance Phase (+exp2)
		  • Swing Phase (+exp1/+exp2)]
		• Transverse Plane
		  • Initial Contact (+exp1/+exp2)
		  • Stance Phase (-)
		  • Swing Phase (-)

de Wit et al. (2004) RCT crossover (6) N_{start}=20 N_{end}=20 TPS=Chronic	E: Walking with non-articulated plastic ankle-foot orthosis C: Walking without non-articulated plastic ankle-foot orthosis Duration: Not Specified	• Timed Up-and-Go (+exp) • Stair Climb (+exp) • Velocity (+exp)
Early vs Late Ankle Foot Orthosis		
Nikamp et al. (2017) RCT (5) N_{start}=33 N_{end}=20 TPS=Acute	E1: Early Ankle Foot Orthosis E2: Late Ankle Foot Orthosis (8wks after) Duration: 2wks of wearing orthotic (assessment at ~1.5mos and 3.5mos post-stroke respectively)	• Gait Kinematics (-) • Spatiotemporal Gait Characteristics (-)
Other Orthotic Devices		
Chiong et al. (2013) RCT (8) N_{start}=9 N_{end}=8 TPS=Chronic	E: Toe Spreader Orthotic C: No Orthotic (conventional care) Duration: 6mo study period	• Number of Steps (-) • Berg Balance Scale (-) • Gait Velocity (-) • Step Length (-) • Stride Length (-) • Cadence (-) • Modified Ashworth Scale (-)

DeMeyer et al. (2015)
RCT (7)
N_{start}=46
N_{end}=45
TPS=Acute
	E1: Bivalve Cast + Physical Therapy
	E2: Pressure-relieving Ankle-foot Orthosis + Physical Therapy
	C: Physical Therapy
	Duration: 60-90 min/day, 5-7 days/week physical therapy & 8-12 h/night bivalve cast and pressure-relieving ankle-foot orthosis
		<u>E1 vs C</u>
		• Modified Ashworth Scale (-)
		• Functional Independence Measure
		  • Transfer (-)
		  • Walking (-)
		  • Ankle Range of Motion (-)
		<u>E2 vs C</u>
		• Modified Ashworth Scale (-)
		• Functional Independence Measure
		  • Transfer (-)
		  • Walking (-)
		  • Ankle Range of Motion (-)

Laufer et al. (2002) RCT crossover (7) N_{start}=30 N_{end}=30 TPS=Subacute	E1: Single point Cane E2: Four-point Cane C: No Cane Duration: Single Session / Condition	<u>E1 vs E2</u> • Sway Index (+exp2) • Weight Distribution (-) <u>E1/E2 vs C</u> • Sway Index (+exp2) • Weight Distribution (-)

Conclusions about Orthotics

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**Shoe insert orthotics** may not have a difference in efficacy when compared to **conventional therapy** for improving motor function.	1	Aruin et al. 2012
1b	**Chignon Ankle-foot orthotics** may not have a difference in efficacy when compared to **conventional ankle-foot orthosis** for improving motor function.	1	De Seze et al. 2011

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	There is conflicting evidence about the effect of **shoe insert orthotics** to improve functional ambulation when compared to **conventional therapy or overground walking training**.	2	Fortes et al. 2020; Forghany et al. 2012
1a	**SWIFT and Chignon ankle-foot orthotics** may not have a difference in efficacy when compared to **no or standard orthotics** for improving functional ambulation.	2	Pomeroy et al. 2016; de Seze et al. 2011
1b	**Toe-spreader orthotics** may not have a difference in efficacy when compared to **no orthotics** for improving functional ambulation.	1	Chiong et al. 2013

BALANCE			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	There is conflicting evidence about the effect **of shoe insert** orthotics to improve balance when compared to **conventional therapy or overground walking training.**	2	Fortes et al. 2020; Aruin et al. 2012
1a	**Ankle-foot orthoses (chignon, dynamic, plantar stoop**) may not have a difference in efficacy when compared to **ankle foot orthotics (standard, rigid, anterior) or no orthotics** for improving balance.	4	Yamamoto et al. 2018; Lee et al. 2014; de Seze et al. 2011; de Wit et al. 2004
1b	**Toe-spreader orthotics** may not have a difference in efficacy when compared to **no orthotics** for improving balance.	1	Chiong et al. 2013
1b	There is conflicting evidence about the effect of **canes** for improving balance when compared **to no canes.**	1	Laufer et al. 2002

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Ankle taping** may produce greater improvements in gait when compared **to placebo or no taping**.	1	Shin et al. 2019
2	**Shoe insert orthotics** may not have a difference in efficacy when compared to **conventional therapy** for improving gait.	1	Aruin et al. 2012
2	**Early ankle-foot orthotics** may not have difference in efficacy when compared to **late ankle-foot orthosis** for improving gait.	1	Nikamp et al. 2017
1a	**Ankle-foot orthoses (posterior, dynamic plantar stoop)** may not have a difference in efficacy when compared to other **ankle foot orthotics (rigid, anterior) or no orthotics** for improving gait.	5	Yamamoto et al. 2018; Zissimopoulos et al. 2015; Zollo et al. 2015; Chen et al. 2010; de Wit et al. 2004
1b	**Toe-spreader orthotics** may not have a difference in efficacy when compared to **no orthotics** for improving gait.	1	Chiong et al. 2013

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1b	**Chignon ankle-foot orthotics** may not have a difference in efficacy when compared to **standard ankle-foot orthotics** for improving performance on activities of daily living.	1	De Seze et al. 2011
1b	**Bivalve casts** may not have a difference in efficacy when compared to **ankle-foot orthotics or conventional therapy** for improving performance on activities of daily living.	1	DeMeyer et al. 2015

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Shoe insert orthotics** may produce greater improvements in range of motion when compared **to overground walking**	1	Forghany et al. 2012
1b	**Bivalve casts** may not have a difference in efficacy when compared to **ankle-foot orthotics or conventional therapy** for improving range of motion.	1	DeMeyer et al. 2015

SPASTICITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Chignon ankle-foot orthotics** may not have a difference in efficacy when compared to **standard ankle-foot orthotics** for improving spasticity.	1	De Seze et al. 2011
1b	**Toe-spreader orthotics** may not have a difference in efficacy when compared to **no orthotics** for improving spasticity	1	Chiong et al. 2013
1b	**Bivalve casts** may not have a difference in efficacy when compared to **ankle-foot orthotics or conventional therapy** for improving spasticity.	1	DeMeyer et al. 2015

Key Points

Ankle-foot orthoses (chignon, dynamic, plantar stoop) may not be beneficial in improving balance and gait following stroke.

Hippotherapy

Adopted from: https://strokerecoveryfoundation.org

Hippotherapy utilizes the natural gait and rhythmic, repetitive movements of a horse to provide motor and sensory input, such inputs are similar to the movement pattern of the pelvis when a person is walking (Koca and Ataseven 2016; Cunningham, 2009). As a result, hippotherapy has garnered attention as a rehabilitative method for lower limb stroke recovery.

Five RCTs were found evaluating hippotherapy for lower extremity motor rehabilitation. Three RCTs compared hippotherapy to conventional therapy (Kim & Lee 2015; Lee & Kim et al. 2015; Sung et al. 2013). One RCT compared hippotherapy to trunk training (Baek et al. 2014). One RCT compared hippotherapy to trunk training (Baek et al. 2014). One RCT compared hippotherapy to treadmill training (Lee et al. 2014).

The methodological details and results of all five RCTs are presented in Table 14.

Table 14. RCTs Evaluating Hippotherapy Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Hippotherapy vs Conventional Therapy		
Kim & Lee (2015) RCT (4) N$_{start}$=20 N$_{end}$=17 TPS=Chronic	E: Hippotherapy C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 6wk	• 10-Metre Walk Test (+exp) • Berg Balance Scale (+exp) • Modified Barthel Index (+exp)
Lee & Kim (2015) RCT (6) N$_{start}$=30 N$_{end}$=30 TPS=Chronic	E: Hippotherapy C: Conventional therapy Duration: 30min/d, 5d/wk for 6wk	• Berg Balance Scale (+exp) • Timed Up & Go Test (+exp)
Sung et al. (2013) RCT (6) N$_{start}$=20 N$_{end}$=20 TPS=Chronic	E: Hippotherapy C: Conventional rehabilitation Duration: 45min/d, 5d/wk for 4wk	• Single support (+exp) • Load response (+exp) • Pre-swing (+exp) • Step length (-) • Stance phase (-) • Swing phase (-) • Cadence (-) • Double support (+exp)
Hippotherapy vs Trunk Training Therapy		
Baek et al. (2014) RCT (3) N$_{start}$=30 N$_{end}$=30 TPS=Chronic	E: Hippotherapy C: Trunk training Duration: 30min/d, 3d/wk for 8wk	• Centre of pressure (+exp)
Hippotherapy vs Treadmill Training		
Lee et al. (2014) RCT (4) N$_{start}$=30 N$_{end}$=30 TPS=Chronic	E: Hippotherapy C: Treadmill training Duration: 1hr/d, 5d/wk for 8wk	• Step length asymmetry ratio (+exp) • Berg Balance Scale (-) • Gait speed (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Hippotherapy

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
2	**Hippotherapy** may produce greater improvements in functional ambulation than **conventional therapy.**	1	Kim & Lee 2015
1b	**Hippotherapy** may not have a difference in efficacy compared to **treadmill training** for improving functional ambulation.	1	Lee et al. 2014

BALANCE

LoE	Conclusion Statement	RCTs	References
1b	**Hippotherapy** may produce greater improvements in balance than **conventional therapy.**	1	Kim & Lee 2015; Lee & Kim et al. 2015
1b	**Hippotherapy** may produce greater improvements in balance than **trunk training.**	1	Baek et al. 2014
1b	**Hippotherapy** may not have a difference in efficacy compared to **treadmill training** for improving balance.	1	Lee et al. 2014

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Hippotherapy** may not have a difference in efficacy compared to **conventional therapy** for improving gait.	1	Sung et al. 2013
1b	**Hippotherapy** may produce greater improvements in gait than **treadmill training.**	1	Lee et al. 2014

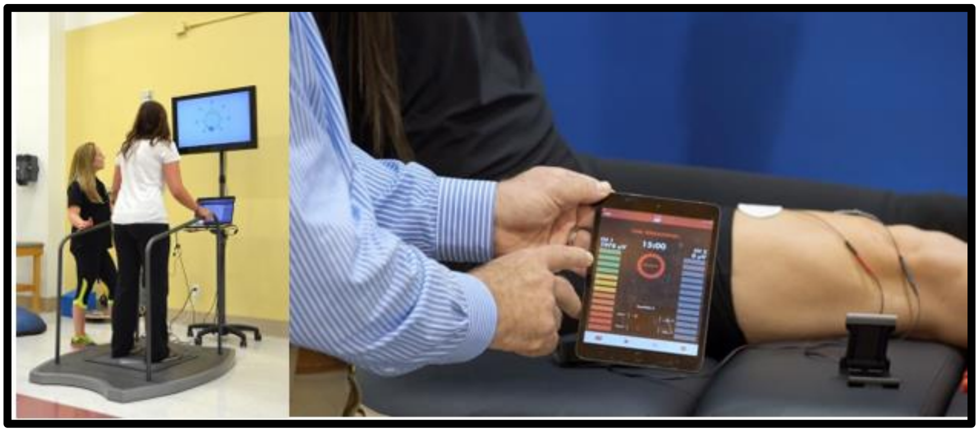
ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
2	**Hippotherapy** may produce greater improvements in activities of daily living than **conventional therapy.**	1	Kim & Lee 2015

Key Points

Hippotherapy may be beneficial for improving balance and activities of daily living, while the literature is mixed regarding hippotherapy for improving functional ambulation and gait following stroke.

Biofeedback



Adopted from: http://aim2walk.ca/stabilometric-platform/ ; https://mikereinold.com/why-you-should-be-using-biofeedback-in-rehabilitation/

Table 15. Classification of Biofeedback used for stroke rehabilitation (Giggins et al. 2013)

Biofeedback category	Subcategories	Examples
Biomechanical	Movement	• Inertial sensors • Force plates • Electrogoimeters • Pressure biofeedback units • Camera based systems • Physiotherapist comments
	Postural Control	
	Force	
Physiological	Neuromuscular system	• EMG biofeedback • Real time ultrasound imagining biofeedback
	Cardiovascular system	• Heart rate biofeedback • Heart rate variability biofeedback
	Respiratory system	• Breathing electrodes and sensors that convert breathing to auditory and visual signals

Biofeedback is a longstanding technique used within rehabilitation that involves providing real-time biological information to patients as a form of augmented or extrinsic feedback during rehabilitation (Giggins et al. 2013). Feedback provided is extrinsic as opposed to intrinsic because additional information is provided beyond self-generated information from intrinsic sensory receptors (Giggins et al. 2013). Providing additional and detailed feedback to patients during rehabilitation may produce a positive impact on their learning and performance through improving accuracy during functional tasks and increasing engagement during rehabilitation (Johnson et al. 2013; Giggins et al. 2013).

There are two strategies through which biofeedback is relayed to the user. The first option is through direct feedback, in which a physiological measurement such as heart rate is displayed (Giggins et al. 2013). The second way is through transformed feedback, in which measurements are used to inform and produce an auditory, visual, or tactile feedback signal (Giggins et al. 2013).

Biofeedback can be classified most broadly into biomechanical or physiological categories (Table 12). Biomechanical feedback can be further broken down based on measurements of movement, postural control, and force (Giggins et al. 2013). Physiological feedback can be broken down based on measurements of the neuromuscular, cardiovascular, and respiratory systems (Giggins et al. 2013).

Electromyography (EMG) biofeedback therapy uses surface electrodes to detect changes in skeletal muscle activity, which is then transformed to a visual or auditory feedback signal (Giggins et al 2013). It is used to increase activity within a paretic muscle or can be used to reduce tone in a spastic muscle (Giggins et al. 2013).

A total of 37 RCTs were found evaluating feedback for lower extremity motor rehabilitation.

Nine RCTs compared gait training with movement or postural control visual biofeedback to gait training with little or no biofeedback (Druzbicki et al. 2016a; Druzbicki et al. 2016b; Druzbicki et al. 2015; Hollands et al. 2015; Khallaf et al. 2014; Mandel et al. 1990; Danks et al. 2016; Dorsch et al. 2015; Mansfield et al. 2015).

Twenty-one RCTs compared balance training with postural control visual feedback to balance training without feedback, or conventional therapy (Ghomashchi et al. 2016; Shin & Song 2016; Ko et al. 2015; Ordahan et al. 2015; Lee et al. 2013b; Rao et al. 2013; Yoon et al. 2013; Chae et al. 2011; Varoqui et al. 2011; Goljar et al. 2010; Alptekin et al. 2008; Eser et al. 2008; Yavuzer et al. 2006; Chen et al. 2002; Cheng et al. 2001; De Seze et al. 2001; Geiger et al. 2001; Walker et al. 2000; Sackley & Lincoln et al. 1997; Wong et al. 1997; Shumway-Cook et al. 1988).

Seven RCTs compared EMG biofeedback with therapy to conventional therapy or motor relearning for lower extremity motor rehabilitation (Xu et al. 2015; Jonsdottir et al. 2010; Bradley et al. 1998; Intiso et al. 1994; Cozean et al. 1988; Mulder et al. 1986; Burnside et al. 1982).

The methodological details and results of all 37 RCTs are presented in Table 16.

Table 16. RCTs Evaluating Biofeedback Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Gait Training with Biomechanical Feedback vs Gait Training or Conventional Therapy		
Druzbicki et al. (2016a) RCT (8) N_{start}=30 N_{end}=30 TPS=Chronic	E: Treadmill training + camera-based movement visual feedback C: Treadmill training Duration: 1.5hr/d, 5d/wk for 2wk	• Step length (-) • Stance phase (-) • Swing phase (-)
Druzbicki et al. (2016b) RCT (7) N_{start}=46 N_{end}=41	E: Treadmill training + camera-based movement visual feedback C: Conventional therapy Duration: 1.5hr/d, 5d/wk for 2wk	• Centre of pressure (-) • Weight symmetry (-) • Sway area (-) • Timed Up & Go Test (-)

TPS=Chronic		
Druzbicki et al. (2015) RCT (7) N_{start}=50 N_{end}=44 TPS=Chronic	E: Treadmill training + camera-based movement visual feedback C: Treadmill training Duration: 1.5hr/d, 5d/wk for 2wk	• 10-Metre Walk Test (-) • 2-Minute Walk Test (-) • Timed Up & Go Test (-) • Cadence (-) • Swing phase (-) • Stance phase (-)
Hollands et al. (2015) RCT (6) N_{start}=56 N_{end}=34 TPS=Subacute	E1: Overground gait training + visual cue feedback based on movement projected on overground walkway E2: Treadmill training + Visual cue feedback based on movement projected on treadmill C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 4wk	• Gait speed (-) • Gait symmetry (-) • Fugl-Meyer Assessment (-) • Berg Balance Scale (-) • Timed Up & Go Test (-) • Falls Efficacy Scale (-)
Gait Training with Activity Feedback vs Gait Training or Conventional Therapy		
Phonthee et al. (2020) RCT (7) N_{start}=39 N_{end}=36 TPS=Chronic	E: Stepping Training with External Feedback C: Stepping Training Alone Duration: 30min, 5d/wk, 4wks	• Lower Limb Support Ability (+exp) • Timed Up and Go Test (+exp) • 10-Meter Walk Test (-) • 6-Minute Walk Test (-) • Step Length (-)
Danks et al. (2016) RCT (4) N_{start}=37 N_{end}=37 TPS=Chronic	E: Gait training + Movement and heart rate biofeedback C: Gait training Duration: 30min/d, 3d/wk for 12wk	• 6-Minute Walk Test (+exp) • Daily walking time (-) • Gait speed (-)
Dorsch et al. (2015) RCT (6) N_{start}=135 N_{end}=125 TPS=Acute	E1: Gait training + Daily accelerometer biofeedback (speed and activity) E2: Gait training + Daily accelerometer feedback (speed only) Duration: 30min/d, 5d/wk for 4wk	• Gait speed (-) • Walking distance (-) • Daily walking time (-) • Functional Ambulation Category (-) • Stroke Impact Scale (-)
Mansfield et al. (2015) RCT (8) N_{start}=57 N_{end}=51 TPS=Subacute	E: Gait training + Daily accelerometer biofeedback (activity) C: Gait training Duration: 1hr/d, 5d/wk for 8wk	• Gait speed (+exp) • Cadence (+exp) • Walking duration (-) • Step count (-)
Gait Training with Postural Control Visual Feedback vs Gait Training or EMG Biofeedback		
Khallaf et al. (2014) RCT (5) N_{start}=16 N_{end}=16 TPS=Chronic	E: Gait training + postural control visual feedback on monitor C: Gait training Duration: Not Specified	• Gait pattern (+exp)
Mandel et al. (1990) RCT (3) N_{start}=37 N_{end}=28 TPS=Chronic	E1: Gait training + postural control audiovisual feedback E2: Gait training + EMG biofeedback C: Gait training	E1 vs E2/C • Gait speed: (+exp$_1$)

	Duration: 40min/d, 3d/wk for 6wk	
Spinal Stabilization with Postural Control Visual Biofeedback vs Conventional Therapy		
Chae et al. (2011) RCT (5) N_{start}=21 N_{end}=21 TPS=Subacute	E: Spinal stabilization exercise + postural control visual biofeedback C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 8wk	• Gait speed (-) • Cadence (-) • Step length (-) • Single support time (-) • Functional Ambulation Category (-)
EMG biofeedback vs Conventional Therapy or Motor Relearning		
Xu et al. (2015) RCT (5) N_{start}=40 N_{end}=40 TPS=Subacute	E: Comprehensive rehabilitation + EMG biofeedback C: Conventional rehabilitation Duration: 45min/d, 5d/wk for 4wk	• Fugl-Meyer Assessment (+exp) • Functional Ambulation Category (+exp)
Jonsdottir et al. (2010) RCT (7) N_{start}=20 N_{end}=18 TPS=Chronic	E: Rehabilitation + EMG biofeedback C: Conventional rehabilitation Duration: 45min/d, 5d/wk for 4wk	• Gait speed (+exp) • Stride length (+exp) • Ankle power (+exp) • Knee flexion (-)
Bradley et al. (1998) RCT (4) N_{start}=21 N_{end}=19 TPS=Acute	E: Rehabilitation + EMG biofeedback C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 8wk	• Mobility (-) • Active movement (-)
Intiso et al. (1994) RCT (6) N_{start}=16 N_{end}=16 TPS=Chronic	E: Rehabilitation + EMG biofeedback C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 4wk	• Gait speed (-) • Step length (-) • Basmajian Gait Rating Scale (-) • Barthel Index (-)
Cozean et al. (1988) RCT (6) N_{start}=36 N_{end}=32 TPS=Chronic	E1: Rehabilitation + EMG biofeedback E2: Rehabilitation + Functional electrical stimulation E3: Rehabilitation + EMG biofeedback + Functional electrical stimulation C: Conventional rehabilitation Duration: 30min/d, 3d/wk for 6wk	E3 vs C • Knee flexion (+exp_3) • Ankle dorsiflexion (+exp_3) • Gait speed (-) • Cycle time (-) • Stance symmetry (-)
Mulder et al. (1986) RCT (4) N_{start}=12 N_{end}=12 TPS=Chronic	E: Motor relearning + EMG biofeedback C: Motor relearning Duration: 20min/d, 2d/wk for 6wk	• Gait (-) • Range of motion (-)
Burnside et al. (1982) RCT (6) N_{start}=22 N_{end}=22	E: Rehabilitation + EMG biofeedback C: Conventional rehabilitation Duration: 15min/d, 2d/wk for 6wk	• Muscle strength (+exp) • Active range of motion (-) • Basmajian Gait Rating Scale (-)

TPS=Chronic		
Lokomat Training vs Galvanic Vestibular Stimulation or Physiotherapy with Visual Feedback		
Krewer et al. (2013a) RCT (8) N_{start}=25 N_{end}=24 TPS=Chronic	E1: Galvanic vestibular stimulation E2: Lokomat training E3: Physiotherapy with visual feedback Duration: 20min session	E1 vs E2/E3: • Burke Lateropulsion Scale (-) • Scale for Contraversive Pushing (-)
Visual Feedback During Cycling Training		
Yang et al. (2015) RCT (7) N_{start}=12 N_{end}=12 TPS=Subacute	E: Computer-generated interactive visual feedback training C: Computer-generated interactive visual feedback training Duration: 20 min physical therapy + 20 min visual feedback training, 3d/wk, 3wks	• Scale for Contraversive Pushing (+exp) • Berg Balance Scale (+exp) • Fugl-Meyer Assessment Lower Extremity (-)
Yang et al. (2014) RCT crossover (7) N_{start}=31 N_{end}=30 TPS=Chronic	E: Conventional Rehabilitation with Visual Biofeedback Cycling C: Conventional Care Only Duration: 30min extra cycling, 5x/wk, 4wks	• Fugl Meyer Assessment (+exp) • 6-Minute Walk Test (+exp) • 10-Meter Walk Test (+exp) • Modified Ashworth Scale (+exp)
Physical Therapy with Rhythmic Auditory Feedback vs Physical Therapy or Conventional Therapy		
Chung et al. (2014) RCT (4) N_{start}=29 N_{end}=22 TPS=Chronic	E: Core training + Feedback C: Core training Duration: 30min/d, 5d/wk for 6wk	• Gait speed (+exp) • Stride length (+exp) • Single support time (+exp) • Timed Up & Go Test (+exp)
Jeong & Kim (2007) RCT (5) N_{start}=33 N_{end}=33 TPS=Chronic	E: Movement exercise + Rhythmic auditory feedback C: Conventional therapy Duration: 40min/d, 4d/wk for 8wk	• Range of motion (+exp) • Flexibility (+exp) • Ankle extension (+exp) • Ankle flexion (-)
Overground Gait Training with Auditory Feedback During Gait Training		
Ploughman et al. (2018) RCT crossover (7) N_{start}=10 N_{end}=10 TPS=Subacute	E1: Verbal Cues and Feedback During Walking E2: Tactile Cues and Feedback During Walking nan Duration: Single Session, 7-10 day washout	• Gait Velocity (-) • Cadence (+exp2) • Step Length Symmetry (-)
Jung et al. (2015) RCT (7) N_{start}=22 N_{end}=21 TPS=Chronic	E: Overground gait training + Auditory feedback C: Gait training Duration: 20min/d, 5d/wk for 8wk	• Gait speed (+exp) • Muscle activation (+exp) • Single limb support phase (+exp)
Ki et al. (2015) RCT (3) N_{start}=30 N_{end}=30 TPS=Chronic	E: Overground gait training + Auditory feedback C: Gait training Duration: 1hr/d, 5d/wk for 6wk	• Timed Up & Go Test (-) • Stance (-)

Sungkarat et al. (2011) RCT (7) N_{start}=35 N_{end}=35 TPS=Chronic	E: Overground gait training + Auditory feedback C: Gait training Duration: *Not Specified*	• Gait speed (+exp) • Gait symmetry (+exp) • Step length asymmetry ratio (+exp) • Single support time asymmetry ratio (+exp) • Berg Balance Scale (+exp)
Dobkin et al. (2010) RCT (7) N_{start}=179 N_{end}=169 TPS=Subacute	E: Gait training + Daily reinforcement C: Gait training Duration: 45min/d, 3d/wk for 4wk	• Gait speed (+exp) • Walking distance (-) • Functional Ambulation Classification (-)
Aruin et al. (2003) RCT (3) N_{start}=16 N_{end}=16 TPS=Chronic	E: Overground gait training + Auditory feedback C: Gait training Duration: 25min (2x/d), 5d/wk for 2wk	• Step width (+exp)
Auditory Feedback During Sit-to-Stand Training		

Engardt & Knutsson, (1994)
RCT (5)
N_{start}=40
N_{end}=36
TPS=Subacute
	E: Continuous Auditory Feedback During Sit to Stand Training
	C: No Feedback During Sit to Stand Training
	Duration: 15min, 3x/d, 5d/wk, 6wks
		• Peak Torque
		  • Knee Flexion (-)
		  • Knee Extension (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Biofeedback

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**EMG biofeedback with conventional therapy** may produce greater improvements in motor function than **conventional therapy.**	1	Xu et al. 2015
1b	There is conflicting evidence about the effect of **balance training with postural control visual biofeedback** to improve motor function when compared **to sham biofeedback or conventional therapy**.	3	Rao et al. 2013; Alptekin et al. 2008; Sackley & Lincoln et al. 1997
1b	**Gait training with movement visual biofeedback** may not have a difference in efficacy compared to **conventional therapy** for improving motor function.	1	Hollands et al. 2015
1b	There is conflicting evidence about the effect of **cycling with feedback** to improve motor function when compared to **conventional therapy.**	2	Yang et al. 2015

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**EMG biofeedback with conventional therapy** may not have a difference in efficacy when compared to **conventional therapy for producing** greater improvements in functional ambulation**.**	6	Xu et al. 2015; Jonsdottier et al. 2010; Bradley et al. 1998; Intiso et al. 1994; Cozean et al. 1988; Mulder et al. 1986;
1b	There is conflicting evidence about the effect of **balance training with postural control visual biofeedback** to improve functional ambulation when compared to **conventional therapy**	3	Chae et al. 2011; Goljar et al. 2010; De Seze et al. 2001
1b	**Gait training with movement visual biofeedback** may not have a difference in efficacy when compared to **gait training** for improving functional ambulation.	1	Druzbicki et al. 2015
1a	**Gait training with activity feedback** may not have a difference in efficacy when compared to **gait training or conventional therapy** for improving functional ambulation.	3	Danks et al. 2016; Dorsch et al. 2015; Mansfield et al. 2015
2	**Gait Training with Postural Visual Feedback** may produce greater improvements in functional ambulation when compared to **EMG biofeedback.**	1	Khallaf et al. 2014
2	**Spinal stabilization with postural control visual feedback** may not have a difference in efficacy when compared to c**onventional therapy for** improving functional ambulation.	1	Chae et al. 2011
1b	**Feedback while cycling** may produce greater improvements in functional ambulation when compared to **conventional therapy.**	1	Yang et al. 2015
2	**Core training with rhythmic auditory stimulation** may produce greater improvements in functional ambulation than **core training.**	1	Chung et al. 2014
1a	There is conflicting evidence about the effect of **overground gait training with verbal feedback** to improve functional ambulation when compared to **gait training.**	3	Jung et al. 2015; Sungkarat 2011; Dobkin et al. 2010

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
2	**Gait training with postural control visual biofeedback** may not have a difference in efficacy compared to **conventional therapy** for improving functional mobility.	1	Eser et al. 2008
2	**EMG biofeedback with conventional therapy** may not have a difference in efficacy compared to **conventional therapy** for improving functional mobility.	1	Bradley et al. 1998

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **balance training with postural control visual biofeedback** to improve balance when compared to **balance training, sham feedback, or conventional therapy.**	18	Lee et al. 2013b; Varoqui et al. 2011; Ghomashchi et al. 2016; Shin & Song 2016; Ko et al. 2015; Ordahan et al. 2015; Goljar et al. 2010; Alptekin et al. 2008; Yavuzer et al. 2006; Chen et al. 2002; De Seze et al. 2001; Geiger et al. 2001; Walker et al. 2000; Shumway-Cook et al. 1988; De Seze et al. 2001; Yoon et al. 2013; Wong et al. 1997; Sackley & Lincoln et al. 1997
1a	**Gait training with movement or postural control visual biofeedback** may not have a difference in efficacy compared to **gait training with less or no biofeedback** for improving balance.	3	Druzbicki et al. 2016; Druzbicki et al. 2015; Hollands et al. 2015
1b	**Gait training with activity feedback** may produce greater improvements in balance when compared to **gait training or conventional therapy.**	1	Ponthee et al. 2020
1b	**Feedback while cycling** may produce greater improvements in balance when compared to **conventional therapy.**	1	Yang et al. 2015
2	**Core training with rhythmic auditory stimulation** may produce greater improvements in balance than **core training.**	1	Chung et al. 2014
1b	**Overground gait training with verbal feedback** may produce greater improvements in balance when compared to **gait training.**	2	Ki et al. 2015; Sungkarat 2011

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**EMG biofeedback with conventional therapy** may not have a difference in efficacy when compared to **conventional therapy for producing** greater improvements in gait.	6	Jonsdottir et al. 2010; Intiso et al. 1994; Cozean et al. 1988; Mulder et al. 1986; Burnside et al.1982
1a	**Gait training with movement visual biofeedback** may not have a difference in efficacy compared to **gait training with less or no biofeedback** for improving gait.	4	Druzbicki et al. 2016a; Druzbicki et al. 2016b; Druzbicki et al. 2015; Hollands et al. 2015
2	**Balance training with postural control visual biofeedback** may not have a difference in efficacy compared to **conventional therapy** for improving gait.	2	Chae et al. 2011; Walker et al. 2000
1a	There is conflicting evidence about the effect of **gait training with activity feedback when** compared to **gait training or conventional therapy** for improving gait	2	Ponthee et al. 2020; Mansfield et al. 2015
2	**Gait training with postural visual feedback** may produce greater improvements in gait when compared to **gait training.**	1	Khallaf et al. 2014

2	**Spinal stabilization with postural control visual feedback** may not have a difference in efficacy when compared to **conventional therapy for** improving functional gait.	1	Chae et al. 2011
2	**Core training with rhythmic auditory stimulation** may produce greater improvements in gait than **core training.**	1	Chung et al. 2014
1a	**There is conflicting evidence** about the effect of overground gait training with verbal feedback when compared to **gait training** for improving gait.	3	Ploughman et al. 2018; Jung et al. 2015; Sungkarat 2011; Dobkin et al. 2010; Aruin et al. 2003

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **balance training with postural control visual biofeedback** to improve activities of daily living when compared to **balance training, sham feedback, or conventional therapy**.	8	Varoqui et al. 2011; Ordahan et al. 2015; Rao et al. 2013; Alptekin et al. 2008; Eser et al. 2008; Chen et al. 2002; De Seze et al. 2001; Sackley & Lincoln et al. 1997
1b	**EMG biofeedback with conventional therapy** may not have a difference in efficacy compared to **conventional therapy** for improving activities of daily living.	1	Intiso et al. 1994

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1a	**EMG biofeedback with conventional therapy or motor relearning** may not have a difference in efficacy when compared to **conventional therapy or motor relearning** for improving range of motion.	4	Jonsdottir et al. 2012; Cozean et al. 1988; Mulder et al. 1986; Burnside et al. 1982
2	**Physical therapy with auditory feedback** may not have a difference in efficacy when compared to **conventional therapy** for improving range of motion.	1	Jeong & Kim 2007

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	**EMG biofeedback with conventional therapy** may produce greater improvements in muscle strength than **conventional therapy.**	2	Jonsdottir et al. 2010; Burnside et al. 1982
1b	**Balance training with postural control visual biofeedback** may not have a difference in efficacy compared to **conventional therapy** for improving muscle strength.	2	Cheng et al. 2001; De Seze et al. 2001
2	**Auditory feedback during sit-to-stand** may not have a difference compared to **sit-to-stand training** for improving muscle strength.	1	Engardt & Knutsson 1994

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Feedback while cycling** may produce greater improvements in spasticity when compared to **conventional therapy.**	1	Yang et al. 2015

PROPRIOCEPTION

LoE	Conclusion Statement	RCTs	References
1b	**Feedback while cycling** may produce greater improvements in proprioception when compared to **conventional therapy.**	1	Yang et al. 2015
1b	**Physiotherapy with visual feedback** may not have a difference in efficacy when compared to **lokomat training or galvanic vestibular stimulation** for improving proprioception.	1	Krewer et al 2013

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1b	**Gait training with movement biofeedback** may not have a difference in efficacy compared to **gait training with less feedback** for improving stroke severity.	1	Dorsch et al. 2015
1b	**Physiotherapy with visual feedback** may not have a difference in efficacy when compared to **lokomat training or galvanic vestibular stimulation** for improving stroke severity.	1	Krewer et al 2013

Key Points

EMG biofeedback with conventional therapy may not be beneficial for improving functional ambulation, gait, and range of motion.

Gait training with movement or postural control visual biofeedback may not be beneficial for improving balance following stroke.

Dual-task training (Cognitive-motor interference)

Adapted from: https://link.springer.com/chapter/10.1007/978-3-030-23762-2_40

Dual-tasking training requires subjects to simultaneously perform complex tasks, such as cognitive and motor tasks, allowing them to improve their coordination of various tasks (Kim et al. 2014). Cognitive-motor tasks are important for various activities of daily living, such as walking while holding a conversation (Liu et al. 2017). Additionally, dual tasks can be two motor tasks to allow for different motor processes to occur simultaneously to further stimulate the damaged brain.

Nine RCTs were found evaluating dual-task training interventions for lower extremity motor rehabilitation. Four RCTs compared dual motor tasks to conventional therapy (Liu et al. 2017; et al. 2012; Shim et al. 2012; Yang et al. 2007). Four RCTs looked at dual motor task interventions (Liu et al. 2017; Seo et al. 2012; Shim et al. 2012; Yang et al. 2007), while six RCTs looked at performing motor and cognitive tasks (Liu et al. 2017; Choi et al. 2015; Choi et al. 2015b; Cho et al. 2015; Jiejiao et al. 2012; Tang et al. 2005).

The methodological details and results of all eight RCTs evaluating dual-task training interventions for lower extremity motor rehabilitation are presented in Table 17.

Table 17. RCTs Evaluating Dual-Task Training Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Dual Motor Task Training vs Balance Training or Conventional Therapy		
Liu et al. (2017) RCT (5) N$_{start}$=28 N$_{end}$=28 TPS=Chronic	E1: Gait training + cognitive task E2: Gait training + motor task C: Conventional therapy Duration: 30min/d, 3d/wk for 4wk	E1 vs E2/C: • Gait speed (-) • Cadence (+exp) • Stride length (-) • Stride time (-)
Seo et al. (2012) RCT (4) N$_{start}$=40 N$_{end}$=40 TPS=Chronic	E: Balance training + motor task C: Balance training Duration: 1hr/d, 5d/wk for 4wk	• Sway velocity (+exp) • Sway area (+exp) • Sway length (-)
Shim et al. (2012) RCT (5) N$_{start}$=35 N$_{end}$=35 TPS=Chronic	E: Gait training + motor task C: Gait training Duration: 30min/d, 3d/wk for 6wk	• Gait speed (+exp) • Cadence (+exp) • Stride length (+exp) • Step length (+exp) • Single limb support (+exp)
Yang et al. (2007) RCT (7) N$_{start}$=25 N$_{end}$=25 TPS=Chronic	E: Gait training + motor task C: No rehabilitation Duration: 30min/d, 3d/wk for 4wk	• Gait speed (+exp) • Cadence (+exp) • Stride length (+exp) • Step length (+exp) • Temporal symmetry index (-)
Dual Cognitive-Motor Task vs Balance Training, Treadmill Training or Conventional Therapy		
Liu et al. (2017) RCT (5) N$_{start}$=28 N$_{end}$=28 TPS=Chronic	E1: Gait training + cognitive task E2: Gait training + motor task C: Conventional therapy Duration: 30min/d, 3d/wk for 4wk	E1 vs E2/C: • Gait speed (-) • Cadence (+exp) • Stride length (-) • Stride time (-)
Choi et al. (2015) RCT (7) N$_{start}$=37 N$_{end}$=28 TPS=Chronic	E: Treadmill training + cognitive-motor dual task C: Treadmill training Duration: 15min/d, 3d/wk for 4wk	• Medial-Lateral Sway Eyes Open (+exp) • Medial-Lateral Sway Eyes Closed (+exp) • Anterior-Posterior Sway Eyes Open (-) • Anterior-Posterior Sway Eyes Closed (+exp) • Timed Up & Go Test (-)
Choi et al. (2015b) RCT (5) N$_{start}$=21 N$_{end}$=21 TPS=Subacute	E: Balance training + cognitive training C: Balance training with balance board Duration: 1hr/d, 3d/wk for 4wk	• Berg Balance Scale (-) • Fugl-Meyer Assessment (-) • Modified Barthel Index (-)
Cho et al. (2015) RCT (7) N$_{start}$=24 N$_{end}$=24 TPS=Chronic	E: Virtual reality treadmill training + cognitive load task C: Virtual reality treadmill training Duration: 30min/d, 5d/wk for 4wk	• Gait speed (+exp) • Cadence (+exp) • Stride length (+exp) • Step length (+exp)
Jiejiao et al. (2012) RCT (8) N$_{start}$=100 N$_{end}$=85 TPS=Chronic	E: Balance training + cognitive training C: Balance training Duration: 40min/d, 3d/wk for 8wk	• Sway distance (+exp)

Tang et al. (2005)
RCT (6)
N_{start}=48
N_{end}=47
TPS=Subacute
	E: Problem-Oriented Movement Therapy
	C: Neurodevelopmental Treatment
	Duration: 50min, 5-6x/wk, 8wks
		• Stroke Rehabilitation Assessment of Movement (+exp)
		  • Upper Extremity (+exp)
		  • Lower Extremity (+exp)
		• Basic Mobility (+exp)

Abbreviations and table notes: ANOVA=analysis of variance; C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Dual-Task Training Interventions

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**Dual-task balance training** may not have a difference in efficacy compared to **balance training alone** for improving motor function.	1	Choi et al. 2015

ACTIVITIES OF DAILY LIVING			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**Dual cognitive-motor training** may not have a difference in efficacy compared to **balance training alone** for improving activities of daily living.	1	Choi et al. 2015b

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	There is conflicting evidence about the effect of **dual motor task training** to improve functional ambulation when compared to **conventional therapy or gait training**.	3	Liu et al. 2017; Shim et al. 2012; Yang et al. 2007
1b	There is conflicting evidence about the effect of **dual cognitive-motor training** to improve functional ambulation when compared to **conventional therapy or virtual reality treadmill training**.	2	Liu et al. 2017; Cho et al. 2015

FUNCTIONAL MOBILITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Dual cognitive-motor training** may produce greater improvements in functional mobility than **conventional therapy.**	1	Tang et al. 2005

BALANCE			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	There is conflicting evidence about the effect of **dual cognitive-motor training** to improve balance when compared to **treadmill training or balance training**.	2	Choi et al. 2015; Choi et al. 2015b

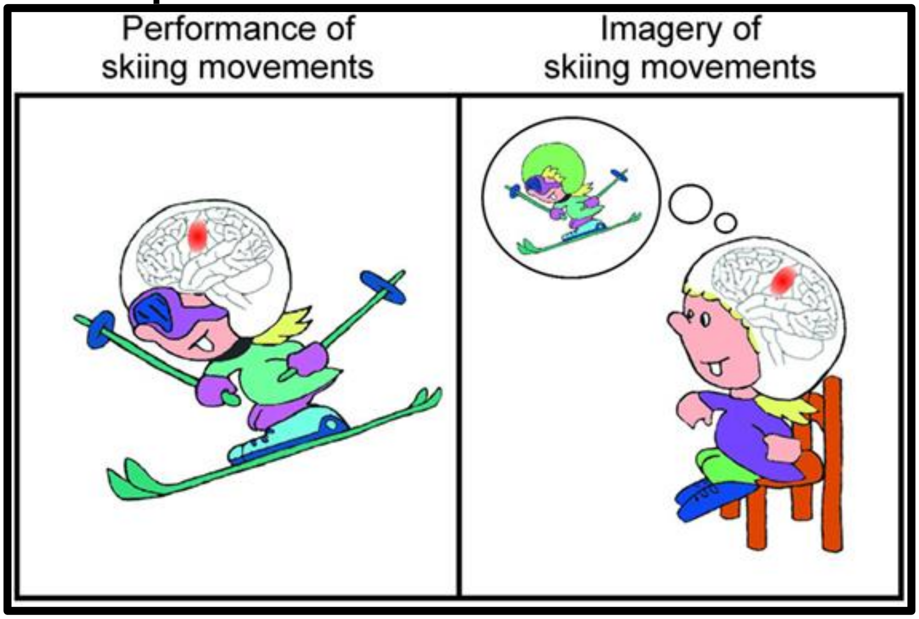
GAIT			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	There is conflicting evidence about the effect of **dual motor task training** to improve gait when compared to **gait training, balance training** and **conventional therapy**.	4	Liu et al. 2017; Seo et al. 2012; Shim et al. 2012; Yang et al. 2007
1a	There is conflicting evidence about the effect of **dual cognitive-motor training** to improve gait when compared to **treadmill training, balance training or conventional therapy**.	4	Liu et al. 2017; Cho et al. 2015; Choi et al. 2015b; Jiejiao et al. 2012

Key points

The literature is mixed regarding the effect of dual motor task training on functional ambulation and gait.

The literature is mixed regarding the effect of dual cognitive-motor training on functional ambulation, balance, and gait.

Mental practice



Adopted from: https://www.ucbmsh.com/motor-imagery-for-improvement-of-gait-in-stroke-patient/

Mental practice as the name suggests, involves cognitively rehearsing a specific task by repetitively imagining oneself performing the precise movements involved in the task in the absence of performing the physical movement (Page et al. 2014). Mental practice is speculated to be effective because of its ability to use the same motor schema as when physically practicing the same task through the activation of similar neural regions and networks during mental practice (Page et al. 2014). The use of mental practice was adapted from the field of sports psychology where the technique has been shown to improve athletic performance, when used as an adjunct to standard training methods (Page et al. 2014). The technique is believed to be advantageous in stroke survivors because certain motor skills may be difficult to physically practice; stroke survivors spend a majority of their time inactive and alone; and repetitive task-specific practice is a prerequisite for cortical plasticity and subsequent motor changes (Page et al. 2014). Mental practice can be used to supplement conventional therapy and can be used at any stage of recovery.

Nine RCTs were found evaluating mental practice for lower extremity motor rehabilitation. Six RCTs compared mental practice combined with rehabilitation to conventional rehabilitation (Kumar et al. 2016; Lee et al. 2015; Braun et al. 2012; Malouin et al. 2009; Cho et al. 2013; Kim et al. 2013). One RCT compared circuit training with mental practice to circuit training and education (Bovonsunthonchai et al. 2020). One RCT compared Mental imagery types with auditory stimulation (Kim et al. 2011). One RCT compared embedded mental practice to additional mental practice (Schuster et al. 2012)

The methodological details and results of all nine RCTs are presented in Table 18.

Table 18. RCTs Evaluating Mental Practice Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Mental Practice Combined with Rehabilitation vs Conventional Rehabilitation		
Kumar et al. (2016) RCT (7) N_{start}=40 N_{end}=40 TPS=Chronic	E: Task-specific training + Mental practice C: Task-specific training Duration: 50min/d, 4d/wk for 3wk	• 10-Metre Walk Test (+exp) • Hip flexor and extensor strength (+exp) • Knee extensor strength (+exp) • Knee flexor strength (-) • Ankle dorsiflexor strength (+exp) • Ankle plantarflexor strength (-)
Lee et al. (2015) RCT (5) N_{start}=36 N_{end}=32 TPS=Chronic	E: Proprioception training + Motor imagery C: Proprioception training Duration: 30min/d, 5d/wk for 8wk	• Berg Balance Scale (+exp) • Timed Up & Go Test (-)
Braun et al. (2012) RCT (7) N_{start}=36 N_{end}=28 TPS=Subacute	E: Conventional rehabilitation + Mental practice C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 2wk	• Rivermead Mobility Index (-) • 10-Metre Walk Test (-) • Berg Balance Scale (-) • Barthel Index (-) • Motricity Index (-) • Performance of activities of daily living (-)
Malouin et al. (2009) RCT (6) N_{start}=12 N_{end}=12 TPS=Chronic	E1: Task-specific training + Mental practice E2 Task-specific training + Cognitive training C: No training Duration: 30min/d, 3d/wk for 4wk	E1 vs E2/C • Limb loading (+exp)
Cho et al. (2013) RCT (6) N_{start}=28 N_{end}=28 TPS=Chronic	E: Gait training + Mental practice C: Gait training Duration: 30min/d, 5d/wk for 6wk	• Fugl-Meyer Assessment (+exp) • 10-Metre Walk Test (+exp) • Timed Up & Go Test (+exp) • Functional Reach Test (+exp)
Kim et al. (2013) RCT (6) N_{start}=30 N_{end}=30 TPS=Chronic	E1: Gait training + Action observation E2: Gait training + Motor imagery C: Gait training Duration: 30min/d, 5d/wk for 4wk	E1 vs C • Gait speed (+exp) • Cadence (+exp) • Single limb support (+exp) • Timed Up & Go Test (+exp) • Functional Ambulation Category (-) • Functional Reach Test (-) • Walking Ability Questionnaire (-) E2 vs E1/C • Gait speed (-) • Cadence (-) • Single limb support (-) • Timed Up & Go Test (-) • Functional Ambulation Category (-) • Functional Reach Test (-) • Walking Ability Questionnaire (-)
Circuit Training Combined with Mental Practice vs Circuit Training and Education		
Bovonsunthonchai et al. (2020) RCT (8) N_{start}=40	E: Structured Progressive Circuit Training + Motor Imagery	• Step Length (+exp) • Stride Length (+exp) • Step Time (+exp)

N_{end}=40 TPS=Mixed	C: Structured Progressive Circuit Training + Health Education Duration: Motor Imagery/Education 25min, Training 65min, 3x/wk, 4wks	• Gait Speed (+exp) • Cadence (+exp) • Symmetry Index a. Step Time (-) b. Step Length (+exp)
Mental Imagery vs Mental Imagery with Auditory Stimulation		
Kim et al. (2011) RCT crossover (4) N_{start}=18 N_{end}=15 TPS=Chronic	E1: Visual Locomotor Imagery Training E2: Kinesthetic Locomotor Imagery Training E3: Visual Locomotor Training with Auditory Step Rhythm E4: Kinesthetic Locomotor Imagery Training with Auditory Step Rhythm Duration: 15 min/condition, 24 hr washout	E1 vs E2 • Timed Up and Go Test (-) E1 vs E3 • Timed Up and Go Test (-) E1 vs E4 • Timed Up and Go Test (+exp4) E2 vs E3 • Timed Up and Go Test (-) E2 vs E4 • Timed Up and Go Test (-) E3 vs E4 • Timed Up and Go Test (-)
Embedded Mental Practice vs Additional Mental Practice		
Schuster et al. (2012) RCT (7) N_{start}=39 N_{end}=39 TPS=Chronic	E1: Conventional rehabilitation + Embedded mental practice E2: Conventional rehabilitation + Added mental practice C: Conventional rehabilitation Duration: 1hr/d, 4d/wk for 10wk	• Chedoke-McMaster Stroke Assessment (-) • Barthel Index (-) • Berg Balance Scale (-) • Activities-Specific Balance Confidence Scale (-)

Abbreviations and table notes: ANOVA=analysis of variance; C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Mental Practice

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	There is conflicting evidence about the effect of **mental practice combined with physical therapy (conventional therapy, gait training)** to improve motor function when compared to these **physical therapy interventions on their own**.	1	Cho et al. 2013
1b	**Embedded mental practice** may not have a difference in efficacy compared to **additional mental practice** for improving motor function.	1	Schuster et a. 2012

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **mental practice combined with different types of physical therapy (task-specific training, conventional therapy, gait training)** to improve functional ambulation when compared to these **physical therapy interventions on their own**.	4	Kumar et al. 2016; Cho et al. 2013; Kim et al. 2013; Braun et al. 2012

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Mental practice combined with physical therapy** may not have a difference in efficacy compared to **physical therapy on its own** for improving functional mobility.	1	Braun et al. 2012

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **mental practice combined with different types of physical therapy (task-specific training, conventional therapy, gait training)** to improve balance when compared to these **physical therapy interventions on their own**.	4	Lee et al. 2015; Cho et al. 2013; Kim et al. 2013; Braun et al. 2012
1b	**Mental practice with progressive circuit training** may produce greater improvements in balance than **progressive circuit training with education.**	1	Bovonsunthoncahi et al. 2020
2	**Kinesthetic locomotor imagery training with auditory step rhythm** may produce greater improvements in balance than **kinesthetic or visual locomotor training alone, or visual locomotor training with rhythmic auditory stimulation**	1	Kim et al. 2011
1b	**Embedded mental practice** may not have a difference in efficacy compared to **additional mental practice** for improving balance.	1	Schuster et a. 2012

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **mental practice combined with different types of physical therapy (task-specific training, conventional therapy, gait training)** to improve gait when compared to these **physical therapy interventions on their own**.	1	Kim et al. 2013; Malouin et al. 2009
1b	**Mental practice with progressive circuit training** may produce greater improvements in gait than **progressive circuit training with education.**	1	Bovonsunthoncahi et al. 2020

ACTIVITIES OF DAILY LIVING			
LoE	Conclusion Statement	RCTs	References
1b	**Mental practice combined with different types of physical therapy (proprioception training, conventional therapy, gait training)** may not have a difference in efficacy compared to **physical therapy interventions on their own** for improving activities of daily living.	1	Braun et al. 2012
1b	**Embedded mental practice** may not have a difference in efficacy compared to **additional mental practice** for improving activities of daily living.	1	Schuster et a. 2012

MUSCLE STRENGTH			
LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **mental practice with task-specific training** to improve muscle strength when compared to **task-specific training**.	1	Kumar et al. 2016

Key Points

The literature is mixed regarding mental practice combined with different types of physical therapy (task-specific training, conventional therapy, gait training) for improving functional ambulation and balance.

Action Observation

Adopted from: https://www.youtube.com/watch?v=QE3CUhmKi7U

Action observation is a form of therapy whereby an individual observes another individual performing a motor task, either on a video or a real demonstration, and then may attempt to perform the same task themselves. For example, the patient may be instructed to watch a video showing an adult stretching out his hand to pick up a cup, bringing the cup to his mouth, and then returning the cup to its initial position - the act of drinking. After observing the video sequence for a time, the participants may or may not be asked to perform the same action (Borges et al. 2018).

The therapy is considered a multisensory approach designed to increase cortical excitability in the primary motor cortex by activating central representations of actions through the mirror neuron system (Kim and Kim, 2015). Although action observation has been evaluated mainly in healthy volunteers, a few studies have evaluated its benefit in motor relearning following stroke.

Five RCTs were found evaluating action observation for lower extremity motor rehabilitation.

Three RCTs compared action observation with gait training to gait training alone or no training (Park et al. 2015; Kim et al. 2013; Kim & Kim. 2012). One RCT compared action observation with gait training and FES to gait training and FES (Park and Kang, 2013). One RCT compared backward walking with action observation to backward walking with sham action observation (Moon & Bae, 2019).

The methodological details and results of all five RCTs are presented in Table 19.

Table 19. RCTs Evaluating Action Observation Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	**Interventions Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures Result (direction of effect)**
Action Observation with Gait Training vs Gait Training or No Training		
Park et al. (2015) RCT (4) N_{start}=40 N_{end}=34 TPS=Chronic	E: Gait training + Action observation C: Gait training Duration: 20min/d, 5d/wk for 8wk	• 10-Metre Walk Test (+exp) • Timed Up & Go Test (+exp) • Limit of stability (+exp) • Sway speed (+exp) • Sway area (-)
Kim et al. (2013) RCT (6) N_{start}=30 N_{end}=30 TPS=Chronic	E1: Gait training + Action observation E2: Gait training + Motor imagery C: Gait training Duration: 30min/d, 5d/wk for 4wk	E1 vs C • Gait speed (+exp) • Cadence (+exp) • Single limb support (+exp) • Timed Up & Go Test (+exp) • Functional Ambulation Category (-) • Functional Reach Test (-) • Walking Ability Questionnaire (-) E2 vs E1/C • Gait speed (-) • Cadence (-) • Single limb support (-) • Timed Up & Go Test (-) • Functional Ambulation Category (-) • Functional Reach Test (-) • Walking Ability Questionnaire (-)
Kim & Kim (2012) RCT (5) N_{start}=30 N_{end}=-29 TPS=Chronic	E: Gait training + Action observation C: No training Duration: 1hr/d, 5d/wk for 4wk	• Gait speed (+exp) • Step length (+exp) • Stride length (+exp) • Single support time (+exp) • Double support time (+exp) • Cadence (+exp)
Action Observation with Gait Training and FES vs Gait Training and FES		
Park & Kang (2013) RCT (4) N_{start}=20 N_{end}=20 TPS=Chronic	E: Gait training + FES + Action observation C: Gait training + FES Duration: 20min/d, 5d/wk for 6wk	• Weight distribution (+exp) • Stability index (+exp) • Gait speed (+exp)
Backward Walking Training with Action Observation		
Moon & Bae (2019) RCT (6) N_{start}=17 N_{end}=14 TPS=Chronic	E: Backward Walking Training with Action Observation + Conventional Therapy C: Backward Walking Training with Sham Action Observation (Landscapes) + Conventional Therapy Duration: Conventional Therapy 30min/d, 5d/wk, 4 wks + Action	• Dynamic Gait Index (+exp) • 10-Metre Walking Test (+exp) • Timed Up and Go Test (+exp)

	Observation (10min), Backward Walking (20min), 3d/wk, 4wks	

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Action Observation

FUNCTIONAL AMBULATION			
LoE	Conclusion Statement	RCTs	References
2	**Action observation with gait training** may produce greater improvements in functional ambulation than **gait training, or no training.**	2	Park et al. 2015; Kim & Kim 2012
2	**Action observation combined with gait training and FES** may produce greater improvements in functional ambulation than **gait training combined with FES.**	1	Park and Kang 2013
1b	**Backward walking training with action observation** may produce greater improvements in functional ambulation than **backward walking training alone.**	1	Moon & Bae 2019

BALANCE			
LoE	Conclusion Statement	RCTs	References
1b	**Action observation with gait training** may produce greater improvements in balance than **gait training.**	2	Park et al. 2015; Kim et al. 2013
2	**Action observation combined with gait training and FES** may produce greater improvements in balance than **gait training combined with FES.**	1	Park and Kang 2013
1b	**Backward walking training with action observation** may produce greater improvements in balance than **backward walking training alone.**	1	Moon & Bae 2019

GAIT			
LoE	Conclusion Statement	RCTs	References
1b	**Action observation with gait training** may produce greater improvements in gait than **gait training or no training.**	3	Park et al. 2015; Kim et al. 2013; Kim & Kim 2012
2	**Action observation combined with gait training and FES** may produce greater improvements in gait than **gait training combined with FES.**	1	Park and Kang 2013
1b	**Backward walking training with action observation** may produce greater improvements in gait than **backward walking training alone.**	1	Moon & Bae 2019

Key Points

Action observation with gait training may be beneficial for improving functional ambulation, balance, and gait.

Mirror therapy

Adopted from: https://en.wikipedia.org/wiki/Mirror_box

In mirror therapy, a mirror is placed beside the unaffected limb, blocking view of the affected limb and creating an illusion of two limbs as if they are both functioning normally. Mirror therapy functions through a process known as mirror visual feedback wherein the movement of one limb is perceived as movement from the other limb (Deconinck et al. 2015). In the brain, mirror therapy is thought to induce neuroplastic changes that promote recovery by increasing excitability of the ipsilateral motor cortex which projects to the paretic limb (Deconinck et al. 2015). Ramachandran et al. (1995) first used this method to understand the effect of vision on phantom sensation and pain in arm amputees. Only recently has it been explored as method for lower limb rehabilitation in stroke survivors (Li et al. 2018).

14 RCTs were found evaluating mirror therapy for lower extremity motor rehabilitation.

Seven RCTs compared mirror therapy to conventional therapy or a sham condition (Arya et al. 2019; Arya et al. 2017; Wang et al. 2017; Ji and Kim 2015; Salem et al. 2015; Mohan et al. 2013; St beyaz et al. 2007). One RCT compared treadmill training with mirror therapy to treadmill training alone (Broderick et al. 2019). Two RCTs compared mirror therapy with task oriented training to task oriented training alone (Cha et al. 2016; Choi et al. 2015). Two RCTs looked at mirror therapy combined with NMES (Xu et al. 2017; Lee et al. 2016). One RCT compared mirror therapy with FES to conventional therapy (Salhab et al. 2016). One RCT compared mirror therapy with rTMS to mirror therapy and sham stimulation (Cha & Kim, 2015).

The methodological details and results of all 14 RCTs evaluating mirror therapy for lower extremity motor rehabilitation are presented in Table 20.

Table 20. RCTs Evaluating Mirror Therapy Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Mirror Therapy vs Conventional Therapy or Sham Therapy		
Arya et al. (2019) RCT (8) N_{start}=36 N_{end}=33 TPS=Chronic	E: Activity-based Mirror Therapy C: Conventional Control Duration: 30min/d, 3-4d/wk, 3mos	• Fugl-Meyer Assessment (+exp) • Rivermead Gait Assessment (+exp) • 10-Meter Walk Test (-)
Arya et al. (2017) RCT (8) N_{start}=36 N_{end}=36 TPS=Subacute	E: Mirror therapy C: Conventional therapy Duration: 60min/d, 3 to 4d/wk, for 12wk	• Brunnstrom recovery stages (-) • Fugl-Meyer Assessment (+exp) • Rivermead visual gait assessment (+exp) • 10-metre walk test (-)
Wang et al. (2017) RCT (6) N_{Start}=36 N_{End}=36 TPS=Subacute	E: Mirror therapy C: Conventional therapy Duration: 45min/d. 5d/wk for 16wk	• Brunnstrom Staging Score (+exp) • Berg Balance Scale (+exp) • Functional Ambulation Category (+exp) • Functional Independence Measure (+exp)
Ji & Kim (2015) RCT (7) N_{start}=34 N_{end}=34 TPS=Subacute	E: Mirror therapy C: Sham therapy Duration: 45min/d, 5d/wk for 4wk	• Single stance (+exp) • Step length (+exp) • Stride length (+exp) • Gait speed (-) • Stance phase (-) • Swing phase (-) • Step width (-) • Cadence (-)
Salem et al. (2015) RCT (4) N_{start}=30 N_{end}=30 TPS=Chronic	E: Mirror therapy C: Conventional therapy Duration: 30min, 5d/wk for 4wk	• Passive ankle dorsiflexion range of motion (+exp) • Modified Ashworth scale (-) • Brunnstrom recovery stages (+exp) • 10-Metre Walk Test (+exp)
Mohan et al. (2013) RCT (4) N_{start}=22 N_{end}=18 TPS=Acute	E: Mirror therapy C: Conventional therapy Duration: 90min/d, 6d/wk for 2wk	• Functional Ambulation Category (-) • Fugl-Meyer Assessment (-) • Brunel Balance Assessment (-)
St beyaz et al. (2007) RCT (7) N_{start}=40 N_{end}=40 TPS=Subacute	E: Mirror therapy on Ankle Dorsiflexion C: Conventional Therapy Duration: 5hrs, 5 d/wk, 4 wks conventional therapy + 30 min/d, 5 d/wk, 4 wks mirror therapy	• Brunnstrom Stages (+exp) • Modified Ashworth Scale (-) • Functional Ambulation Category (-) • Functional Independence Measure (+exp)
Treadmill Training Combined with Mirror Therapy vs Treadmill Training		
Broderick et al. (2019) RCT (6) N_{start}=30 N_{end}=23 TPS=Chronic	E: Treadmill Training + Mirror Therapy C: Treadmill Training + Sham Duration: 30min, 3d/wk, 4wks	• 10-Meter Wak Test (-) • 6-Minute Walk Test (-) • Modified Ashworth Scale • Hip (-) • Knee (-) • Ankle (+exp)

		• Fugl-Meyer Assessment (-)
Mirror Therapy Combined with Task Oriented Training vs Task Oriented Training		
Cha et al. (2016) RCT (5) N_{start}=25 N_{end}=20 TPS=Chronic	E: Mirror therapy + task-oriented training C: Task oriented training Duration: 30min/d, 2x/d, 5x/wk, 4wks	• Berg Balance Scale (+exp) • Timed Up-and-Go (+exp) • Balance Index (+exp) • Dynamic Limits of Stability (+exp)
Choi et al. (2015) RCT (5) N^{start}=26 N^{end}=24 TPS=Chronic	E: Stepper Exercise + Visual Feedback (with mirror) C: Stepper Exercise Duration: 30 min/d, 3d/wk, 6wks	• Muscle Strength • Hip joint extensor muscle (+exp) • Knee joint extensor muscle (-) • 10-Meter Walking Test (+exp) • 11 Stair Climbing Test (-)
Mirror Therapy with Cyclic NMES vs Mirror Therapy, Sham Therapy or Conventional Therapy		
Xu et al. (2017) RCT (9) N_{start}=69 N_{end}=69 TPS=Acute	E1: Mirror therapy + cyclic NMES E2: Mirror therapy C: Training using non-reflective side of mirror Duration: 30min/d, 5d/wk for 4wk	E1/E2 versus C: • 10-Meter Walk Test (+exp, +exp2) • Brunnstrom stages (+exp, +exp2) • Passive ankle range of motion (+exp, +exp2) • Modified Ashworth Scale (+exp) E1 versus E2: • 10-Meter Walk Test (+exp) • Brunnstrom stages (-) • Passive ankle range of motion (-) • Modified Ashworth Scale (-)
Lee et al. (2016) RCT (6) N_{start}=27 N_{end}=27 TPS=Chronic	E: Mirror therapy + cyclic NMES C: Conventional therapy Duration: 2hr/d, 5d/wk for 4wk	• Muscle strength (+exp) • Modified Ashworth Scale (-) • Berg Balance Scale (+exp) • 6-Minute Walk Test (-) • Timed Up & Go Test (-)
Mirror Therapy with Functional Electrical Stimulation vs Conventional Therapy		
Salhab et al. (2016) RCT (4) N_{start}=18 N_{end}=18 TPS=Chronic	E: Mirror therapy + Functional electrical stimulation C: Conventional therapy Duration: 50min/d, 4d/wk for 2wk	• Fugl-Meyer Assessment (+exp) • 10-Metre Walk Test (+exp) • Ankle dorsiflexion range of motion (+exp)
Mirror Therapy with rTMS vs Mirror Therapy with Sham Stimulation		
Cha & Kim (2015) RCT (8) N_{start}=36 N_{end}=31 TPS=Subacute	E: Mirror therapy + Repetitive transcranial magnetic stimulation C: Mirror therapy + Sham stimulation Duration: 30min/d, 5d/wk for 4wk	• Dynamic limits of stability (+exp) • Berg Balance Scale (-) • Timed Up & Go Test (+exp) • Balance Index (+exp)

Abbreviations and table notes: ANCOVA=analysis of covariance; ANOVA=analysis of variance; C=control group; D=days; E=experimental group; FES=functional electrical stimulation; H=hours; Min=minutes; NMES=neuromuscular electrical stimulation; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Mirror Therapy

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	**Mirror therapy** may produce greater improvements in motor function than **conventional therapy or a sham condition**.	6	Arya et al. 2019; Arya et al. 2017; Wang et al. 2017; Salem et al. 2015; Mohan et al. 2013; St beyaz et al. 2007
1b	**Mirror therapy with treadmill training** may not have a difference in efficacy when compared to **treadmill training** for improving motor function.	1	Broderick et al. 2019
1b	**Mirror therapy with cyclic NMES** may produce greater improvements in motor function than a **sham condition**.	1	Xu et al. 2017
2	**Mirror therapy with FES** may produce greater improvements in motor function than **conventional therapy**.	1	Salhab et al. 2016

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Mirror therapy** may not have a difference in efficacy when compared to **conventional therapy or a sham condition** for improving functional ambulation.	5	Arya et al. 2019; Arya et al. 2017; Wang et al. 2017; Ji & Kim, 2015; Salem et al. 2015; Mohan et al. 2013; St beyez et al. 2007
1b	**Mirror therapy combined with treadmill training** may not have a difference in efficacy when compared to **treadmill training** for improving functional ambulation.	1	Broderick et al. 2019
2	**Mirror therapy combined with task-oriented training** may produce greater improvements in functional ambulation than **task-oriented training.**	1	Choi et al. 2015
1a	There is conflicting evidence about the effect of **mirror therapy with cyclic NMES** to improve functional ambulation when compared to **conventional therapy or a sham condition**.	2	Xu et al. 2017; Lee et al. 2016
2	**Mirror therapy with FES** may produce greater improvements in functional ambulation than **conventional therapy**.	1	Salhab et al. 2016

BALANCE

LoE	Conclusion Statement	RCTs	References
1b	**Mirror therapy** may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	2	Wang et al. 2017; Mohan et al. 2013
2	**Mirror therapy combined with task-oriented training** may produce greater improvements in balance than **task-oriented training.**	2	Cha et al. 2016; Choi et al. 2015

1b	There is conflicting evidence about the effect of **mirror therapy with cyclic NMES** to improve balance when compared to **conventional therapy**.	1	Lee et al. 2016
1b	**Mirror therapy with rTMS** may produce greater improvements in balance than **mirror therapy with sham stimulation**.	1	Cha & Kim, 2015

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **mirror therapy** to improve gait when compared to **conventional therapy or a sham condition**.	3	Arya et al. 2019; Arya et al. 2017; Ji & Kim 2015

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Mirror therapy** may produce greater improvements in activities of daily living than **conventional therapy**.	2	Wang et al. 2017; St beyez et al. 2007
2	**Mirror therapy combined with task-oriented training** may produce greater improvements in activities of daily living than **task-oriented training.**	1	Cha et al. 2016

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
2	**Mirror therapy** may produce greater improvements in range of motion than **conventional therapy or a sham condition** for improving range of motion.	1	Salem et al. 2015
2	**Mirror therapy with FES** may produce greater improvements in range of motion than **conventional therapy**.	1	Salhab et al. 2016

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
2	There is conflicting evidence about the effect of **mirror therapy combined with task-oriented training** to improve muscle strength when compared to **task-oriented training**.	1	Choi et al. 2015
1b	**Mirror therapy with cyclic NMES** may produce greater improvements in muscle strength than **conventional therapy**.	1	Lee et al. 2016

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Mirror therapy** may not have a difference in efficacy when compared to **conventional therapy or a sham condition** for improving spasticity.	2	Salem et al. 2015; St beyez et al. 2007

1b	**Mirror therapy combined with treadmill training** may not have a difference in efficacy when compared to **treadmilling training** for improving spasticity.	1	Broderick et al. 2019
1b	There is conflicting evidence about the effect of **mirror therapy with NMES** to improve spasticity when compared to **a sham condition or conventional therapy**.	2	Xu et al. 2017; Lee et al. 2016

Key Points

Mirror therapy may be helpful in improving motor function.

Mirror therapy may not be beneficial for improving functional ambulation.

The literature is mixed regarding the effect of mirror therapy on gait.

Aquatic therapy

Adopted from: https://completept.com

Aquatic therapy employs the natural properties of water (i.e. buoyancy, hydrostatic pressure, hydrodynamic forces, thermodynamics and viscosity) to act as a rehabilitation intervention in supporting weight and offsetting gravity during exercises related to balance and gait performed in water (Becker, 2009).

Aquatic therapies may vary, with some forms including traditional exercises, neurodevelopmental techniques, proprioceptive neuromuscular facilitation, and task-specific training. The Halliwick Method is an example of a motor rehabilitation program that is based on neurodevelopmental techniques, in which core stability is a major focus (Martin et al. 1981). The Bad Ragaz Ring Method is an example of a motor rehabilitation program that is based on proprioceptive neuromuscular facilitation techniques, in which improving range of motion is a major focus (Boyle et al. 1981). Alternative and complementary medicine techniques have also been integrated into aquatic therapy programs, examples include Ai chi, which is derived from tai chi, as well as Watsu, which is derived from shiatsu (Ross & Presswalla 1998; Lutz 1999).

16 RCTs were found evaluating aquatic therapy for lower extremity motor rehabilitation.

12 RCTs compared aquatic therapy to conventional therapy (Ku et al. 2020; Cha et al. 2017; Chan et al. 2017; Park et al. 2016; Zhang et al. 2016; Kim et al. 2015a; Kim et al. 2015b; Zhu et al. 2015; Furnari et al. 2014; Tripp et al. 2014; Park et al. 2011; Noh et al. 2008). Two RCTs compared aquatic treadmill walking to treadmill walking on land (Lee et al. 2018; Park et al. 2012). Two RCTs compared aquatic dual-task training to conventional therapy (Saleh et al. 2019; Kim et al. 2016).

The methodological details and results of all 16 RCTs evaluating aquatic therapy for lower extremity motor rehabilitation are presented in Table 21.

Table 21. RCTs Evaluating Aquatic Therapy Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Aquatic Therapy vs Conventional Therapy		
Ku et al. (2020) RCT (8) N$_{start}$=20 N$_{end}$=20 TPS=Chronic	E: Ai Chi (modified aquatic therapy) C: Water Based Exercise Duration: 60min/d, 3d/wk, 6wks	• Berg Balance Scale (+exp) • Limit of Stability (-) • Fugl-Meyer Assessment Lower Extremity (+exp) • Gait Performance (-)
Cha et al. (2017) RCT (8) N$_{start}$=22 N$_{end}$=22 TPS=Chronic	E: Aquatic therapy (Bad Ragaz Ring Method) C: Conventional therapy Duration: 1h/d, 3d/wk for 6wk	• Timed Up and Go Test (-) • Barthel Index (+exp) • Gastrocnemius and tibialis anterior muscle strength (+exp)
Chan et al. (2017) RCT (5) N$_{start}$=32 N$_{end}$=25 TPS=Subacute	E: Aquatic therapy with conventional therapy C: Conventional therapy Duration: 1h/d, 2d/wk for 6wk	• Berg Balance Scale (-) • Community Balance and Mobility Test (-) • Timed Up and Go Test (-) • 2-Minute Walk Test (-)
Park et al. (2016) RCT (6) N$_{start}$=28 N$_{end}$=NR TPS=Chronic	E: Aquatic therapy (Halliwick, Watsu, and Trunk Training) C: Conventional therapy Duration: 30min/d, 4d/wk for 6wk	• Gait Speed (-) • Walking cycle (+con) • Affected side stance phase (-) • Affected side stride length (+con) • Symmetry index of stance phase or stride length (-)
Zhang et al. (2016) RCT (7) N$_{start}$=36 N$_{end}$=36 TPS=Subacute	E: Aquatic therapy (Halliwick method) C: Conventional therapy Duration: 40min/d, 5d/wk for 8wk	• Functional Ambulation Category Score (+exp) • Barthel Index (+exp) • Knee extension (+exp) • Ankle plantarflexion torque (+exp) • Lower knee extension co-contraction ratio (+exp) • Modified Ashworth Scale (-)
Kim et al. (2015) RCT (4) N$_{start}$=20 N$_{end}$=NR TPS=Chronic	E: Aquatic therapy (based on proprioceptive neuromuscular facilitation) C: Conventional therapy Duration: 30min/d, 5d/wk for 6wk	• Berg Balance Scale (+exp) • Timed Up and Go Test (+exp) • Functional Reach Test (+exp) • One Leg Stand Test (+exp) • Functional Independence Measure (+exp)
Kim et al. (2015b) RCT (4) N$_{start}$=20 N$_{end}$=NR TPS=Chronic	E: Aquatic therapy (based on proprioceptive neuromuscular facilitation) C: Conventional therapy Duration: 30min/d, 5d/wk for 6wk	• Berg Balance Scale (+exp) • Functional Reach Test (+exp) • 10-Meter Walk Test (+exp) • Timed Up and Go Test (+exp)
Zhu et al. (2015) RCT (8) N$_{start}$=28 N$_{end}$=28 TPS=Chronic	E: Aquatic therapy C: Conventional therapy Duration: 45min/d, 5d/wk for 4wk	• Berg Balance Scale (-) • Functional Reach Test (+exp) • Timed Up and Go Test (-) • 2-Minute Walk Test (+exp)
Furnari et al. (2014) RCT (5) N$_{start}$=40 N$_{end}$=NR TPS=Chronic	E: Aquatic therapy (Halliwick and Ai Chi) C: Conventional therapy Duration: 1h/d, 6d/wk for 8wk	• Plantar surface and plantar load (+exp) • Length of ball stabilometric analysis (+exp) • Gait speed (+exp) • Semi step length (-) • Cadence (-) • Stance phase (+exp)

		• Swing phase (+exp) • Double support phase (+exp)
Tripp et al. (2014) RCT (7) N_{start}=30 N_{end}=27 TPS=Subacute	E: Aquatic therapy (Halliwick) C: Conventional therapy Duration: 35-45min/d, 5d/wk for 2wk	• Berg Balance Scale (+exp) • Functional Reach Test (-) • Functional Ambulation Category Score (+exp) • Rivermead Mobility Index (-) •
Park et al. (2011) RCT (4) N_{start}=44 N_{end}=NR TPS=Chronic	E: Aquatic therapy C: Conventional therapy Duration: 35min/d, 6d/wk for 6wk	• Performance-Oriented Mobility Assessment (+exp) • Joint Position Sense (+exp)
Noh et al. (2008) RCT (5) N_{start}=25 N_{end}=20 TPS=Chronic	E: Aquatic therapy (Halliwick and Ai Chi methods) C: Conventional therapy Duration: 1h/d, 3d/wk for 8wk	• Berg Balance Scale (+exp) • Weight shift laterally (-) • Weight shift forward and backward (+exp) • Rising from chair balance assessment (-) • Modified Motor Assessment Scale (-) • Knee extensor peak torque (-) • Knee flexor peak torque (+exp) • Back extensor/flexor muscle strength (-)
Aquatic Treadmill Walking vs Treadmill Walking or Cycle Ergometer		
Park et al. (2012) RCT (4) N_{start}=20 N_{end}=NR TPS=Chronic	E: Underwater treadmill walking C: Overground treadmill walking Duration: 30min/d, 4d/wk for 6wk	• Body weight on foot (+exp) • Short Physical Performance Battery (-)
Lee et al. (2018) RCT (7) N_{start}=37 N_{end}=32 TPS=Acute	E: Aquatic Treadmill Training C: Aerobic Exercise (ergometers) Duration: 30min, 5x/wk, 4wks	• Fugl Meyer Assessment (-) • Berg Balance Scale (-) • Modified Barthel Index (-) • Strength a. Knee Flexion (+exp) b. Knee Extension (+exp) • Step Length (+exp)
Dual-Task Aquatic Training vs Neurodevelopmental Techniques or Land-Based Dual Motor Task		
Saleh et al. (2019) RCT (6) N_{start}=50 N_{end}=50 TPS=Chronic	E: Aquatic-based Dual-task Motor Training C: Land-based Dual-task Motor Training Duration: 45min, 3x/wk, 6wks	• Overall Stability Index (-) • Anteroposterior Stability Index (-) • Mediolateral Stability Index (-) • Walking Speed (+exp) • Step Length (+exp) • Time of Support (+exp) •
Kim et al. (2016) RCT (4) N_{start}=20 N_{end}=NR TPS=Chronic	E: Aquatic therapy (Dual-task training with upper extremity tasks) C: Neurodevelopmental techniques Duration: 1h/d, 5d/wk for 6wk	• Berg Balance Scale (+exp) • Five-Time Sit to Stand Test (+exp) • Functional Reach Test (+exp) • 10-Meter Walk Test (+exp) • Timed Up and Go Test (+exp) • Functional Gait Assessment (+exp)

Abbreviations and table notes: ANCOVA=analysis of covariance; C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Aquatic Therapy

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Aquatic therapy** may produce greater improvements in motor function than **conventional therapy**	1	Ku et al. 2020
1b	There is conflicting evidence about the effect of **aquatic treadmill training** to improve motor function when compared to **cycle ergometer**.	1	Lee et al. 2018

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Aquatic therapy** may produce greater improvements in functional ambulation than **conventional therapy**.	8	Chan et al. 2017; Park et al. 2016; Zhang et al. 2016; Kim et al. 2015b; Zhu et al. 2015; Furnari et al. 2014; Tripp et al. 2014; Chu et al. 2004
1b	**Aquatic dual-task training** may produce greater improvements in functional ambulation than **neurodevelopmental techniques or land-based dual motor task.**	2	Saleh et al. 2019; Kim et al. 2016

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Aquatic therapy** may not have a difference in efficacy when compared to **conventional therapy** for improving functional mobility.	1	Tripp et al. 2014
2	**Aquatic treadmill walking** may not have a difference in efficacy compared to **traditional treadmill training** for improving functional mobility.	1	Park et al. 2012

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Aquatic therapy** may not have a difference in efficacy when compared to **conventional therapy** for improving balance.	12	Ku et al. 2020; Cha et al. 2017; Chan et al. 2017; Kim et al. 2015; Kim et al. 2015b; Zhu et al. 2015; Furnari et al. 2014; Park et al. 2014; Tripp et al. 2014; Park et al. 2011; Noh et al. 2008; Chu et al. 2004
1b	There is conflicting evidence about the effect of **aquatic treadmill training** to improve balance when compared to **traditional treadmill training**.	2	Lee et al. 2018; Park et al. 2012
1b	There is conflicting evidence about the effect of **aquatic dual-task training** to improve balance when compared to **neurodevelopmental techniques or land-based dual motor task.**	2	Saleh et al. 2019; Kim et al. 2016

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **aquatic therapy** to improve gait when compared to **conventional therapy**.	4	Ku et al. 2020; Park et al. 2016; Furnari et al. 2014; Noh 2008
1b	**Aquatic dual-task training** may produce greater improvements in gait than **neurodevelopmental techniques or land-based dual motor task.**	2	Saleh et al. 2019; Kim et al. 2016

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Aquatic therapy** may produce greater improvements in activities of daily living than **conventional therapy**	5	Cha et al 2017; Zhang et al. 2016; Kim et al. 2015; Furnari et al. 2014; Noh 2008
1b	**Aquatic treadmill walking** may not have a difference in efficacy when compared to **cycle ergometer** for improving activities of daily living.	1	Lee et al. 2018

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	**Aquatic therapy** may produce greater improvements in muscle strength than **conventional therapy**	3	Cha et al. 2017; Zhang et al. 2016; Noh et al. 2008; Chu et al. 2004

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Aquatic therapy** may not have a difference in efficacy when compared to **conventional therapy** for improving spasticity.	1	Zhang et al. 2016

PROPRIOCEPTION

LoE	Conclusion Statement	RCTs	References
2	**Aquatic therapy** may produce greater improvements in proprioception than **conventional therapy**	1	Park et al. 2011

Key Points

Aquatic therapy may be beneficial for improving functional ambulation, activities of daily living, and muscle strength.

The literature is mixed regarding the effects of aquatic therapy for improving gait.

Aquatic therapy may not be beneficial for improving balance.

Strength and Resistance Training

Adopted from: https://aspirefitnessrehab.com.au/our-services/

Weakness has been defined as inadequate capacity to generate normal levels of muscle force (Miller et al.1998). Gray et al. (2012) found that individuals experience decreases in muscle fibre length and lean muscle mass post stroke. Neural input to muscle groups are reduced, resulting in weakness and a decrease in muscle fibre length, which the fibres may adapt to if the muscle is not moved through the full range of motion (Gray et al. 2012). In contrast, Klein et al. (2013) did not find any significant differences in muscle volume or atrophy between the contralesional and ipsilesional limbs in relation to weakness. However, the authors reported lower levels of maximal voluntary contraction torque in the contralesional limb, which was associated with deficits in muscle activation and electromyographic amplitude.

Muscle strengthening as an intervention is designed to improve the force-generation capacity of hemiplegic limbs and enhance functional abilities. Conventional physiotherapy rehabilitation programs may not include muscle strengthening as there is a belief that strength training may increase spasticity (Forster & Young 1995). While the effectiveness of strength training is difficult to assess due to variability in training programs, it has been suggested that strength training should be recommended as part of a stroke rehabilitation program (Ada et al. 2006).

Strength or resistance training can take various forms in which eccentric, isometric, or concentric exercises are performed. The muscle lengthens during contraction in eccentric training, stays constant during isometric training, and shortens during concentric training. Other forms of strength or resistance training can include the way in which the exercise is performed. For example, in the case of isokinetic strength training, the exercise machines used produce a constant pace of work or speed regardless of the effort expended. Alternatively, functional strength training involves performing functional exercises that mimic common real-life activities and that require the muscles to work together. Progressive resistance training involves performing exercises in which additional load is continuously added to facilitate adaptation. Strength or resistance training can also be coupled with other forms of exercises such as aerobic training, can be administered in various settings, and also at various intensities.

32 RCTs were found evaluating strength and resistance training for lower extremity motor rehabilitation.

18 RCTs compared strength and resistance training to conventional therapy (Hendrey et al. 2018; Fernandez-Gonzalo et al. 2016; Sen et al. 2015; Zou et al. 2015; Mares et al. 2014; Son et al. 2014; Lee et al. 2013; Lee & Kang 2013; Sekhar et al. 2013; Patil et al. 2011; Cooke et al. 2010; Lovell et al. 2009; Bale et al. 2008; Flansbjer et al. 2008; Akbari & Karimi, 2006; Yang et al. 2006; Moreland et al. 2003; Glasser. 1986). Four RCTs compared strength and resistance training to stretching or relaxation (Ivey et al. 2017; Moore et al. 2016; Mead et al. 2007; Kim et

al. 2001). Four RCTs compared aerobic and resistance training to conventional therapy or aerobic training alone (Marzolini et al. 2018; Lee et al. 2015; Teixeira-Salmela et al. 1999; Duncan et al. 1998). Four RCTs compared strength and resistance training modalities (Alabdulwahab et al. 2015; Clark & Patten et al. 2013; Lee et al. 2010; Page et al. 2008). One RCT compared strength and resistance training intensity (Lamberti et al. 2017). One RCT compared strength training with mirror therapy to strength training alone (Simpson et al. 2019).

The methodological details and results of all 32 RCTs are presented in Table 22.

Table 22. RCTs Evaluating Strength and Resistance Training Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) **Study Design (PEDro Score)** **Sample Size$_{start}$** **Sample Size$_{end}$** **Time post stroke category**	**Interventions** **Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures** **Result (direction of effect)**
Strength or Resistance Training vs Conventional Therapy		
Hendrey et al. (2018) RCT (8) N$_{start}$=30 N$_{end}$=30 TPS=Subacute	E: Ballistic Strength Training C: Conventional Therapy Duration: 45/d, 3d/wk, 6 wks	• Timed Up and Go Test (-) • Comfortable Gait Velocity (+exp) • Fast Gait Velocity (-) • Muscle Torque (-)
Fernandez-Gonzalo et al. (2016) RCT (5) N$_{start}$=32 N$_{end}$=29 TPS=Chronic	E: Eccentric resistance training C: Conventional therapy Duration: 30min/d, 5d/wk for 12wk	• Timed Up-and-Go Test (+exp)
Şen et al. (2015) RCT (5) N$_{start}$=50 N$_{end}$=48 TPS=Subacute	E: Isokinetic strength training C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 3wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Timed Up-and-Go Test (+exp) • Berg Balance Scale (+exp) • Stair Climbing Test (+exp) • Rivermead Mobility Index (+exp) • Functional Independence Measure (+exp)
Zou et al. (2015) RCT (7) N$_{start}$=56 N$_{end}$=51 TPS=Chronic	E: Lower Body Resistance Training C: Conventional therapy Duration: 1session/day, 3sessions/wk, 8wks experimental, equal training time in control group of conventional therapy + 40min/d, 3d/wk, 8wks physiotherapy	• Weighted Paretic Leg Extension (+exp) • Paretic Leg Press (+exp) • Fugl-Meyer Lower Extremity (-)
Mares et al. (2014) RCT (8) N$_{start}$=52 N$_{end}$=48 TPS=Chronic	E: Functional strength training for lower limb C: Functional strength training for upper limb Duration: 1hr/d, 4d/wk for 6wk	• Functional Ambulation Categories (-) • Modified Rivermead Mobility Index (-) • Timed Up-and-Go Test (-)
Son et al. (2014) RCT (6) N$_{start}$=28 N$_{end}$=26 TPS=Chronic	E: Resistance training C: Conventional therapy Duration: 30min/d, 5d/wk for 6wk	• Berg Balance Scale (+exp) • Timed Up-and-Go Test (+exp) • Sway Distance (+exp)

Lee et al. (2013) RCT (5) N_{start}=28 N_{end}=28 TPS=Chronic	E: Progressive resistance training + Foot-ankle compression C: Conventional therapy Duration: 30min/d, 5d/wk for 6wk	• Gait velocity (+exp) • Step time (+exp) • Double limb support (+exp) • Step length (+exp) • Stride length (+exp) • Heel-to-heel support (+exp) •
Lee & Kang (2013) RCT (3) N_{start}=20 N_{end}=20 TPS=Chronic	E: Isokinetic strength training C: Conventional therapy Duration: 45min/d, 3d/wk for 6wks	• Gait velocity (+exp) • Timed Up-and-Go Test (+exp) • Stair up and down time (+exp) • Hip muscle strength (+exp)
Sekhar et al. (2013) RCT (5) N_{start}=40 N_{end}=40 TPS=Not Reported	E: Isokinetic Strength and Balance Training C: Conventional Care Duration: 6wks	• Peak Torque (+exp) • Berg Balance Scale (+exp)
Patil et al. (2011) RCT (2) N_{start}=16 N_{end}=16 TPS=Subacute	E: Theraband Elastic Resistance Band during Gait Training C: Conventional Therapy and Gait Training Duration: 45min/d, 3d/wk, 6 wks	• Wisconsin Gait Scale (-) • Rivermead Mobility Index (-)
Cooke et al. (2010) RCT (7) N_{start}=109 N_{end}=80 TPS=Chronic	E: Functional strength training C1: High-intensity physiotherapy C2: Low-intensity physiotherapy	E vs C1/C2 • Walking Speed: (-) C1 vs C2 • Walking Speed: (+con$_1$) • Rivermead Mobility Index (-) • Knee flexion peak torque (-) • Knee extensor peak torque (-)
Lovell et al. (2009) RCT (5) N_{start}=24 N_{end}=24 TPS=Not Reported	E: Strength Training (Incline Squat Machine) C: Conventional Therapy Duration: 3 sets of 6-10 repetitions at 70-90% 1RM, 3d/wk, 16wks	• Leg Strength (+exp) • V02 Max (-)
Bale et al. (2008) RCT (6) N_{start}=18 N_{end}=18 TPS=Subacute	E: Functional strength training C: Conventional therapy Duration: 50min/d, 5d/wk for 4wk	• Habitual gait speed (+exp) • Maximum gait speed (-) • Knee muscle strength (-) • Maximum weight bearing (-)
Flansbjer et al. (2008) RCT (6) N_{start}=24 N_{end}=24 TPS=Chronic	E: Progressive resistance training C: Conventional therapy Duration: 1hr/d, 2d/wk for 10wk	• Knee extension (+exp) • Knee flexion (+exp) • Timed Up & Go Test (+exp) • 6-Minute Walk Test (-) • Fast gait speed (-)
Akbari & Karimi, (2006) RCT (5) N_{start}=34 N_{end}=34 TPS=Chronic	E: Strengthening Exercises C: Conventional Therapy Duration: 3hrs/d, 3x/wk, 4wks	• Modified Ashworth Scale (+exp) • Dynamometer (-)
Yang et al. (2006) RCT (7)	E: Progressive resistance training C: Conventional therapy Duration: 30min/d, 3d/wk for 4wk	• Gait velocity (+exp) • 6-Minute Walk Test (+exp) • Timed Up-and-Go Test (+exp)

N_{start}=48 N_{end}=46 TPS=Chronic		• Stride length (+exp) • Cadence (+exp) • Muscle strength (+exp) • Step Test (-)
Moreland et al. (2003) RCT (6) N_{start}=133 N_{end}=106 TPS=Subacute	E: Progressive resistance training C: Training without resistance Duration: 30min/d, 5d/wk for 6wk	• 2-Minute Walk Test (-) • Chedoke-McMaster Stroke Assessment (-)
Glasser (1986) RCT (4) N_{start}=20 N_{end}=20 TPS=Chronic	E: Isokinetic strength training C: Conventional therapy Duration: 1hr/d, 5d/wk for 5wk	• Functional Ambulation Profile (-)
Strength or Resistance Training vs Stretching or Relaxation		
Ivey et al. (2017) RCT (4) N_{Start}=38 N_{End}=30 TPS=Chronic	E: Strength training C: Stretching Duration: 45min/d, 3d/wk for 3mo	• Number of submaximal weight leg press repetitions possible at a specified cadence (+exp) • 6-minute walk distance (+exp) • 10-Min Walking Test (-) • Meter walk speed (-) • Peak oxygen consumption (+exp) • One repetition max (+exp)
Moore et al. (2016) RCT (5) N_{start}=40 N_{end}=40 TPS=Chronic	E: Progressive exercise program C: Stretching Duration: 45min/d, 3d/wk for 19wk	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (+exp) • Timed Up-and-Go Test (+exp) • Berg Balance Scale (+exp)
Mead et al. (2007) RCT (8) N_{start}=66 N_{end}=66 TPS=Chronic	E: Progressive resistance training C: Relaxation Duration: 30min/d, 3d/wk for 12wk	• Timed Up-and-Go Test (+exp) • Rivermead Mobility Index (-) • Sit-to-Stand Test (-) • Elderly Mobility Score (-) • Functional Independent Measure (-)
Kim et al. (2001) RCT (7) N_{start}=20 N_{end}=20 TPS=Chronic	E: Isokinetic strength training C: Passive range of motion Duration: 45min/d, 3d/wk for 6wk	• Walking speed (-) • Muscle strength (-)
Aerobic and Resistance Training vs Conventional Therapy or Aerobic Training		
Marzolini et al. (2018) RCT (6) N_{start}=73 N_{end}=68 TPS=Chronic	E: Overground walking and resistance training C: Overground walking Duration: 5d/wk for 6mo	• 6-minute walk test (-) • Stair climb time (-) • Sit to stand time (-) • Total lean mass of legs (-) • Total body fat percentage of legs (-) • Knee extension strength – unaffected side(+exp) • Knee extension strength – affected side (-)
Lee et al. (2015) RCT (6) N_{start}=30 N_{end}=30 TPS=Chronic	E: Resistance training + Aerobic training C: Conventional therapy Duration: 1hr/d, 3d/wk for 16wk	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (+exp) • Timed Up-and-Go Test (-) • 30-Second Chair Test (-)
Teixeira-Salmela al. (1999) RCT (5) N_{start}=13 N_{end}=13	E: Resistance training + Aerobic training C: Conventional therapy Duration: 1hr/d, 3d/wk for 10wk	• Gait velocity (+exp) • Stair climb (+exp) • Adjusted Activity Scale (+exp) • Human Activity Profile (+exp)

TPS=Chronic		• Nottingham Health Profile (+exp)
Duncan et al. (1998) RCT (6) N_{start}=20 N_{end}=20 TPS=Subacute	E: Home-based strength and resistance training program C: Conventional therapy Duration: 1hr/d, 3d/wk for 8wk	• Fugl-Meyer Assessment (+exp) • 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Berg Balance Scale (+exp) • Barthel Index (-) • Lawton IADL (-)
Strength and Resistance Training Modalities		
Alabdulwahab et al. (2015) RCT (6) N_{start}=26 N_{end}=23 TPS=Chronic	E: Functional limb overloading (90% of waking hours wearing weight) E2: Limb overload resistance training Duration: 1hr/d, 3d/wk for 4wk	• Gait Speed (+exp) • Cadence (+exp) • Weight Bearing (+exp) • Stroke Impact Scale (+exp)
Clark & Patten (2013) RCT (8) N_{start}=35 N_{end}=33 TPS=Chronic	E1: Eccentric resistance training + Gait training E2: Concentric resistance training + Gait training Duration: 90min/d, 3d/wk for 6wk	E1 vs E2 • Muscle power (+exp$_1$) • Muscle activation (+exp$_1$) • Self-selected walking speed (-) • Fastest walking speed (-) •
Lee et al. (2010) RCT (8) N_{start}=48 N_{end}=41 TPS=Subacute	E1: Progressive resistance training + Cycling E2: Progressive resistance training + Sham cycling E3: Sham progressive resistance training + Cycling E4: Sham progressive resistance training + Sham cycling Duration: 1hr/d, 3d/wk for 10wk	E1/E2 vs E3/E4 • Muscle strength (+exp$_1$, +exp$_2$) • Muscle endurance (+exp$_1$, +exp$_2$) • Peak power (+exp$_1$, +exp$_2$) E1 vs E2 • Muscle strength (-) • Muscle endurance (-) • Peak power (-) E3 vs E4 • Muscle strength (+exp$_3$) • Muscle endurance (+exp$_3$) • Peak power (+exp$_3$)
Page et al. (2008) RCT (4) N_{start}=7 N_{end}=7 TPS=Chronic	E1: Resistance training E2: Home-based exercise program Duration: 45min/d, 5d/wk for 2wk	• Berg Balance Scale (-) • Fugl-Meyer Assessment (-)
Strength and Resistance Training Intensity		
Lamberti et al. (2017) RCT (7) N_{start}=35 N_{end}=35 TPS=Chronic	E: Low-intensity walking and resistance training program C: High-intensity walking and resistance training program Duration: 60min/d, 3d/wk for 8wk	• 6-minute Walk Test (-) • Berg Balance Scale (-) • Gait speed (-) • Muscle performance of femoral biceps and quadriceps (-)
Strength Training Combined with Mirror Therapy		
Simpson et al. (2019) RCT (7) N_{start}=35 N_{end}=31 TPS=Chronic	E: Unilateral Strength Training + Mirror Therapy C: Unilateral Strength Training Duration: 4-5 sets of repetitions (~25min), 3d/wk, 4wks	• Maximal Voluntary Contraction in Trained and Untrained Ankles (-) • Modified Ashworth Scale (-) a. Hip (-) b. Knee (-) c. Ankle (-) • Ten Meter Walk Test (-) • Timed Up-and-Go (-) • London Handicap Scale (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Strength and Resistance Therapy

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Aerobic and resistance training** may produce greater improvements in motor function than **conventional therapy.**	1	Duncan et al. 1998
1b	**Strength or resistance training** may produce greater improvements in motor function than **stretching**	1	Ouellette et al. 2004
2	**Resistance training** may not have a difference in efficacy when compared to **home-based exercise** for improving motor function.	1	Page et al. 2008

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **strength or resistance training** to improve functional ambulation when compared to **conventional therapy**.	10	Sen et al. 2015; Mares et al. 2014; Lee et al. 2013; Lee & Kang, 2013; Cooke et al. 2010; Bale et al. 2008; Flansbjer et al. 2008; Yang et al. 2006; Moreland et al. 2003; Glasser et al. 1986
1a	**Aerobic and resistance training** may produce greater improvements in functional ambulation than **conventional therapy**.	3	Lee et al. 2015; Duncan et al. 1998; Marzolini et al. 2018
1b	**Functional limb overloading** may produce greater improvements in functional ambulation than **limb overloading resistance training.**	1	Alabdulwahab et al. 2015
1b	There is conflicting evidence about the effect of **strength or resistance training** to improve functional ambulation when compared to **stretching.**	3	Ivey et al. 2017; Moore et al. 2016; Kim et al. 2001
1b	**Strength training with mirror therapy** may not have a difference in efficacy when compared to **strength training alone** for improving functional ambulation.	1	Simpson et al. 2019

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1a	**Strength or resistance training** may not have a difference in efficacy when compared to **conventional therapy** for improving functional mobility.	4	Sen et al. 2015; Mares et al. 2014; Patil et al. 2011; Cooke et al. 2010;
1b	**Strength or resistance training** may not have a difference in efficacy when compared to **relaxation** for improving functional mobility.	1	Mead et al. 2007

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Strength or resistance training** may produce greater improvements in balance than **conventional therapy**.	8	Hendry et al. 2018; Fernandez-Gonzalo et al. 2016; Sen et al. 2015; Mares et al. 2014; Son et al. 2014; Lee & Kang 2013; Sekhar et al. 2013; Flansbjer et al. 2008; Yang et al. 2006
1b	There is conflicting evidence about the effect of **strength or resistance training** to improve balance when compared to **stretching or relaxation**.	2	Moore et al. 2016; Mead et al. 2007;
1a	There is conflicting evidence about the effect of **aerobic and resistance training** to improve balance when compared to **conventional therapy or aerobic training.**	4	Marzolini et al. 2018; Lee et al. 2015; Teixeira-Salmela et al. 1999; Duncan et al. 1998
2	**Resistance training** may not have a difference in efficacy when compared to **home-based exercise** for improving balance.	1	Page et al. 2008
1b	**Low intensity endurance and resistance training** may not have a difference in efficacy when compared to **high intensity endurance and resistance training** for improving balance.	1	Lamberti et al. 2017
1b	**Strength training with mirror therapy** may not have a difference in efficacy when compared to **strength training alone** for improving balance.	1	Simpson et al. 2019

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **strength or resistance training** to improve gait when compared to **conventional therapy**.	7	Hendry et al. 2018; Son et al. 2014; Lee et al. 2013; Patil et al. 2011; Yang et al. 2006
1b	**Functional limb overloading** may produce greater improvements in gait than **limb overloading resistance.**	1	Alabdulwahab et al. 2015
1b	There is conflicting evidence about the effect of **aerobic and resistance training** to improve gait when compared to **conventional therapy or aerobic training.**	2	Marzolini et al. 2018; Teixeira-Salmela et al. 1999
1a	**Strength or resistance training** may not have a difference in efficacy when compared to **stretching** for improving gait.	3	Ivey et al. 2017; Ouellette et al. 2004; Kim et al. 2001
1b	**Eccentric resistance with gait training** may not have a difference in efficacy when compared to **concentric resistance training with gait training** for improving gait.	1	Clark & Patten et al. 2013
1b	**Low intensity endurance and resistance training** may not have a difference in efficacy when compared to **high intensity endurance and resistance training** for improving gait.	1	Lamberti et al. 2017

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
2	**Strength and resistance training** may produce greater improvements in activities of daily living than **conventional therapy**	1	Sen et al. 2015
1b	**Aerobic and strength training** may produce greater improvements in activities of daily living than **conventional therapy**	1	Duncan et al. 1998
1b	**Functional limb overloading** may produce greater improvements in activities of daily living than **limb overloading resistance training.**	1	Alabdulwahab et al. 2015
1b	**Low intensity endurance and resistance training** may produce greater improvements in activities of daily living than **high intensity endurance and resistance training.**	1	Lamberti et al. 2017
1b	**Strength or resistance training** may not have a difference in efficacy when compared to **relaxation** for improving activities of daily living.	1	Mead et al. 2007

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **strength or resistance training** to improve muscle strength when compared to **conventional therapy.**	8	Hendry et al. 2018; Zou et al. 2015; Lee & Kang 2013; Sekhar et al. 2013; Lovell et al. 2009; Bale et al. 2008; Akbari & Karimi, 2006; Yang et al. 2006
1b	**Eccentric resistance and progressive resistance training** may produce greater improvements in muscle strength than **concentric resistance and sham progressive resistance,** respectively**.**	2	Clark & Patten et al. 2013; Lee et al. 2010
1b	There is conflicting evidence about the effect of **strength or resistance training** to improve muscle strength when compared to **stretching.**	2	Ivey et al. 2017; Kim et al. 2001
1b	There is conflicting evidence about the effect of **aerobic and resistance training** to improve muscle strength when compared to **aerobic training.**	1	Marzolini et al. 2018
1b	**Low intensity endurance and resistance training** may not have a difference in efficacy when compared to **high intensity endurance and resistance training** for improving muscle strength.	1	Lamberti et al. 2017
1b	**Strength training with mirror therapy** may not have a difference in efficacy when compared to **strength training alone** for improving muscle strength.	1	Simpson et al. 2019

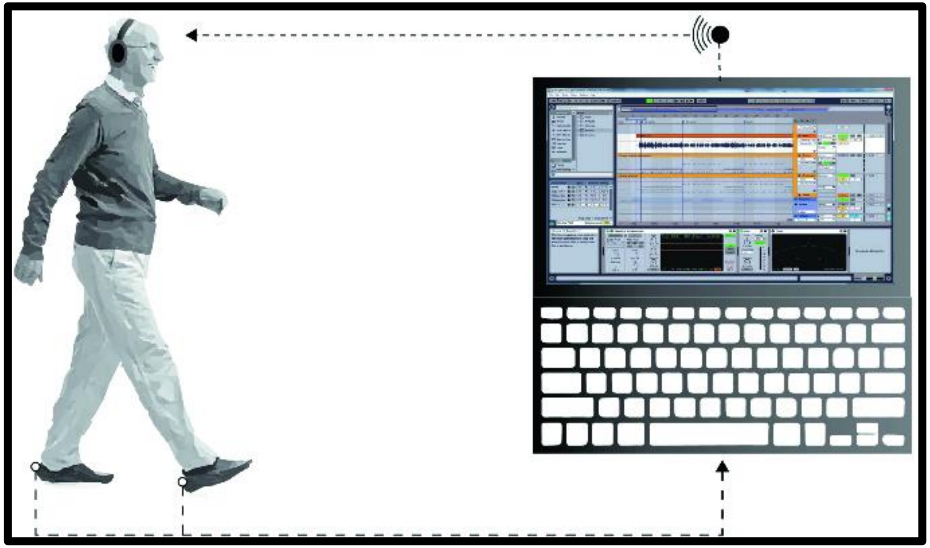
Key Points

The literature is mixed regarding strength and resistance training for functional ambulation, gait, and motor strength.

Strength and resistance training may be helpful for improving balance.

Strength and resistance training may not be beneficial for improving functional mobility.

Rhythmic Auditory Stimulation



Adapted from: https://www.sciencedirect.com/science/article/abs/pii/S2211285518302337

Rhythmic auditory stimulation (RAS) is a form of gait training that involves the sensory cueing of motor systems. The rhythmic auditory stimulus provides a time reference for motor gait response, such that the gait response and auditory stimulus develop into a stable temporal relationship (Thaut et al. 1997). This is possible due to the strong connection between auditory and motor systems across cortical, subcortical and spinal levels.

RAS can be implemented through use of metronomes or music cues that set a tempo to which a patient follows during a training session. Various mechanisms have been proposed to explain how rhythm may influence motor rehabilitation, including through accelerating motor learning, providing a different type of motor learning process, acquiring or refining temporal skills, and lastly through improving emotional engagement and motivation (Schaefer 2014).

14 RCTs were found evaluating rhythmic auditory stimulation for lower extremity motor rehabilitation. Three RCTs compared treadmill training with rhythmic auditory stimulation to treadmill training (Song & Ryu 2016; Yang et al. 2016; Yoon & Kang 2016). Six RCTs compared overground gait training with rhythmic auditory stimulation to overground gait training (Cha et al. 2014; Suh et al. 2014; Kim & Oh 2012; Thaut et al. 2007; Schauer et al. 2003; Thaut et al. 1997). Two RCTs compared other physical exercises with rhythmic auditory stimulation to physical exercise or conventional therapy (Chung et al. 2014; Jeong & Kim 2007). Two RCT compared treadmill training with rhythmic auditory stimulation to overground training with rhythmic auditory stimulation (Manika et al. 2018; Park et al. 2015). One RCT investigated mental auditory stimulation with mental imagery (Kim et al. 2011).
The methodological details and results of all 14 RCTs are presented in Table 23.

Table 23. RCTs Evaluating Rhythmic Auditory Stimulation Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Treadmill Training with Rhythmic Auditory Stimulation vs Treadmill Training		
Song & Ryu (2016) RCT (5) N_{start}=40 N_{end}=36 TPS=Chronic	E: Treadmill training + Rhythmic auditory stimulation C: Treadmill training Duration: 30min/d, 5d/wk for 4wk	• 10-Metre Walk Test (+exp) • Dynamic Gait Index (+exp) • Cadence (+exp) • Step length (+exp)
Yang et al. (2016) RCT (6) N_{start}=24 N_{end}=24 TPS=Subacute	E: Treadmill training + Rhythmic auditory feedback C: Treadmill training Duration: 30min/d, 3d/wk for 4wk	• Gait speed (+exp) • Cadence (+exp) • Stride length (+exp) • Step length (+exp) • Limb support (+exp) • Gait symmetry (+exp) • Timed Up & Go Test (+exp) •
Yoon & Kang (2016) RCT (4) N_{start}=30 N_{end}=30 TPS=Chronic	E1: Incline treadmill training + Rhythmic auditory stimulation E2: Incline treadmill training C: Treadmill training Duration: 30min/d, 5d/wk for 4wk	E1 vs E2/C • Timed Up & Go Test (+exp) • Berg Balance Scale (+exp) • 6-Minute Walk Test (+exp) • Gait speed (+exp) • Symmetry Index (+exp) • Single Limb Support (+exp) • Cadence (+exp) E2 vs C • Timed Up & Go Test: $(+exp_2)$ • Berg Balance Scale: $(+exp_2)$ • 6-Minute Walk Test: $(+exp_2)$ • Gait speed: $(+exp_2)$ • Symmetry index: $(+exp_2)$ • Single Limb Support: (-) • Cadence: (-)
Overground Gait Training with Rhythmic Auditory Stimulation vs Overground Gait Training		
Cha et al. (2014) RCT (7) N_{start}=20 N_{end}=20 TPS=Chronic	E: Overground gait training + Rhythmic auditory stimulation C: Gait training Duration: 30min/d, 5d/wk for 2wk	• Gait speed (+exp) • Stride length (+exp) • Double support period (+exp) • Cadence (+exp) • Berg Balance Scale (+exp)
Suh et al. (2014) RCT (6) N_{start}=16 N_{end}=16 TPS=Chronic	E: Overground gait training + Rhythmic auditory stimulation C: Gait training Duration: 45min/d, 5d/wk for 3wk	• Standing balance (+exp) • Gait speed (+exp) • Stride length (+exp) • Cadence (+exp)
Kim & Oh (2012) RCT (4) N_{start}=20 N_{end}=20 TPS=Chronic	E: Overground gait training + Rhythmic auditory stimulation C: gait training Duration: 20min/d, 3d/wk for 6wk	• Gait speed (+exp) • Stride length (+exp) • Single support time (+exp)
Thaut et al. (2007) RCT (7) N_{start}=78 N_{end}=56 TPS=Acute	E: Overground gait training + Rhythmic auditory stimulation C: Gait training Duration: 30min/d, 5d/wk for 3wk	• Gait speed (+exp) • Stride length (+exp) • Cadence (+exp) • Symmetry Index (+exp)

Schauer et al. (2003) RCT (4) N_{start}=23 N_{end}=23 TPS=Subacute	E: Overground gait training + Auditory feedback C: Gait training Duration: 20min/d, 5d/wk for 2wk	• Gait speed (+exp) • Gait symmetry (+exp) • Stride length (+exp) • Cadence (+exp)
Thaut et al. (1997) RCT (3) N_{start}=20 N_{end}=20 TPS=Subacute	E: Overgound gait training + Rhythmic auditory stimulation C: Gait training Duration: 30min (2x/d), 3d/wk for 6wk	• Gait speed (+exp) • Stride length (+exp) • Muscle activation (+exp) • Stride symmetry (+exp)
Physical Therapy with Rhythmic Auditory Feedback vs Physical Therapy or Conventional Therapy		
Chung et al. (2014) RCT (4) N_{start}=29 N_{end}=22 TPS=Chronic	E: Core training + Feedback C: Core training Duration: 30min/d, 5d/wk for 6wk	• Gait speed (+exp) • Stride length (+exp) • Single support time (+exp) • Timed Up & Go Test (+exp)
Jeong & Kim (2007) RCT (5) N_{start}=33 N_{end}=33 TPS=Chronic	E: Movement exercise + Rhythmic auditory stimulation C: Conventional therapy Duration: 40min/d, 4d/wk for 8wk	• Range of motion (+exp) • Flexibility (+exp) • Ankle extension (+exp) • Ankle flexion (-)
Treadmill Training with Rhythmic Auditory Stimulation vs Overground Gait or Treadmill Training without Rhythmic Auditory Stimulation		
Mainka et al. (2018) RCT (6) N_{start}=45 N_{end}=35 TPS=Subacute	E1: Treadmill training (TT) (Loko S70) with Rhythmic Auditory Stimulation (RAS) E2: Treadmill Training (TT) (Loko S70) C: Neurodevelopmental Techniques Duration: 15-30min/d, 5d/wk, 4wks RAS-TT, TT or NDT + 30-60min/d, 1d/wk, wks physiotherapy in all groups	E1 Vs C • Fast Gait Speed Test a. Velocity (+exp1) b. Cadence (+exp1) c. Stride Length (-) d. Locomotor e. Velocity (-) f. Cadence (-) g. Stride Length (-) • Three Minute Walk Test (-) • Instrumental Evaluation of Balance (-) E2 Vs C • Fast Gait Speed Test h. Velocity (-) i. Cadence (-) j. Stride Length (-) k. Locomotor l. Velocity (-) m. Cadence (-) n. Stride Length (-) • Three Minute Walk Test (-) • Instrumental Evaluation of Balance (-) E1 Vs E2 • Fast Gait Speed Test o. Velocity (+exp1) p. Cadence (+exp1) q. Stride Length (-) r. Locomotor s. Velocity (-) t. Cadence (-)

		u. Stride Length (-) • Three Minute Walk Test (-) • Instrumental Evaluation of Balance (-)
Park et al. (2015) RCT (5) N_{start}=19 N_{end}=19 TPS=Chronic	E: Treadmill training + Rhythmic auditory stimulation C: Overground training + Rhythmic auditory stimulation Duration: 45min/d, 3d/wk for 4wk	• Gait speed (+exp) • 6-Minute Walk Test (+exp) • Functional Gait Assessment (+exp) • Step cycle (+exp) • Step length (+exp) • Timed Up & Go Test (-)
Auditory Stimulation with Mental Imagery vs Mental Imagery		
Kim et al. (2011) RCT crossover (4) N_{start}=18 N_{end}=15 TPS=Chronic	E1: Visual Locomotor Imagery Training E2: Kinesthetic Locomotor Imagery Training E3: Visual Locomotor Training with Auditory Step Rhythm E4: Kinesthetic Locomotor Imagery Training with Auditory Step Rhythm Duration: 15 min/condition, 24 hr washout	E1 vs E2 • Timed Up and Go Test (-) E1 VS E3 • Timed Up and Go Test (-) E1vs E4 • Timed Up and Go Test (+exp4) E2 vs E3 • Timed Up and Go Test (-) E2 vs E4 • Timed Up and Go Test (-) E3 vs E4 • Timed Up and Go Test (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Rhythmic Auditory Stimulation

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Treadmill training with rhythmic auditory stimulation** may produce greater improvements in functional ambulation than **treadmill training.**	3	Song & Ryu 2016; Yang et al. 2016; Yoon & Kang 2016
1a	**Overground gait training with rhythmic auditory stimulation** may produce greater improvements in functional ambulation than **overground gait training.**	5	Cha et al. 2014; Suh et al. 2014; Kim and Oh, 2012; Thaut et al. 2007; Schauer et al. 2003
1b	There is conflicting evidence about the effect of **treadmill training with rhythmic auditory stimulation** to improve functional ambulation when compared to **treadmill/overground gait training alone.**	2	Mainka et al. 2018; Park et al. 2015

BALANCE			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Treadmill training with rhythmic auditory stimulation** may produce greater improvements in balance than **treadmill training.**	2	Yang et al. 2016; Yoon & Kang 2016
1a	**Overground gait training with rhythmic auditory stimulation** may produce greater improvements in balance than **overground gait training.**	2	Cha et al. 2014; Suh et al. 2014

2	**Core training with rhythmic auditory stimulation** may produce greater improvements in balance than **core training.**	1	Chung et al. 2014
1b	There is conflicting evidence about the effect of **treadmill training with rhythmic auditory stimulation** to improve balance when compared to **treadmill/overground gait training alone.**	2	Mainka et al. 2018 Park et al. 2015
2	**Kinesthetic locomotor imagery training with auditory step rhythm** may produce greater improvements in balance than **kinesthetic or visual locomotor training alone, or visual locomotor training with rhythmic auditory stimulation**	1	Kim et al. 2011

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Treadmill training with rhythmic auditory stimulation** may produce greater improvements in gait than **treadmill training.**	3	Song & Ryu 2016; Yang et al. 2016; Yoon & Kang 2016
1a	**Overground gait training with rhythmic auditory stimulation** may produce greater improvements in gait than **overground gait training.**	6	Cha et al. 2014; Suh et al. 2014; Kim & Oh 2012; Thaut et al. 2007; Schauer et al. 2003; Thaut et al.1997
2	**Core training with rhythmic auditory stimulation** may produce greater improvements in gait than **core training.**	1	Chung et al. 2014
1b	**Treadmill training with rhythmic auditory stimulation** may produce greater improvements in gait than **treadmill/overground gait training alone.**	2	Mainka et al. 2018; Park et al. 2015

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
2	**Physical exercise with rhythmic auditory stimulation** may produce greater improvements in range of motion than **conventional therapy.**	1	Jeong & Kim 2007

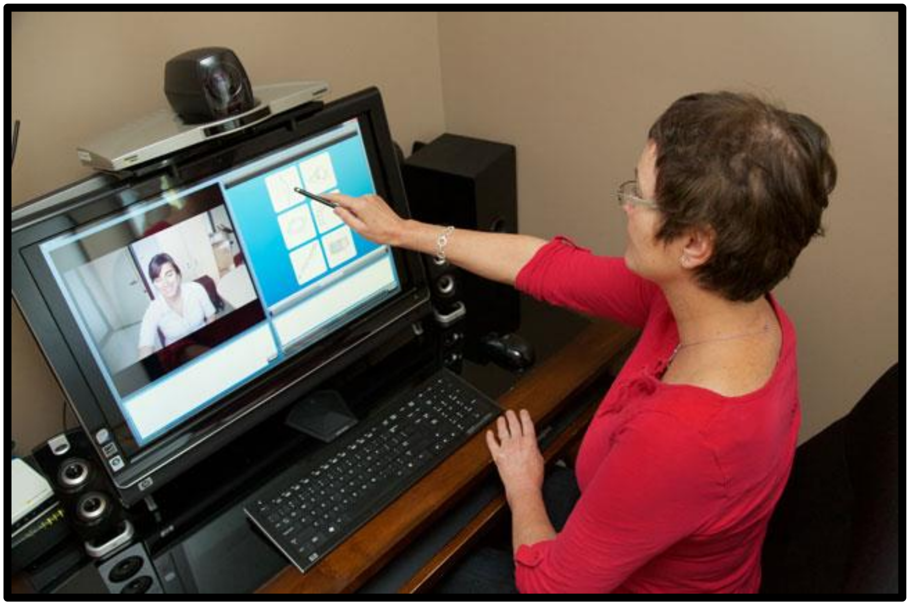
Key Points

Treadmill training with rhythmic auditory stimulation may be helpful in improving functional ambulation and gait.

Overground gait training with rhythmic auditory stimulation may be helpful in improving functional ambulation and gait.

Technology based interventions

Telerehabilitation and Home-Based Physiotherapy



Adopted from: http://www.telereadaptation.com/en/projet/telerehabilitation-in-speech-therapy/

Telerehabilitation is the process of providing rehabilitation services remotely through information and communication technologies (e.g. a kiosk, telephone and computer) (Dodakian et al. 2017; Emmerson et al. 2017). This rehabilitation method is particularly useful for patients who cannot access a rehabilitation center (Benvenuti et al. 2014). Additionally, this intervention can be delivered for a longer duration and at a reduced cost when compared to therapies provided in the inpatient rehabilitation setting (Benvenuti et al. 2014).

Caregiver mediated programs are programs that allow a patient to receive exercise treatment in the comfort of their own home (Van Den Berg et al. 2016). These programs are run by a person who is not a licensed healthcare professional but instead more of a member of the patient's social network (Wang et al. 2015). This can help a patient feel more comfortable and may decrease their anxiety about starting a new program (Van Den Berg et al. 2016).

A total of ten RCTs were found that evaluated telerehabilitation and home-based physiotherapy programs for lower extremity motor rehabilitation. Three RCTs compared home based physiotherapy to conventional therapy (Chen et al. 2020a; Lin et al. 2004; Ada et al. 2003, Duncan et al. 2003). One RCT compared telerehabilitation physiotherapy with EMG-NMES to conventional therapy with EMG-NMES (Chen et al. 2020b). Five RCTs compared a caregiver-mediated exercise program with conventional care (Esteki-Ghashghaei et al. 2020; Nordin et al. 2019; Van Den Berg et al. 2016; Wang et al. 2015; Galvin et al. 2011). The methodological details and results of all ten RCTs evaluating telerehabilitation and home-based physiotherapy programs for lower extremity motor rehabilitation are presented in Tables 24.

Table 24. RCTs Evaluating Telerehabilitation for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Home Based Physiotherapy vs Conventional Therapy or No Therapy		

Chen et al. (2020a)
RCT (5)
N$_{start}$=140
N$_{end}$=121
TPS=Subacute
	E: Home-Based Rehabilitation Exercise Program
	C: Conventional Care
	Duration: 30min, 3x/wk, first 3mo
		• Fugl-Meyer Assessment (-)
		• Modified Ashworth Scale (-)
		• 10-Meter Walk Test
		  • Gait Speed (-)
		  • Step Size (-)
		• Barthel Index (+exp)

Lin et al. (2004)
RCT crossover (6)
N$_{start}$=19
N$_{end}$=19
TPS=Chronic
	E: Home-based Low Intensity Physical Therapy
	C: No therapy (10 week delay after joining trial)
	Duration: 50-60min, 1d/wk, 10wks
		• Barthel Index (-)
		• Stroke Rehabilitation Assessment of Movement
		  • Lower Limb (-)
		  • Mobility (-)

Ada et al. (2003) RCT (7) N$_{start}$=29 N$_{end}$=27 TPS=Chronic	E: Home exercise program + Telerehab C: Treadmill training and overground gait training Duration: 30min/d, 3d/wk for 4w	• 6-Minute Walk Test (+con) • 10-Metre Walk Test (+con)
Duncan et al. (2003) RCT (8) N$_{start}$=100 N$_{end}$=92 TPS=Chronic	E: Home-based exercise program C: Conventional rehabilitation Duration: 90min/d, 3d/wk for 12wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Berg Balance Scale (+exp) • Functional Reach Test (+exp) • Fugl-Meyer Assessment (-) • Muscle strength (-)
Telerehabilitation Physiotherapy Combined with EMG-NMES vs Conventional Therapy Combined with EMG-NMES		
Chen et al. (2020b) RCT (8) N$_{start}$=52 N$_{end}$=44 TPS=Acute	E: Telerehabilitation Physiotherapy + EMG-NMES E: Standard Physiotherapy + EMG-NMES Duration: 60min therapy, 20min NMES, 10x/wk, 12wks	• Fugl-Meyer Assessment - UE & LE total (+exp) • Modified Barthel Index (-)
Caregiver-Mediated Programs vs Conventional Care		
Esteki-Ghashghaei et al. (2020) RCT (5) N$_{start}$=57 N$_{end}$=40 TPS=Not Reported	E: At Home Motivation-based Education Program (BASNEF model) C: Conventional Care Duration: 3 sessions of training, 3mos of at home program	• Fugl-Meyer Assessment - Lower Extremity (+exp)
Nordin et al. (2019) RCT (8) N$_{start}$=91 N$_{end}$=83 TPS=Chronic	E: Caregiver Mediated at Home Therapy C: Conventional Outpatient Clinic Therapy Duration: 60min, 12wks, (home-based 2x/wk, Clinic 1x/wk)	• Rivermead Mobility Index (-) • Berg Balance Scale (-) • Walking Speed (-) • Five Times Sit to Stand Test (-)
Van Den Berg et al. (2016) RCT (8) N$_{start}$=63 N$_{end}$=59 TPS= Not Reported	E: Caregiver-mediated exercise program with telerehabilitation support C: Usual care Duration: 30min/d, 5d/wk for 8wk	• Stroke Impact Scale - Mobility (-) • Nottingham Extended ADL Index (-)
Wang et al. (2015) RCT (6) N$_{start}$=51 N$_{end}$=51	E: Caregiver-mediated exercise program C: Usual care Duration: 90min/d, 5d/wk for 4wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Berg Balance Scale (+exp) • Barthel Index (+exp)

TPS=Chronic		• Stroke Impact Scale (+exp)
Galvin et al. (2011) RCT (8) N_{start}=40 N_{end}=35 TPS=Acute	E: Family-Mediated Exercise Intervention (FAME) C: Conventional Care Duration: 35min/d of FAME, 8wks	• Fugle-Meyer Assessment (+exp) • Modified Ashworth Scale (+exp) • Berg Balance Scale (+exp) • 6-Minute Walk Test (+exp) • Barthel Index (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
$+exp_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Telerehabilitation and Home-based Physiotherapy

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Home-based exercise programs** may not have a difference in efficacy compared to **conventional therapy** for improving motor function.	2	Chen et al. 2020a; Duncan et al. 2003
1b	**Telerehabilitation EMG-NMES physiotherapy** may produce greater improvements in motor function than **standard EMG-NMES physiotherapy**	1	Chen et al. 2020b
1b	**Caregiver-mediated exercise programs** may produce greater improvements in motor function than **conventional therapy.**	2	Esteki-ghashghaei et al. 2020; Galvin et al. 2011

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	There is conflicting evidence about the effect of **caregiver-mediated programs** to improve functional ambulation when compared to **conventional care**.	3	Nordin et al. 2019; Wang et al. 2015; Galvin et al. 2011
1a	**Home-based exercise programs** may not have a difference in efficacy compared to **conventional therapy** for improving functional ambulation.	3	Chen et al. 2020a; Ada et al. 2003

FUNCTIONAL MOBILITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Home-based exercise programs** may not have a difference in efficacy compared to **no therapy** for improving functional mobility.	1	Lin et al. 2004
1b	**Caregiver-mediated exercise programs** may not have a difference in efficacy compared to **conventional therapy** for improving functional mobility.	1	Nordin et al. 2019

BALANCE

LoE	Conclusion Statement	RCTs	References
1b	**Home-based exercise programs** may produce greater improvements in balance than **conventional therapy.**	**1**	Duncan et al. 2003
1a	There is conflicting evidence about the effect of **caregiver-mediated programs** to improve balance when compared to **conventional care**.	3	Nordin et al. 2019; Wang et al. 2015; Galvin et al. 2011

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **caregiver-mediated programs** to improve activities of daily living when compared to **conventional care**.	3	Van Den Berg et al. 2016; Wang et al. 2015; Galvin et al. 2011
1b	There is conflicting evidence about the effect of **home-based exercise programs** to improve activities of daily living when compared to **conventional therapy or no therapy**.	2	Chen et al. 2020a; Lin et al. 2004

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Home-based exercise programs** may not have a difference in efficacy compared to **conventional therapy** for improving muscle strength.	1	Duncan et al. 2003

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Home-based exercise programs** may not have a difference in efficacy compared to **conventional therapy** for improving spasticity.	1	Chen et al. 2020a
1b	**Caregiver-mediated exercise programs** may produce greater improvements in spasticity than **conventional therapy.**	1	Galvin et al. 2011

Key Points

The literature is mixed regarding the effect of caregiver-mediated programs for improving activities of daily living, balance and functional ambulation.

Virtual Reality

Adopted from https://www.hvhcc.com/services

Virtual reality (VR) is a technology that allows individuals to experience and interact with virtual environments, often through a game. VR simulates life-like learning and can be used to increase intensity of training while providing three-dimensional feedback of a visual, sensory, and auditory nature (Saposnik et al. 2010).

VR tools are classified as either immersive (i.e. three-dimensional environment via head-mounted display) or non-immersive (i.e. two-dimensional environment via conventional computer monitor or projector screen). Customized VR programs have been created and tested in rehabilitation research, although commercial gaming consoles (e.g. Nintendo Wii) have also been used to deliver VR training.

A total of 40 RCTs were found evaluating virtual reality for lower extremity motor rehabilitation.

21 RCTs compared virtual reality to conventional therapy, balance training, or treadmill training (Lin et al. 2020; Choi et al. 2017; Braun et al. 2016; Hung et al. 2016; In et al. 2016; Simsek & Cekok 2016; Bower et al. 2015; Da Silva Ribeiro et al. 2015; Llorens et al. 2015; Yatar et al. 2015; Morone et al. 2014; Lee et al. 2014; Barcala et al. 2013; Fritz et al. 2013; Rajaratnam et al. 2013; Cho et al. 2012; Kim et al. 2012; Lee et al. 2012; Jung et al. 2011; Kim et al. 2009; You et al. 2005). One RCT compared virtual reality to treadmill training (Bang et al. 2016). Ten RCTs compared virtual reality with treadmill training to conventional therapy, overground gait training, or treadmill training (Kim et al. 2016; Kim et al. 2015; Mao et al. 2015; Cho et al. 2014; Cho et al. 2013; Jung et al. 2012; Kang et al. 2012; Yang et al. 2011; Yang et al. 2008; Jaffe et al. 2004). One RCT compared virtual reality robotic training to robotic training (Mirelman et al. 2009). Seven RCTs compared various modalities of administered virtual reality (dos Santos Junior et al. 2019; Calabra et al. 2017; Forrester et al. 2016; Yom et al. 2015; Bower et al. 2014; McEwen et al. 2014; Mirelman et al. 2010)

The methodological details and results of all 40 RCTs are presented in Table 25.

Table 25. RCTs Evaluating Virtual Reality Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Virtual Reality vs Conventional Therapy, Balance Training		
Lin et al. (2020) RCT (8) N_{start}=152 N_{end}=143 TPS=Acute	E: Virtual Reality (Kinect) with Early Conventional Rehabilitation C: Early Conventional Rehabilitation Duration: rehab 60min, 5x/wk, VR 8hrs/wk, 4wks	• Manual Muscle Test (-) • Postural Assessment Scale (-) • Barthel Index (-)
Choi et al. (2017) RCT (6) N_{Start}=36 N_{End}=36 TPS=Chronic	E1: Game-based (Wii balance board) CIMT E2: General game-based training program C: Traditional physical therapy Duration: 30min/d. 3d/wk for 4wk	• Functional Reach Tests (-) • Timed Up and Go Test (-) • Sway Mean Velocity (-) E1/E2 vs C: • Modified Functional Reach Tests (+exp1/exp2) E1 vs. E2/C • Anteroposterior Center of Pressure (+exp1) • Sway Area (+exp1) • Symmetric Weight Bearing (+exp1) E1 vs. C • Medial-Lateral Center of Pressure (+exp1)
Braun et al. (2016) RCT (8) N_{start}=28 N_{end}=28 TPS=Subacute	E: Dynamic balance training with Balance Trainer C: Static balance training with a conventional standing frame Duration: 30min/d, 3d/wk for 4wk	• Berg Balance Scale (+exp) • Functional Ambulation Category (+exp) • De Morton Mobility Index (+exp) • Functional Independence Measure (+exp)
Hung et al. (2016) RCT (5) N_{start}=27 N_{end}=27 TPS=Chronic	E: Virtual reality-based balance training C: Conventional rehabilitation Duration: 20min/d, 3d/wk for 6wk	• Timed Up & Go Test (+exp) • Weight bearing (+exp) • Proprioception (+exp) • Muscle strength (-) • Sway Area (-)
In et al. (2016) RCT (5) N_{start}=30 N_{end}=25 TPS=Chronic	E: Virtual reality-based balance training C: Conventional rehabilitation Duration: 45min/d, 3d/wk for 4wk	• Functional Reach Test (+exp) • Timed Up & Go Test (+exp) • Berg Balance Scale (+exp) • Postural Sway (+exp) • 10-Metre Walk Test (+exp)
Şimşek & Cekok (2016) RCT (7) N_{start}=44 N_{end}=44 TPS=Chronic	E: Wii-based balance training C: Conventional rehabilitation Duration: 1hr/d, 3d/wk for 10wk	• Nottingham Health Profile (-) • Functional Independence Measure (-)
Bower et al. (2015) RCT (4) N_{start}=16 N_{end}=16 TPS=Chronic	E: Virtual reality training (PrimeSense) C: Conventional rehabilitation Duration: 25min/d, 3d/wk for 4wk	• 6-Minute Walk Test (+exp) • Functional Independence Measure (+exp) • Step Test (-) • Functional Reach Test (-) • Motor Assessment Scale (-)
Da Silva Ribeiro et al. (2015) RCT (7) N_{start}=30 N_{end}=30	E: Virtual reality training (Wii) C: Conventional rehabilitation Duration: *Not Specified*	• 36-Item Short Form Survey (-) • Fugl-Meyer Assessment (-)

TPS= Chronic		
Llorens et al. (2015) RCT (8) N_{start}=20 N_{end}=20 TPS=Chronic	E: Virtual reality stepping training (computer) C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 4wk	• 10-Metre Walk Test (+exp) • Brunel Balance Assessment (+exp) • Berg Balance Scale (-) • Tinetti Performance-Oriented Mobility Assessment (-)
Yatar et al. (2015) RCT (4) N_{start}=33 N_{end}=33 TPS=Chronic	E: Wii-based balance training C: Progressive balance training Duration: 1hr/d, 3d/wk for 4wk	• Berg Balance Scale (-) • Timed Up & Go Test (-) • Functional Reach Test (-) • Activity-Specific Balance Confidence Scale (-) • Dynamic Gait Index (-) • Frenchay Activities Index (-)
Morone et al. (2014) RCT (7) N_{start}=50 N_{end}=46 TPS=Subacute	E: Wii-based balance training C: Balance training Duration: 40min (2x/d), 3d/wk for 6wk	• Berg Balance Scale (+exp) • Barthel Index (+exp) • 10-Metre Walk Test (-) • Functional Ambulation Category (-)
Lee et al. (2014) RCT (7) N_{start}=21 N_{end}=21 TPS=Chronic	E: Virtual reality-based balance training C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 4wk	• Gait Velocity (+exp) • Step length (+exp) • Stride length (+exp) • Cadence (-) • Berg Balance Scale (-) • Timed Up & Go Test (-)
Barcala et al. (2013) RCT (7) N_{start}=20 N_{end}=20 TPS=Subacute	E: Wii-based balance training C: Conventional rehabilitation Duration: 1hr/d, 2d/wk for 5wk	• Berg Balance Scale (-) • Timed Up & Go Test (-) • Functional Independence Measure (-) • Stabilometry (-)
Fritz et al. (2013) RCT (8) N_{start}=30 N_{end}=30 TPS=Chronic	E: Virtual reality training (Wii) C: Usual care Duration: 1hr/d, 4d/wk for 5wk	• Fugl-Meyer Assessment (-) • 6-Minute Walk Test (-) • 3-Metre Walk Test (-) • Dynamic Gait Index (-) • Berg Balance Scale (-) • Timed Up & Go Test (-) • Stroke Impact Scale (-)
Rajaratnam et al. (2013) RCT (4) N_{start}=19 N_{end}=19 TPS=Acute	E: Virtual-reality based balance training C: Conventional rehabilitation Duration: 1hr/d, 6d/wk for 4wk	• Functional Reach Test (+exp) • Berg Balance Scale (-) • Timed Up & Go Test (-) • Centre of Pressure (-) • Modified Barthel Index (-)
Cho et al. (2012) RCT (5) N_{start}=22 N_{end}=22 TPS=Chronic	E: Wii-based balance training C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 6wk	• Berg Balance Scale (+exp) • Timed Up & Go Test (+exp) • Postural sway (-)
Kim et al. (2012) RCT (4) N_{start}=20 N_{end}=20 TPS=Chronic	E: Wii-based balance training C: Control group Duration: 30min/d, 3d/wk for 3wk	• Postural Assessment Scale (+exp) • Modified Motor Assessment Scale (+exp) • Functional Independence Measure (-)
Lee et al. (2012) RCT (8) N_{start}=40 N_{end}= 40 TPS=Chronic	E: Balance training with Balance Control Trainer C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 4wk	• Berg Balance Scale (+exp) • Timed Up & Go Test (+exp) • Functional Ambulation Categories (+exp) • Modified Barthel Index (-)
Jung et al. (2011) RCT (4)	E: Virtual reality-based balance training	• Berg Balance Scale (+exp) • 10-Metre Walk Test (-)

N_{start}=22 N_{end}=22 TPS=NR	C: Balance training Duration: 1hr/d, 5d/wk for 6wk	
Kim et al. (2009) RCT (6) N_{start}=24 N_{end}=21 TPS=Chronic	E: Virtual reality-based balance training C: Conventional rehabilitation Duration: 40min/d, 4d/wk for 4wk	• Berg Balance Scale (+exp) • Balance Performance Monitor (+exp) • Modified Motor Assessment Scale (+exp) • 10-Metre Walk Test (+exp) • Cadence (+exp) • Step time (+exp) • Step length (+exp) • Stride length (+exp)
You et al. (2005) RCT (5) N_{start}=10 N_{end}=10 TPS=Chronic	E: Virtual reality training (computer) C: Conventional rehabilitation Duration: 45min/d, 5d/wk for 4wk	• Functional Ambulation Categories (+exp) • Modified Motor Assessment Scale (+exp)
Virtual Reality Training vs Treadmill Training		
Bang et al. (2016) RCT (4) N_{start}=40 N_{end}=37 TPS=Chronic	E: Virtual reality training (Wii) C: Treadmill training Duration: 40min/d, 3d/wk for 8wk	• Weight bearing (+exp) • Stance phase (-) • Swing phase (-) • Cadence (-)
Virtual Reality with Treadmill Training vs Conventional Therapy, Overground Gait Training, or Treadmill Training		
Kim et al. (2016) RCT (6) N_{start}=30 N_{end}=27 TPS=Subacute	E1: Treadmill training + Virtual reality E2: Community ambulation training C: Conventional rehabilitation	E2 vs C • 6-Minute Walk Test: (+exp$_2$) E1 vs C • Timed Up & Go Test: (+exp) E2 vs E1/C • Timed Up & Go Test (+exp$_2$) E1/E2 vs C • Activities-Specific Balance Confidence Scale: (+exp, +exp$_2$) E1 vs E2 • Activities-Specific Balance Confidence Scale (-) E1 vs E2/C • 6-Minute Walk Test (+exp) • Gait speed (-) • Step length (-) • Stride length (-) • Cadence (-)
Kim et al. (2015) RCT (4) N_{start}=20 N_{end}=20 TPS=Chronic	E: Treadmill training + Virtual reality C: Conventional rehabilitation Duration: 60min/d, 5d/wk for 4wk	• Sway length (+exp) • Sway velocity (+exp)
Mao et al. (2015) RCT (5) N_{start}=29 N_{end}=24 TPS=Subacute	E: Treadmill training + Virtual reality C: Overground gait training Duration: 30min/d, 5d/wk for 3wk	• Gait kinematics (+exp) • Fugl-Meyer Assessment (-) • Brunel Balance Assessment (-)
Cho et al. (2014) RCT (7) N_{start}=30	E: Treadmill training + Virtual reality C: Treadmill training Duration: 30min/d, 3d/wk for 6wk	• Balance Berg Scale (+exp) • Timed Up & Go Test (+exp) • Gait speed (+exp) • Cadence (+exp)

N_{end}=30 TPS=Chronic		• Single limb support period (+exp) • Double limb support period (+exp) • Step length (+exp) • Stride length (+exp)
Cho et al. (2013) RCT (7) N_{start}=14 N_{end}=14 TPS=Chronic	E: Treadmill training + Virtual reality C: Treadmill training Duration: 30min/d, 3d/wk for 6wk	• Berg Balance Scale (+exp) • Timed Up & Go Test (+exp) • Gait speed (+exp) • Cadence (+exp)
Jung et al. (2012) RCT (5) N_{start}=22 N_{end}=22 TPS=Chronic	E: Treadmill training + Virtual reality C: Treadmill training Duration: 30min/d, 5d/wk for 3wk	• Timed Up & Go Test (+exp) • Activities-Specific Balance Confidence Scale (+exp)
Kang et al. (2012) RCT (7) N_{start}=30 N_{end}=30 TPS= Chronic	E1: Treadmill training + Virtual reality E2: Treadmill training C: Conventional rehabilitation Duration: 30min/d, 3d/wk for 4wk	E1 vs E2/C • 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Timed Up & Go Test (+exp) E1 vs C • Functional Reach Test (+exp) E1 vs E2 • Functional Reach Test (-)
Yang et al. (2011) RCT (4) N_{start}=14 N_{end}=14 TPS=Chronic	E: Treadmill training + Virtual reality C: Treadmill training Duration: 20min, 3x/wk, 3wks	• Centre of pressure (+exp) • Symmetric index (+exp) • Sway excursion (+exp) • Level walking (-)
Yang et al. (2008) RCT (6) N_{start}=20 N_{end}=20 TPS=Chronic	E: Treadmill training + Virtual reality C: Treadmill training Duration: 30min/d, 5d/wk for 3wk	• Gait speed (+exp) • Walking time (+exp) • Walking Ability Questionnaire (+exp) • Activities-Specific Balance Confidence Scale (+exp)
Jaffe et al. (2004) RCT (4) N_{start}=20 N_{end}=20 TPS=Chronic	E: Treadmill training + Virtual reality C: Treadmill training Duration: Six 1h sessions over 2wk	• Performance-Oriented Assessment of Mobility (-) • Gait speed (+exp) • Cadence (-) • Step length (-) • Stride length (+exp) • 6-minute walk test (-)
Virtual Reality Robotic Training vs Robotic Training		
Mirelman et al. (2009) RCT (5) N_{start}=18 N_{end}=15 TPS=Chronic	E: Virtual reality robotic training (computer) C: Robotic training Duration: 30min/d, 3d/wk for 4wk	• 10-Metre Walk Test (+exp) • 6-Minute Minute Test (+exp) • Step count (+exp)
Virtual Reality Modalities		
dos Santos Junior et al. (2019) RCT (6) N_{start}=48 N_{end}=40 TPS=Chronic	E1: Virtual Reality E2: Virtual Reality + Proprioceptive Neuromuscular Facilitation C: Proprioceptive Neuromuscular Facilitation Duration: 50min/d, 2d/wk, 8wks	E1/E2 vs C • Fugl-Meyer Assessment (-) • Sensory Assessment (-) • Balance (-) E1 vs E2 • Fugl-Meyer Assessment (-) • Sensory Assessment (-) • Balance (-)
Calabra et al. (2017) RCT (8)	E: Robotic-assisted gait training (Lokomat-Pro) + VR	• Riverhead Mobility Index (+exp)

N_{start}=24 N_{end}=24 TPS=Chronic	C: Robotic-assisted gait training (Lokomat-Nanos) Duration: 45min/d, 5d/wk, 8wks	- Tinetti Performance Oriented Mobility Assessment (+exp) - Modified Ashworth Scale (-) - Hip force (+exp) - Knee force (+exp)
Forrester et al. (2016) RCT (4) N_{start}=35 N_{end}=26 TPS=Chronic	E: Treadmill training + Virtual reality + Ankle robotics C: Seated training + Virtual reality + Ankle robotics Duration: 45min/d, 5d/wk for 6wk	- Gait speed (+exp) - Paretic limb support (+exp) - Ankle range of motion (+exp) - Ankle target speed (+exp) - Ankle target accuracy (+exp) - Centre of pressure (-)
Llorens et al. (2015b) RCT (8) N_{start}=31 N_{end}=31 TPS=Chronic	E: Virtual reality-based balance training at home C: Virtual reality-based balance training in clinic Duration: 45min/d, 3d/wk for 7wk	- Brunel Balance Assessment (-) - Berg Balance Scale (-) - Performance-Oriented Mobility Assessment (-)
Yom et al. (2015) RCT (6) N_{start}=20 N_{end}=20 TPS=Chronic	E: Virtual reality ankle training (computer) C: Video-based ankle training Duration: 30min/d, 5d/wk for 6wk	- Gait speed (+exp) - Cadence (+exp) - Step length (+exp) - Stride length (+exp) - Stance time (+exp) - Swing time (+exp) - Double limb support (+exp) - Timed Up & Go Test (+exp)
McEwen et al. (2014) RCT (3) N_{start}=59 N_{end}=59 TPS=Chronic	E: Virtual reality-based balance training C: Virtual reality seated training Duration: 30min/d,5d/wk for 2wk	- Timed Up & Go Test (+exp) - 2-Minute Walk Test (+exp) - Chedoke-McMaster Stroke Assessment Scale (+exp)

Mirelman et al. (2010)
RCT (3)
N_{start}=18
N_{end}=18
TPS=Chronic
	E: Platform Force-Feedback + Virtual Reality
	C: Platform Force-Feedback
	Duration: 1hr/d, 3d/wk, 4wks
		- Self-Selected Walking Speed (+exp)
		- Ankle Gait Kinetics (+exp)
		- Range of Motion:
		  - Hip Range (-)
		  - Ankle Range (-)
		  - Knee Range (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Virtual Reality Training

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	**Virtual reality training** may not have a difference in efficacy compared to **conventional care** for improving motor function.	2	Da Silva Ribeiro et al. 2015; Fritz et al. 2013
2	**Virtual reality with treadmill training** may not have a difference in efficacy compared to **overground gait training** for improving motor function.	1	Mao et al. 2015

1b	**Virtual reality with proprioceptive neuromuscular facilitation** may not have a difference in efficacy compared to **virtual reality, or proprioceptive neuromuscular facilitation alone** for improving motor function.	1	Dos Santos Junior et al. 2019

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **virtual reality training** to improve functional ambulation when compared to **balance training or conventional therapy**.	10	Braun et al. 2016; In et al. 2016; Bower et al. 2015; Llorens et al. 2015; Morone et al. 2014; Fritz et al. 2013; Lee et al. 2012; Jung et al. 2011; Kim et al. 2009; You et al. 2005
1a	**Virtual reality with treadmill training** may produce greater improvements in functional ambulation than **conventional therapy or treadmill training.**	3	Kim et al. 2016; Kang et al. 2012; Jaffe et al. 2004
2	**Virtual reality robotic training** may produce greater improvements in functional ambulation than **robotic training.**	1	Mirelman et al. 2009
2	**Virtual reality balance training** may produce greater improvements in functional ambulation than **virtual reality seated training.**	1	McEwen et al. 2014
2	**Virtual reality with platform force training** may produce greater improvements in functional ambulation than **platform force training alone.**	1	Mirelman et al. 2010

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
2	**Virtual reality balance training** may produce greater improvements in functional mobility than **virtual reality seated training.**	1	McEwen et al. 2014
1b	There is conflicting evidence about the effect of **virtual reality training** to improve functional mobility when compared to **conventional therapy**.	1	Braun et al. 2016
2	**Virtual reality with treadmill training** may not have a difference in efficacy compared to **treadmill training** for improving functional mobility.	1	Jaffe et al. 2004

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **virtual reality training** to improve balance when compared to **balance training or conventional therapy**.	18	Lin et al. 2020; Choi et al. 2017; Braun et al. 2016; Hung et al. 2016; In et al. 2016; Bower et al. 2015; Llorens et al. 2015; Yatar et al. 2015; Lee et al. 2014; Morone et al. 2014; Barcala et al. 2013; Fritz et al. 2013; Rajaratnam et al. 2013; Cho et al. 2012; Kim et al. 2012; Lee et al. 2012; Jung et al. 2011; Kim et al. 2009
2	**Virtual reality** may produce greater improvements in balance than **treadmill training.**	1	Bang et al. 2016

1a	**Virtual reality with treadmill training** may produce greater improvements in balance than **conventional therapy or treadmill training.**	10	Kim et al. 2016; Kim et al. 2015; Mao et al. 2015; Cho et al. 2014; Cho et al. 2013; Jung et al. 2012; Kang et al. 2012; Yang et al. 2011; Yang et al. 2008; Jaffe et al. 2004
1b	**Virtual reality ankle training** may produce greater improvements in balance than **video-based ankle training.**	1	Yom et al. 2015
2	**Virtual reality balance training** may produce greater improvements in balance than **virtual reality seated training.**	1	McEwen et al. 2014
1b	**Wii-based balance training** may not have a difference in efficacy compared to **Wii-based upper limb training** for improving balance.	1	Bower et al. 2014
2	There is conflicting evidence about the effect of **treadmill training combined with virtual reality and ankle robotics** to improve balance when compared to **seated training with virtual reality and ankle robotics**.	1	Forrester et al. 2016

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **virtual reality training** to improve gait when compared to **balance training or conventional therapy**.	6	Choi et al. 2017; Hung et al. 2016; Yatar et al. 2015; Lee et al. 2014; Fritz et al. 2013; Kim et al. 2009
2	**Virtual reality** may not have a difference in efficacy compared to **treadmill training** for improving gait.	1	Bang et al. 2016
1a	**Virtual reality with treadmill training** may produce greater improvements in gait than **overground gait training, treadmill training, or conventional therapy.**	8	Kim et al. 2016; Kim et al. 2015; Mao et al. 2015; Cho et al. 2014; Cho et al. 2013; Yang et al. 2011; Yang et al. 2008; Jaffe et al. 2004
2	**Virtual reality with treadmill training and ankle robotics** may produce greater improvements in gait than **virtual reality with seated training and ankle robotics.**	1	Forrester et al. 2016
1b	**Virtual reality ankle training** may produce greater improvements in gait than **video-based ankle training.**	1	Yom et al. 2015
2	**Virtual reality robotic training** may produce greater improvements in gait than **robotic training.**	1	Mirelman et al. 2009

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Virtual reality training** may not have a difference in efficacy compared to **balance training or conventional therapy** for improving activities of daily living.	13	Lin et al. 2020; Braun et al. 2016; Simsek & Cekok 2016; Bower et al. 2015; Yatar et al. 2015; Morone et al. 2014; Barcala et al. 2013; Rajaratnam et al. 2013; Kim et al. 2012; Lee et al. 2012; Kim et al. 2009; You et al. 2005

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
2	**Virtual reality with treadmill training and ankle robotics** may produce greater improvements in range of motion than **virtual reality with seated training and ankle robotics.**	1	Forrester et al. 2016

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Virtual reality training** may not have a difference in efficacy compared to **conventional therapy** for improving muscle strength.	2	Lin et al. 2020; Hung et al. 2016

SPASTICITY

LoE	Conclusion Statement	RCTs	References
2	**Virtual reality training** may not have a difference in efficacy compared to **conventional therapy** for improving spasticity.	1	Bower et al. 2015

PROPRIOCEPTION

LoE	Conclusion Statement	RCTs	References
2	**Virtual reality training** may produce greater improvements in proprioception than **conventional therapy.**	1	Hung et al. 2016

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1b	**Virtual reality training** may not have a difference in efficacy compared to **conventional therapy** for improving stroke severity.	1	Fritz et al. 2013

Key Points

The literature is mixed with respect to the effect of virtual reality training on functional ambulation, balance, and gait.

Virtual reality training may not be beneficial in improving activities of daily living.

Virtual reality with treadmill training may be helpful in improving balance and functional ambulation.

Electromechanical devices

Adopted from: http://internationalmedipol.com/lokomat-robotic-walking-system; https://www.odtmag.com/contents/view_breaking-news/2018-03-02/hybrid-assistive-limb-hal-treatment-for-spinal-cord-injury-available-in-us

Recently, considerable effort has been invested in developing electromechanical-assisted training devices for gait training. Most of these devices are generally classified as either an “end-effector device” (i.e. patients are placed on foot plates that stimulate the stance and swing phases of gait) or an “exoskeleton device” (i.e. patients are outfitted with a programmable device that moves the hips and knees during gait). The most commonly studied end-effector device is the Gait Trainer (Reha-Stim; Berlin Germany), while the Lokomat (Hokoma; Zurich, Switzerland) is the most studied exoskeleton device (Mehrholz & Pohl, 2012). Other exoskeleton devices that have been studied can be classified as either an exoskeleton system or an exoskeleton portable device. A third category of electromechanical devices can be described as a robotic arm control system group, as described by Ochi et al. (2015).

The main advantage electromechanical devices may offer over conventional gait training is that they may increase the number of repetitions performed and reduce the need for intensive therapist involvement, thereby increasing therapist productivity and accelerating patient recovery.

A table of various robotic devices used in stroke rehabilitation is outlined below (Table 26).

Table 26. Electromechanical devices used for lower limb rehabilitation post-stroke

Electromechanical Devices	**Description**
End-Effectors • G-EO System • Gait Trainer I and II (GT I, GT II)	The G-EO system is a gait-trainer robotic device that provides a supportive harness and uses foot plates to simulate floor walking and also walking up and down stairs (Hesse et al. 2012).
	The GT II is a gait-trainer robotic device that offers body weight support through a harness and also endpoint feet trajectories through foot plates (Iosa et al. 2011).
Exoskeleton Systems • Lokomat • Walkbot • Hybrid Assistive Limb (HAL) • AutoAmbulator	The Lokomat is a widely used exoskeleton device that features a treadmill, a dynamic body weight support system, and a motor-driven robotic orthosis (Bae et al. 2016). The robotic orthosis is used to control gait pattern through adjusting gait speed, guidance force,

• LokoHelp	and support from body weight (Bae et al. 2016).
	The Walkbot is a gait rehabilitation exoskeleton that features powered hip-knee-ankle joint drive motor design as well as a biofeedback platform (Kim et al. 2015).
	The HAL is a wearable robotic exoskeleton that supports participants in walking, standing, and performing other leg movements (Yoshikawa et al. 2018). The HAL detects bioelectrical signals generated by muscles and floor-reaction-force signals and responds to the user's voluntary movements instead of following a predefined motion (Yoshikawa et al. 2018).
	The AutoAmbulator is a gait rehabilitation exoskeleton that provides body weight support treadmill training with the assistance of a harness and robot arms. The robot arms have four degrees of freedom and control various aspects of the gait cycle (Fisher et al. 2011).
	The LokoHelp device is placed on top of a treadmill and is an easily installed or removed. It works through transmitting the treadmill movement to levers on either side of the device which then create movements that imitate stance and swing phases of gait (Freivogel et al. 2009).
Exoskeleton Portable Devices • Stride Management Assist (SMA) • Anklebot • Bionic Leg	The Stride Management Assist (SMA) device is a robotic exoskeleton that provides assistance with high flexion and extension in each leg. This device uses neural oscillators and the user's Central Pattern Generator to generate assist torques during the gait cycle to regulate walking patterns (Buesing et al. 2015).
	The Anklebot is a robotic device consisting of a knee brace that is attached to a custom shoe (Forester et al. 2013). It is designed to strengthen the ankle and the lower extremity through adjusting the force applied depending on varying requirements (Forrester et al. 2013).
	The Bionic Leg device is a powered knee orthosis that uses sensors, accelerometers, and joint angle detectors to detect the user's movements and provide mechanical assistance (Stein et al. 2014).

Robotic Arm Control System - Gait-Assistance Robot (GAR)	The gait-assistance robot is a robotic arm control system that includes 4 robotic arms, a full weight-bearing system, and a visual foot pressure biofeedback system (Nakanishi et al. 2014). The four separate robotic arms provide the ability to move the lower body automatically and independently (Ochi et al. 2015). This device does not suspend a patient with a harness and thus promotes full body weight bearing while on a treadmill (Ochi et al. 2015).

43 RCTs were found that evaluated lower limb robotics for motor rehabilitation.

10 RCTs evaluated end-effectors (Stolz et al. 2019; Kim et al. 2018; Hesse et al. 2012; Morone et al. 2011; Peurala et al. 2009; Ng et al. 2008; Dias et al. 2007; Pohl et al. 2007; Tong et al. 2006; Peurala et al. 2005). Two RCTs compared end-effector gait training to body weight supported treadmill training (Kim et al. 2020; Werner et al. 2002). 21 RCTs evaluated the exoskeleton systems (Mustafaoglu et al. 2020; Kim et al. 2019; Calabro et al. 2018; Bang & Shin 2016; Han et al. 2016; Cho et al. 2015; Kim et al. 2015; Ochi et al. 2015; van Nunen 2015; Ucar et al. 2014; Watanabe et al. 2014; Kelley et al. 2013; Chang et al. 2012; Fisher et al. 2011; Freivogel et al. 2009; Hidler et al. 2009; Schwartz et al. 2009; Westlake & Patten 2009; Hornby et al. 2008; Husemann et al. 2007; Mayr et al. 2007). One RCT evaluated exoskeleton system effectiveness depending on method of administering exercises (Bae et al. 2016). Five RCTs evaluated portable exoskeleton devices (Buesing et al. 2015; Forrester et al. 2014; Goodman et al. 2014; Stein et al. 2014; Waldman et al. 2013). One RCT evaluated a robotic training with restraint (Bonnyaud et al. 2014). One RCT compared robotic training with virtual reality to robotic training (Calabra et al. 2017). One RCT compared galvanic vestibular stimulation to robotic gait training (Krewer et al. 2013a). One RCT compared body weight supported robotic treadmill training with full assistance to training with assistance as needed (Seo et al. 2018).

The methodological details and results of all 43 RCTs are presented in Table 27.

Table 27. RCTs Evaluating Electromechanical Devices for Lower Extremity Motor Rehabilitation

Authors (Year) **Study Design (PEDro Score)** **Sample Size$_{start}$** **Sample Size$_{end}$** **Time post stroke category**	**Interventions** **Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures** **Result (direction of effect)**
End-Effector Gait Training vs Conventional Therapy, Overground Gait Training, or Treadmill Training		

Stolz et al. (2019)
RCT (5)
N$_{start}$=40
N$_{end}$=36
TPS=Acute
	E: Robotic Gait Trainer (Robowalk)
	C: Conventional Care
	Duration: 30min, 6x/wk until discharge (~3wks)
		• 10-Meter Walk Test
		  • Speed (-)
		  • Cadence (-)
		• Timed Up and Go Test (-)
		• 6-Minute Walk Test (-)
		• Functional Independence Measure (-)

Kim et al. (2018) RCT (4) N$_{start}$=58 N$_{end}$=48 TPS=Subacute	E: Robotic End-Effector training (Morning Walk) C: Conventional physiotherapy Duration: 30minutes conventional therapy + 1 hr robot training in experimental group, 1.5hr conventional therapy in control group 5d/wk, 3wks (15 sessions total)	• Functional Ambulation Category (-) • Motricity Index Lower Paretic Limb (+exp) • 10-Meter Walk Test (-) • Modified Barthel Index (-) • Rivermead Mobility index (-) • Berg Balance Scale (+exp)
Hesse et al. (2012) RCT (6) N$_{start}$=30 N$_{end}$=30 TPS=Subacute	E: G-EO System (Reha Technology) training C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 4wk	• Motricity Index (+exp) • Resistance to passive movement scale (-) • Functional Ambulation Category (+exp) • Rivermead Mobility Index (+exp)
Morone et al. (2011) RCT (6) N$_{start}$=48 N$_{end}$=43 TPS=Subacute	E: Gait Trainer GT II (Rehastim) and conventional gait training C: Conventional gait training Duration: 30min (2x/d), 5d/wk for 12wks	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (-) • Motricty Index (-) • Ashworth Scale (-) • Rankin Scale (-) • Functional Ambulation Category (+exp) • Rivermead Mobility Index (+exp) • Barthel Index (+exp)
Peurala et al. (2009) RCT (5) N$_{start}$=56 N$_{end}$=54 TPS=Acute	E1: Gait Trainer GT I (Rehastim) E2: Overground gait training C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 4wk	E1/E2 vs C • Functional Ambulation Category (+exp, +exp2) • 10-Metre Walk Test (+exp, +exp2) • 6-Minute Walk Test (+exp, +exp2) • Rivermead Motor Assessment (+exp, +exp2) • Rivermead Mobility Index (+exp, +exp2) • Modified Motor Assessment Scale (+exp, +exp2) E1 vs E2 • Functional Ambulation Category (-) • 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Rivermead Motor Assessment (-) • Rivermead Mobility Index (-) • Modified Motor Assessment Scale (-)
Ng et al. (2008) RCT (6) N$_{start}$=54 N$_{end}$=54 TPS=Subacute	E1: Gait Trainer GT II (Rehastim) + Functional electrical stimulation E2: Gait Trainer GT II (Rehastim) C: Overground gait training Duration: 20min/d, 5d/wk for 4wk	E1/E2 vs C • 10-Metre Walk Test: (+exp1, +exp2) • Elderly Mobility Scale: (+exp1, +exp2) • Functional Ambulation Category: (+exp1, +exp2) E1 vs E2

		• 10-Metre Walk Test: (-) • Elderly Mobility Scale: (-) • Functional Ambulation Category: (-) • Motricity Index (-) • Berg Balance Scale (-) • Barthel Index (-) • Functional Independence Measure (-)
Dias et al. (2007) RCT (6) N_{start}=40 N_{end}=36 TPS=Chronic	E: Gait Trainer GT I (Rehastim) C: Conventional rehabilitation Duration: 1hr/d, 5d/wk for 5wk	• Motricity Index (-) • Toulouse Motor Scale (-) • Modified Ashworth Spasticity Scale (-) • Berg Balance Scale (-) • Rivermead Mobility Index (-) • Fugl-Meyer Stroke Scale (-) • Barthel Index (-) • Time Up-and-Go Test (-)
Pohl et al. (2007) RCT (8) N_{start}=155 N_{end}=150 TPS=Acute	E: Gait Trainer GT I (Rehastim) C: Conventional rehabilitation Duration: 45min/d, 5d/wk for 4wk	• Functional Ambulation Category (+exp) • Barthel Index (+exp)
Tong et al. (2006) RCT (6) N_{start}=46 N_{end}=45 TPS=Subacute	E1: Gait Trainer GT II (Rehastim) + Functional electrical stimulation (gait trainer) E2: Gait Trainer GT II (Rehastim) C: Overground gait training Duration: 40min/d, 5d/wk for 6wk	E1/E2 vs C • 10-Metre Walk Test (+exp$_1$, +exp$_2$) • Berg Balance Scale (+exp$_1$, +exp$_2$) • Motricity Index (+exp$_1$, +exp$_2$) • Elderly Mobility Scale (+exp$_1$, +exp$_2$) • Barthel Index (+exp$_1$, +exp$_2$) • Functional Ambulation Category (+exp$_1$, +exp$_2$) • Functional Independence Measure (+exp$_1$, +exp$_2$) E1 vs E2 • 10-Metre Walk Test (-) • Berg Balance Scale (-) • Motricity Index (-) • Elderly Mobility Scale (-) • Barthel Index (-) • Functional Ambulation Category (-) • Functional Independence Measure (-)
Peurala et al. (2005) RCT (6) N_{start}=45 N_{end}=45 TPS=Chronic	E1: Gait Trainer GT I (Rehastim) + Functional electrical stimulation E2: Gait Trainer GT I (Rehastim) C: Overground gait training Duration: 20min/d, 4d/wk for 6wk	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Modified Motor Assessment Scale (-) • Functional Independence Measure (-) • Dynamic balance (-) • Static balance (-)
End-Effector Gait Training vs Body Weight Supported Treadmill		
Kim et al. (2020) RCT (7) N_{start}=30 N_{end}=28 TPS=Chronic	E: End-effector Robot-Assisted Gait Training C: Body Weight Supported Treadmill Training Duration: 30min/d, 5da/wk, 4wks	• Fugl-Meyer Assessment (+exp) • Timed Up-and-Go (-) • Ten Meter Walk Test (-)
Werner et al. (2002) RCT (7) N_{start}=30 N_{end}=28 TPS=Subacute	E1: Gait Trainer GT I (Rehastim) E2: Body weight-supported treadmill training Duration: 20min/d, 5d/wk for 6wk	• Functional Ambulation Category (+exp) • Rivermead Motor Assessment (-) • 10-Metre Walk Test (-)
Exoskeleton Systems vs Conventional Therapy, Overground Gait Training, or Treadmill Training		

Mustafaoglu et al. (2020) RCT crossover (6) N_{start}=51 N_{end}=51 TPS=Chronic	E1: Robot Assisted Gait Training (Lokomat)+ Conventional Therapy E2: Robot Assisted Gait Training (Lokomat) C: Conventional therapy Duration: E1 RAGT (45 min, 2 non-consecutive d/wk, 6-wks) + CT (45 min/d 5 d/wk, 6-wks) E2: 45 min/d, 2 non-consecutive d/wk, 6 wks C: 45 mins/d, 5 d/wk, 6wks CT	E1 vs C • Barthel Index (+exp1) • Six Minute Walk Test (+exp1) • Stair Climb Test (+exp1) • Fugl-Meyer Lower Extremity (+exp1) • Comfortable 10-m Walk Test (+exp1) • Fast 10-m Walk Test (-) E2 vs C • Barthel Index (-) • Six Minute Walk Test (-) • Stair Climb Test (-) • Fugl-Meyer Lower Extremity (-) • Comfortable 10-m Walk Test (-) • Fast 10-m Walk Test (-) E1 vs E2 • Barthel Index (+exp1) • Six Minute Walk Test (+exp1) • Stair Climb Test (+exp1) • Fugl-Meyer Lower Extremity (-) • Comfortable 10-m Walk Test (+exp1) • Fast 10-m Walk Test (-)

Kim et al. (2019)
RCT crossover (7)
N_{start}=19
N_{end}=17
TPS=Chronic
	E: Robot Assisted Gait Training (Lokomat) + conventional physiotherapy
	C: Conventional Control
	Duration: 30min RAGT, 30min CPT in experimental or 60min control CPT/d, 5d/wk, 8wks (40 sessions total). No washout period.
		• Berg Balance Scale (-)
		• Trunk Impairment Scale (-)
		• Fugl-Meyer Assessment Lower Extremity (+exp)
		• Functional Ambulation Category (-)
		• Ten Meter Walk Test (-)
		• Falls Efficacy Scale (-)
		• Scale for the Assessment and Rating of Ataxia
		    • Gait (+exp)
		    • Stance (+exp)
		• Sitting (-)

Calabro et al. (2018) RCT (7) N_{start}=40 N_{end}=40 TPS=Chronic	E: Exoskeleton GaitTrainer (Ekso) C: Overground Walking Training Duration: 45min, 5x/wk, 8wks	• 10-Meter Walk Test (+exp) • Timed up and Go Test (+exp) • Rivermead Mobility Index (+exp) • Gait Quality Index (+exp) • Step Cadence (+exp) • Gait Cycle Duration (+exp) • Stance/Swing Ratio (+exp)
Bang & Shin (2016) RCT (7) N_{start}=18 N_{end}=18 TPS=Chronic	E: Lokomat gait training C: Treadmill training Duration: 1hr/d, 5d/wk for 4wk	• Gait speed (+exp) • Cadence (+exp) • Step Length (+exp) • Berg Balance Scale (+exp) • Activities-Specific Balance Confidence (+exp)
Han et al. (2016) RCT (5) N_{start}=60 N_{end}=60 TPS=Subacute	E: Lokomat gait training C: Conventional rehabilitation Duration: 90min/d, 5d/wk for 4wk	• Functional Ambulation Category (-) • Fugl-Meyer Assessment (-) • Berg Balance Scale (-) • Modified Barthel Index (-)
Cho et al. (2015) RCT (4) N_{start}=20 N_{end}=20 TPS=Chronic	E: Lokomat gait training C: Conventional rehabilitation Duration: 30min/d, 3d/wk for 4wk	• Modified Barthel Index (+exp) • Berg Balance Scale (-) • Functional Ambulation Category (-) • Modified Ashworth Scale (-) • Fugl-Meyer Assessment (-) • Motricity Index (-)

Kim et al. (2015) RCT (6) N_{start}=30 N_{end}=28 TPS=Subacute	E: Walkbot gait training C: Conventional rehabilitation Duration: 1hr/d, 3d/wk for 4wk	• Functional Ambulation Category (+exp) • Berg Balance Scale (+exp) • Modified Barthel Index (+exp)
Ochi et al. (2015) RCT (6) N_{start}=26 N_{end}=26 TPS=Acute	E: Gait-assistance robotic (GAR) training C: Overground gait training Duration: 1hr/d, 5d/wk for 6wk	• Functional Ambulation Category (+exp) • Fugl-Meyer Assessment (-) • Functional Independence Measure (-) • 10-Metre Walk Test (-)
van Nunen (2015) RCT (4) N_{start}=30 N_{end}=30 TPS=Subacute	E: Lokomat gait training C: Conventional gait training Duration: 30min/d, 5d/wk for 8wk	• 10-Metre Walk Test (-) • Berg Balance Scale (-) • Timed Up & Go Test (-) • Motricity Index (-) • Rivermead Mobility Index (-) • Fugl-Meyer Assessment (-) • Functional Ambulation Category (-)
Ucar et al. (2014) RCT (4) N_{start}=22 N_{end}=20 TPS=Chronic	E: Lokomat gait training C: Conventional rehabilitation Duration: 20min/d, 5d/wk for 2wk	• 10-Metre Walk Test (+exp) • Timed Up & Go Test (+exp)
Watanabe et al. (2014) RCT (4) N_{start}=32 N_{end}=37 TPS=Subacute	E: Hybrid Assistive Limb gait training C: Conventional gait training Duration: 30min/d, 3d/wk for 4wk	• Functional Ambulation Category (+exp) • Maximum walking speed (-) • Fugl-Meyer Assessment (-) • Short Physical Performance Battery (-) • 6-Minute Walk Test (-) • Timed Up & Go Test (-)
Kelley et al. (2013) RCT (6) N_{start}=21 N_{end}=21 TPS=Chronic	E: Lokomat gait training C: Overground gait training Duration: 1hr/d, 5d/wk for 8wk	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Stroke Impact Scale (-) • Fugl-Meyer Assessment (-) • Functional Independence Measure (-)
Chang et al. (2012) RCT (7) N_{start}=37 N_{end}=37 TPS=Acute	E: Lokomat gait training C: Conventional rehabilitation Duration: 100min/d, 5d/wk for 4wk	• Fugl-Meyer Assessment (+exp) • Functional Ambulation Category (-) • Motricity Index (-)
Fisher et al. (2011) RCT (5) N_{start}=20 N_{end}=20 TPS=Chronic	E: AutoAmbulator gait training C: Conventional rehabilitation Duration: 1h/d for 24d	• 8-Metre Walk Test (-) • 3-Minute Walk Test (-) • Tinetti Balance Assessment (-)
Freivogel et al. (2009) RCT (8) N_{start}=16 N_{end}=16 TPS=Acute	E: LokoHelp gait training C: Conventional gait training Duration: 30min/d, 5d/wk for 2wk	• 6-Minute Walk Test (+exp) • 10-Metre Walk Test (-) • Berg Balance Scale (-) • Rivermead Mobility Index (-) • Functional Ambulation Category (-)
Hidler et al. (2009) RCT (5) N_{start}=63 N_{end}=58 TPS=Subacute	E: Lokomat gait training C: Conventional gait training Duration: 1hr/d, 6d/wk for 4wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Berg Balance Scale (-) • Functional Ambulation Category (-) • Rivermead Mobility Index (-) • Motor Assessment Scale (-)

		• Frenchay Activity Index (-) • NIH Stroke Scale (-)
Schwartz et al. (2009) RCT (6) N_{start}=67 N_{end}=61 TPS=Subacute	E: Lokomat gait training C: Conventional rehabilitation Duration: 30min/d, 3d/wk for 6wk	• Functional Ambulatory Category (+exp) • NIH Stroke Scale (+exp) • Stroke Activity Scale (-) • Gait speed (-) • Gait endurance (-) • Stair climb (-)
Westlake & Patten (2009) RCT (6) N_{start}=16 N_{end}=15 TPS=Chronic	E: Lokomat gait training C: Body-weight supported treadmill training Duration: 45min/d, 3d/wk for 4wk	• Self-selected walking speed (-) • Fast walking speed (-) • 6-Minute Walk Test (-) • Berg Balance Scale (-) • Fugl-Meyer Assessment (-) • Short Physical Performance Battery (-) • Step length ratio (-)
Hornby et al. (2008) RCT (5) N_{start}=48 N_{end}=45 TPS=Chronic	E: Lokomat gait training C: Conventional gait training Duration: 30min/d, 3d/wk for 4wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (-) • Berg Balance Scale (-) • Emory Functional Ambulation Profile (-)
Husemann et al. (2007) RCT (7) N_{start}=30 N_{end}=30 TPS=Acute	E: Lokomat gait training C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 4wk	• Functional Ambulation Category (-) • Motricity Index (-) • Barthel Index (-) • 10-Metre Walk Test (-) • Cadence (-) • Stride duration (-) • Stance duration (-) • Single support time (-)
Mayr et al. (2007) RCT (5) N_{start}=16 N_{end}=16 TPS=Acute	E: Lokomat gait training C: Conventional rehabilitation Duration: 30min/d, 5d/wk for 4wk	• Rivermead Motor Assessment (+exp) • EU Walking Scale (+exp) • Motricity Index (+exp) • Medical Research Council Scale (+exp) • Ashworth Scale (+exp) • 6-Minute Walk Test (+exp) • 10-Metre Walk Test (-)
Exoskeleton Systems Administration Method		
Bae et al. (2016) RCT (6) N_{start}=34 N_{end}=34 TPS=Chronic	E: Lokomat gait training, Heart rate reserve guided C: Lokomat gait training, Rate of perceived exertion guided Duration: 30min/d, 5d/wk for 4wk	• Fugl-Meyer Assessment (+exp) • 10-Metre Walk Test (+exp) • Gait kinematics (+exp)
Exoskeleton Portable Devices vs Overground Gait Training or Stretching		
Buesing et al. (2015) RCT (6) N_{start}=54 N_{end}=54 TPS=Chronic	E: Stride Management Assist gait training C: Gait training Duration: 1hr/d, 3d/wk for 8wk	• Gait speed (-) • Cadence (-) • Step time (-) • Swing time (-) • Stride Length (-) • Gait symmetry (-)
Forrester et al. (2014) RCT (5) N_{start}=39 N_{end}=33 TPS=Subacute	E: Anklebot + Stretching C: Stretching Duration: 30min/d, 3d/wk for 4wk	• Step time symmetry (+exp) • Step length symmetry (+exp) • Angular velocity (+exp) • Step time (-) • Step length (-) • 8-Metre Walk Test (-)

		• Berg Balance Scale (-) • Ankle Range of Motion (-) • Manual Muscle Test (-) • Functional Independence Measure (-)
Goodman et al. (2014) RCT (3) N_{start}=17 N_{end}=10 TPS=Chronic	E: Ankle Robot Training with High Reward (Monetary) E: Ankle Robot Training with Low Reward Duration: 1hr, 3/wk, 3wks	• Gait Velocity (-) • Cadence (-) • Step Length (-) • Step Time (-)
Stein et al. (2014) RCT (7) N_{start}=24 N_{end}=24 TPS=Chronic	E: Bionic Leg gait training C: Gait training Duration: 1hr/d, 3d/wk for 6wk	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Timed Up & Go Test (-) • Sit-to-Stand Test (-) • Berg Balance Scale (-) • Emory Functional Ambulation Profile (-) • California Functional Evaluation (-) • Romberg Test (-)
Waldman et al. (2013) RCT (5) N_{start}=24 N_{end}=24 TPS=Subacute	E: Ankle robotics + Active movement training + Stretching C: Active movement training + Stretching Duration: 1hr/d, 5d/wk for 6wk	• 6-Minute Walk Test (-) • Modified Ashworth Scale (-) • Stroke Rehabilitation Assessment of Movement (-) • Berg Balance Scale (-)
Robotic Training vs Restraint Vs Robotic Training		
Bonnyaud et al. (2014) RCT (4) N_{start}=26 N_{end}=26 TPS=Chronic	E: Lokomat Gait Training + Restraint of Non-paretic Limb C: Lokomat Gait Training Duration: Single Session - 20min	• Spatiotemporal Gait Analysis (-) • Kinematic Gait analysis (-) • Kinetic Gait Analysis (-)
Robotic Combined with Virtual Reality vs Robotics		
Calabra et al. (2017) RCT (8) N_{start}=24 N_{end}=24 TPS=Chronic	E: Robotic-assisted gait training (Lokomat-Pro) + VR C: Robotic-assisted gait training (Lokomat-Nanos) Duration: 45min/d, 5d/wk, 8wks	• Riverhead Mobility Index (+exp) • Tinetti Performance Oriented Mobility Assessment (+exp) • Modified Ashworth Scale (-) • Hip force (+exp) • Knee force (+exp)
Lokomat Training vs Galvanic Vestibular Stimulation or Physiotherapy with Visual Feedback		
Krewer et al. (2013a) RCT (8) N_{start}=25 N_{end}=24 TPS=Chronic	E1: Galvanic vestibular stimulation E2: Lokomat training E3: Physiotherapy Duration: 20min session	E1 vs E2/E3 • Burke Lateropulsion Scale (-) • Scale for Contraversive Pushing (-)
Robot as Gait Training as Needed vs Robot Assisted Gait Training Full Time		

Seo et al. (2018)
RCT (5)
N_{start}=24
N_{end}=12
TPS=Chronic
	E1: Body Weight Supported Robotic Treadmill Training (Walkbot) with Assistance as Needed
	E: Body Weight Supported Robotic Treadmill Training with Full Assistance
	Duration: 45min, 2x/wk, 10wks
		• Fugl Meyer Assessment (-)
		• Functional Ambulation Category (-)
		• Motricity Index (-)
		• Step Length Asymmetry (-)
		• Stride Length (-)
		• Gait Speed (-)
		• Range of Motion
		    • Hip Flexion/Extension (-)
		    • Knee Flexion/Extension (-)
		    • Ankle Dorsiflexion (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group

+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Electromechanical Devices

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **end-effector assisted gait training** to improve motor function when compared to **conventional therapy overground walking.**	2	Peurala et al. 2009; Dias et al. 2007
1a	There is conflicting evidence about the effect of **end-effector assisted gait training** to improve motor function when compared to **body weight supported treadmill training.**	2	Kim et al. 2020; Werner et al. 2002
1a	**Exoskeleton systems** may not have a difference in efficacy compared to **conventional therapy, overground gait training, or body-weight supported treadmill walking** for improving motor function.	11	Mustafaoglu et al. 2020; Kim et al. 2019; Han et al. 2016; Cho et al. 2015; Ochi et al. 2015; van Nunen et al. 2015; Watanabe et al. 2014; Kelley et al. 2013; Chang et al. 2012; Westlake & Patten 2009; Mayr et al. 2007
1b	**Portable exoskeletons** may not have a difference in efficacy compared to **gait training** for improving motor function.	1	Stein et al. 2014
1b	**Lokomat assisted gait training guided by heart rate reserve** may produce greater improvements in motor function than **Lokomat assisted gait training guided by perceived exertion.**	1	Bae et al. 2016
2	**Robotic gait training with assistance as needed** may not have a difference in efficacy compared to **robotic gait training with full assistance** for improving motor function.	1	Seo et al. 2019

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1a	**End-effector assisted gait training with or without functional electrical stimulation** may produce greater improvements in functional mobility than **conventional therapy, treadmill training, or overground gait training**	7	Kim et al. 2018; Hesse et al. 2012; Morone et al. 2011; Peurala et al. 2009; Ng et al. 2008; Dias et al. 2007; Tong et al. 2006
1a	**Exoskeleton systems** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving functional mobility.	7	Calabro et al. 2018; Van Nunen et al. 2015; Watanabe et al. 2014; Chang et al. 2012; Hidler et al. 2009; Westlake & Patten 2009; Freivogel et al. 2009
2	**Portable exoskeletons with stretching** may not have a difference in efficacy compared to **conventional therapy with stretching** for improving functional mobility.	1	Waldman et al. 2013

1b	**Lokomat with virtual reality** may produce greater improvements in functional mobility than **lokomat training alone.**	1	Calabra et al. 2017

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **end-effector assisted gait training with or without functional electrical stimulation** to improve functional ambulation when compared to **conventional therapy or overground gait training**	9	Stolz et al. 2019; Kim et al. 2018; Hesse et al. 2012; Morone et al. 2011; Peurala et al. 2009; Ng et al. 2008; Pohl et al. 2007; Tong et al. 2006; Peurala et al. 2005
1a	There is conflicting evidence about the effect of **end-effector assisted gait training** to improve functional ambulation when compared to **body weight supported treadmill training.**	2	Kim et al. 2020; Werner et al. 2002
1b	**Lokomat assisted gait training guided by heart rate reserve** may produce greater improvements in functional ambulation than **Lokomat assisted gait training guided by perceived exertion.**	1	Bae et al. 2016
1a	**Exoskeleton systems** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving functional ambulation.	21	Mustafaoglu et al. 2020; Kim et al. 2019; Calabro et al. 2018; Bang & Shin, 2016; Han et al. 2016; Cho et al. 2015; Kim et al. 2015; Ochi et al. 2015; van Nunen et al. 2015; Ucar et al. 2014; Watanabee et al. 2014; Kelley et al. 2013; Chang et al. 2012; Fisher et al. 2011; Freivogel et al. 2009; Hidler et al. 2009; Schwartz et al. 2009; Westlake & Patten 2009; Hornby et al. 2008; Husemann et al. 2007; Mayr et al. 2007;
1a	**Portable exoskeletons** may not have a difference in efficacy compared to **gait training or stretching** for improving functional ambulation**.**	4	Buesing et al. 2015; Forrester et al. 2014; Stein et al. 2014; Waldman et al. 2013
2	**Robotic gait training with assistance as needed** may not have a difference in efficacy compared to **robotic gait training with full assistance** for improving functional ambulation.	1	Seo et al. 2019

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Lokomat assisted gait training guided by heart rate reserve** may produce greater improvements in gait than **Lokomat assisted gait training guided by perceived exertion.**	1	Bae et al. 2016
1a	There is conflicting evidence about the effect of **exoskeleton systems** to improve gait when compared to **conventional therapy or treadmill training.**	5	Kim et al. 2019; Calabro et al. 2018; Bang & Shin 2016; Westlake & Patten 2009; Husemann et al. 2007
1b	**Portable exoskeletons** may not have a difference in efficacy compared to **gait training and stretching alone** for improving gait.	3	Buesing et al. 2015; Forrester et al. 2014; Goodman et al. 2014

2	**Exoskeletons with restraint** may not have a difference in efficacy compared to **exoskeletons alone** for improving gait**.**	1	Bonnyaud et al. 2014
2	**Robotic gait training with assistance as needed** may not have a difference in efficacy compared to **robotic gait training with full assistance** for improving gait.	1	Seo et al. 2019

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**End-effector assisted gait training** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving balance.	6	Stolz et al. 2019; Kim et al. 2018; Ng et al. 2018; Dias et al. 2007; Tong et al. 2006; Peurala et al. 2005
1b	**End-effector assisted gait training** may not have a difference in efficacy compared to **body weight supported treadmill training** for improving balance.	1	Kim et al. 2020
1a	**Exoskeleton systems** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving balance.	13	Mustafaoglu et al. 2020; Kim et al. 2019; Calabro et al. 2018; Bang & Shin, 2016; Han et al. 2016; Cho et al. 2015; Kim et al. 2015; van Nunen et al. 2015; Ucar et al. 2014; Watanabee et al. 2014; Fisher et al. 2011; Freivogel et al. 2009; Hidler et al. 2009; Schwartz et al. 2009; Westlake & Patten 2009; Hornby et al. 2008
1b	**Portable leg and ankle portable exoskeletons** may not have a difference in efficacy compared to **gait training or stretching** for improving balance**.**	3	Forrester et al. 2014; Stein et al. 2014; Waldman et al. 2013
1b	**Lokomat with virtual reality** may produce greater improvements in balance than **lokomat training alone.**	1	Calabra et al. 2017
1b	**Galvanic vestibular stimulation** may not have a difference in efficacy compared to **lokomat training** for improving balance.	1	Krewer et al. 2013a

SPASTICITY

LoE	Conclusion Statement	RCTs	References
2	There is conflicting evidence about the effect of **exoskeleton systems** to improve spasticity when compared to **conventional therapy**.	2	Cho et al. 2015; Mayr et al. 2007
1a	**End-effector assisted gait training** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving spasticity.	2	Morone et al. 2011; Dias et al. 2007
2	**Portable ankle exoskeleton training with stretching** may not have a difference in efficacy compared to **conventional therapy with stretching** for improving spasticity	1	Waldman et al. 2013

1b	**Lokomat with virtual reality** may not have a difference in efficacy compared to **lokomat training alone** for improving spasticity.	1	Calabra et al. 2017

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
2	**Portable exoskeletons with stretching** may not have a difference in efficacy compared to **stretching** for improving range of motion.	1	Forrester et al. 2014
2	**Robotic gait training with assistance as needed** may not have a difference in efficacy compared to **robotic gait training with full assistance** for improving range of motion.	1	Seo et al. 2019

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**End-effector assisted gait training** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving activities of daily living.	9	Stolz et al. 2019; Kim et al. 2018; Morone et al. 2011; Peurala et al. 2009; Ng et al. 2008; Dias et al. 2007; Tong et al. 2006; Peurala et al. 2005; Dias et al. 2007; Pohl et al. 2007
1a	**Exoskeleton systems** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving activities of daily living.	8	Mustafaoglu et al. 2020; Han et al. 2016; Cho et al. 2015; Kim et al. 2015; Ochi et al. 2015; Kelley et al. 2013; Schwartz et al. 2009; Husemann et al 2007
2	**Portable exoskeletons** may not have a difference in efficacy compared to **stretching** for improving activities of daily living.	1	Forrester et al. 2014

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **end-effector assisted gait training** to improve muscle strength when compared to **conventional therapy or overground gait training**.	6	Kim et al. 2018; Hesse et al. 2012; Morone et al. 2011; Ng et al. 2008; Dias et al. 2007; Tong et al. 2006
1a	**Exoskeleton systems** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving muscle strength.	5	Cho et al. 2015; van Nunen et al. 2015; Chang et al. 2012; Husemann et al. 2007; Mayr et al. 2007
2	**Portable exoskeletons with stretching** may not have a difference in efficacy compared to **stretching** for improving muscle strength.	1	Forrester et al. 2014
1b	**Lokomat with virtual reality** may produce greater improvements in muscle strength than **lokomat training alone.**	1	Calabra et al. 2017
2	**Robotic gait training with assistance as needed** may not have a difference in efficacy compared to **robotic gait training with full assistance** for improving muscle strength.	1	Seo et al. 2019

PROPRIOCEPTION			
LoE	Conclusion Statement	RCTs	References
1b	**Portable exoskeletons** may not have a difference in efficacy compared to **gait training** for improving proprioception.	1	Stein et al. 2014

STROKE SEVERITY			
LoE	Conclusion Statement	RCTs	References
1b	**End-effector assisted gait training** may not have a difference in efficacy compared to **conventional therapy or overground gait training** for improving stroke severity.	1	Morone et al. 2011
1b	**Exoskeleton systems** may produce greater improvements in stroke severity than **conventional therapy.**	1	Schwartz et al. 2009

Key Points

The literature is mixed regarding the effect of end-effector gait training on functional ambulation and muscle strength.

End-effector assisted gait training with or without functional electrical stimulation may be helpful in improving functional mobility.

End-effector assisted gait training may not be beneficial for improving balance and activities of daily living.

Exoskeleton systems may not be beneficial for improving motor function, functional ambulation, functional mobility, balance, activities of daily living, and muscle strength.

Sensorimotor stimulation

Functional Electrical Stimulation

Adopted from: http://inirehab.com/functional-electrical-stimulation-fes-explained/

Functional electrical stimulation (FES), the integration of neuromuscular electrical stimulation with functional activity or training, was first implemented with the goal of assisting stroke patients with foot drop (Liberson et al. 1961; Peckham & Knutson 2005). FES is currently used to improve the function of the paretic extremity during various motor tasks (Liberson et al. 1961). FES works through applying short, programmed bursts of current to the nerve and muscles in the affected region to produce muscle contractions in a coordinated way.

A total of 41 RCTs were found evaluating functional electrical stimulation for lower extremity motor rehabilitation. 17 RCTs compared functional electrical stimulation to gait training, conventional therapy or sham stimulation (Dujovic et al. 2017; Sheffler et al. 2015; Spaich et al. 2014; You et al. 2014; Sheffler et al. 2013; Morone et al. 2012; Daly et al. 2011; Cheng et al. 2010; Embrey et al. 2010; Kojovic et al. 2009; Kottink et al. 2007; Daly et al. 2006; Yan et al. 2005; Newsam & Baker 2004; Bogatai et al. 1995; MacDonell et al. 1994; Cozean et al. 1988). Eight RCTs compared cycling with functional electrical stimulation to conventional therapy or cycling with or without sham functional electrical stimulation (Shariat et al. 2019; Bustamante Valles et al. 2016; De Sousa et al. 2016; Peri et al. 2016; Bauer et al. 2015; Ambrosini et al. 2011; Ferrante et al. 2008; Janssen et al. 2008). Three RCTs compared treadmill training with functional electrical stimulation to treadmill training with or without sham functional electrical stimulation (Awad et al. 2016; Cho et al. 2015; Hwang et al. 2015). Three RCTs compared robot-assisted functional electrical stimulation to gait training or robot-assisted gait training (Bae et al. 2014; Tong et al. 2006; Peurala et al. 2005). Three RCTs evaluated various other training with functional electrical stimulation (Chung et al. 2015; Kunkel et al. 2013; Solopova et al. 2011). One RCT compared functional electrical stimulation to electrical nerve stimulation (Sharif et al. 2017). Four RCTs compared functional electrical stimulation to ankle foot orthoses (Bethoux et al. 2014; Everaert et al. 2013; Salisbury et al. 2013; Kluding et al. 2013). Two RCTs compared modalities of functional electrical stimulation (Zheng et al. 2018; Tan et al. 2014).

The methodological details and results of all 41 RCTs are presented in Table 28.

28. RCTs Evaluating Functional Electrical Stimulation Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
FES vs Gait Training, Conventional Therapy or Sham Stimulation		
Dujovic et al. (2017) RCT (7) N$_{start}$=16 N$_{end}$=16 TPS=Subacute	E: Functional Electrical Stimulation C: Conventional Therapy Duration: 20-40min/d, 5d/wk for 4wk	• Fugl-Meyer Assessment (-) • Berg Balance Scale (-) • Barthel Index (-) • 10-Metre Walk Test (+exp)
Sheffler et al. (2015) RCT (6) N$_{start}$=110 N$_{end}$=96 TPS=Subacute	E: Gait training + FES C: Gait training Duration: 1hr/d, 2d/wk for 12wk	• Gait speed (-) • Stride length (-) • Hip power (-) • Ankle power (-) • Cadence (-)
Spaich et al. (2014) RCT (8) N$_{start}$=30 N$_{end}$=30 TPS=Chronic	E: Gait training + FES C: Gait training Duration: 40min/d, 5d/wk for 4wk	• Gait speed (+exp) • Gait cycle duration (+exp) • Stance duration (+exp) • Stance time symmetry ratio (+exp) • Functional Ambulation Category (-)
You et al. (2014) RCT (7) N$_{start}$=42 N$_{end}$=38 TPS=Chronic	E: Rehabilitation + FES C: Rehabilitation Duration: 30min/d, 5d/wk for 3wk	• Fugl-Meyer Assessment (+exp) • Modified Barthel Index (+exp) • Berg Balance Scale (+exp) • Postural Assessment Scale for Stroke (-) • Composite Spasticity Scale (+exp)
Sheffler et al. (2013) RCT (7) N$_{start}$=110 N$_{end}$=98 TPS=Chronic	E: Gait training + FES C: Gait training Duration: 1hr/d, 2d/wk for 12wk	• Modified Emory Functional Ambulation Profile (+exp) • Fugl-Meyer Assessment (-)
Morone et al. (2012) RCT (8) N$_{start}$=20 N$_{end}$=20 TPS=Subacute	E: Gait training + FES C: Gait training Duration: 40min/d, 5d/wk for 4wk	• 10-Metre Walk Test (+exp) • Functional Ambulation Classification (+exp) • Rivermead Mobility Index (-) • Modified Ashworth Scale (-) • Barthel Index (-)
Daly et al. (2011) RCT (7) N$_{start}$=54 N$_{end}$=47 TPS=Chronic	E: Gait training + Intramuscular FES C: Gait training Duration: 90min/d, 4d/wk for 12wk	• Gait Assessment & Intervention Tool (+exp)
Cheng et al. (2010) RCT (6) N$_{start}$=15 N$_{end}$=15 TPS=Chronic	E: Rehabilitation + FES C: Rehabilitation Duration: 30min/d, 3d/wk for 4wk	• Emory Functional Ambulation Profile (+exp) • Gait symmetry (+exp) • Balance performance (-) • Dorsiflexor muscle strength (-) • Composite Spasticity Scale (+exp)
Embrey et al. (2010) RCT crossover (4) N$_{start}$=33 N$_{end}$=28 TPS=Chronic	E: FES of Dorsiflexors and Plantar Flexors during gait C: Overground walking without functional electrical stimulation Duration: 1h/d, 6d/wk, for 6mos	• 6-minute walk test (+exp) • Emroy Functional Ambulatory Profile (+exp)

Kojovic et al. (2009) RCT (5) N_{start}=13 N_{end}=13 TPS=Acute	E: Gait training + FES C: Gait training Duration: 45min/d, 3d/wk for 4wk	• 6-Metre Walk Test (+exp) • Fugl-Meyer Assessment (+exp) • Barthel Index (+exp)
Kottink et al. (2007) RCT (5) N_{start}=29 N_{end}=29 TPS=Chronic	E: Gait training + FES C: Gait training Duration: 45min/d, 3d/wk for 5wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp)
Daly et al. (2006) RCT (8) N_{start}=32 N_{end}=32 TPS=Chronic	E: Gait training + Intramuscular FES C: Gait training Duration: 30min/d, 3d/wk for 4wk	• Tinetti Gait Scale (+exp) • Tinetti Balance Scale (-) • 6-Minute Walk Test (-) • Fugl-Meyer Assessment (-)
Yan et al. (2005) RCT (6) N_{start}=46 N_{end}=41 TPS=Acute	E1: Rehabilitation + FES E2: Rehabilitation + Sham FES C: Rehabilitation Duration: 1hr/d, 5d/wk for 3wk	• Walking ability (+exp) • Ankle flexion (+exp) • Spasticity (-)
Newsam & Baker (2004) RCT (5) N_{start}=20 N_{end}=20 TPS=Subacute	E: Rehabilitation + FES C: Rehabilitation Duration: 1hr/d, 5d/wk for 6wk	• Motor unit recruitment (+exp) • Maximum voluntary isometric torque (+exp)
Bogataj et al. (1995) RCT (6) N_{start}=20 N_{end}=19 TPS=Chronic	E: Rehabilitation + FES C: Rehabilitation Duration: 45min/d, 3d/wk for 8wk	• Fugl-Meyer Assessment (+exp) • Gait speed (+exp) • Cadence (+exp) • Stride length (+exp)
MacDonell et al. (1994) RCT (5) N_{start}=35 N_{end}=31 TPS=Acute	E: Rehabilitation + FES C: Rehabilitation Duration: 20min/d, 3d/wk for 5wk	• Functional Ambulation Category (+exp) • Barthel Index (+exp)
Cozean et al. (1988) RCT (6) N_{start}=36 N_{end}=36 TPS=Chronic	E1: Gait training + FES E2: Gait training + Biofeedback E3: Gait training + FES + Biofeedback C: Standard care Duration: 30min/d, 3d/wk for 6wk	E3 vs E1/E2/C • Gait cycle time (+exp_3) • Stride length (+exp_3) • Knee flexion (+exp_3) • Ankle flexion (+exp_3)
Cycling with FES vs Conventional Therapy, or Cycling with or without Sham FES		
Shariat et al. (2019) RCT (6) N_{start}=36 N_{end}=30 TPS=Chronic	E: Interval Cycling + Functional Electrical Stimulation C: Linear cycling protocol + Functional Electrical Stimulation Duration: 28min/d, 3d/wk, 4 wks	• Functional Ambulation Category (-) • Timed up-and-go (+exp) • Ankle ROM affected side (+exp) • Knee ROM affected side (+exp) • 10-m walk (-) • Spasticity in plantar flexors (+exp) • Spasticity in quadriceps (+exp) • Single leg stance (-)
Bustamante Valles et al. (2016) RCT (3) N_{start}=27 N_{end}=20 TPS=Chronic	E: Circuit Training (NESS L300 & Motomed Viva 2 FES+ Cycling) C: Conventional Therapy Duration: 2hrs, 24 sessions over 6-8wks	• Fugl-Meyer Assessment (+exp) • 6-Minute Walk Test (-) • 10-Meter Walk Test (-) • Timed Up and Go Test (-)
De Sousa et al. (2016)	E: Cycling + FES	• Muscle strength (+exp) • Functional Independence Measure (-)

RCT (7) N_{start}=40 N_{end}=37 TPS=Subacute	C: Physiotherapy Duration: 30min/d, 5d/wk for 4wk	
Peri et al. (2016) RCT (7) N_{start}=16 N_{end}=16 TPS=Acute	E: Cycling + FES C: Physiotherapy Duration: 30min/d, 5d/wk for 3wk	• Mechanical Efficiency Index (+exp) • 6-Minute Walk Test (-) • Functional Independence Measure (-) • Gait speed (-)
Bauer et al. (2015) RCT (7) N_{start}=40 N_{end}=40 TPS=Chronic	E: Cycling + FES C: Cycling Duration: 20min/d, 3d/wk for 4wk	• Functional Ambulation Category: 4wk (+exp), 6wk (-) • Performance-Oriented Mobility Assessment: 4wk (+exp), 6wk (-) • Motricity Index (-) • Modified Ashworth Scale (-)
Ambrosini et al. (2011) RCT (8) N_{start}=35 N_{end}=35 TPS=Chronic	E: Cycling + FES C: Cycling + Sham FES Duration: 25min/d, 5d/wk for 4wk	• 50-Metre Walk Test (+exp) • Motricity Index (+exp) • Trunk Control Test (+exp) • Upright Motor Control Test (+exp) • Pedaling Unbalance (+exp)
Ferrante et al. (2008) RCT (6) Nstart=20 Nend=20 TPS=Subacute	E: FES + Cycling Ergometer C: Conventional Care Duration: conventional for 3hrs/d, FES cycling 35min/d, 4wks	• Trunk Control Test (-) • Motricity Index (-) • Upright Motor Control Test (-) • 50-m Walking Test (-) • Sit to Stand Task (speed) (-) • Quadricep Strength (+exp)
Janssen et al. (2008) RCT (6) N_{start}=12 N_{end}=12 TPS=Chronic	E: Cycling + FES C: Cycling + Sham FES Duration: 30min/d, 2d/wk for 6wk	• 6-Minute Walk Test (-) • Berg Balance Scale (-) • Rivermead Mobility Index (-)
Treadmill Training with FES vs Treadmill Training with or without Sham FES		
Awad et al. (2016) RCT (6) N_{start}=50 N_{end}=46 TPS=Chronic	E1: Fastest speed treadmill training + FES E2: Fastest speed treadmill training C: Self-selected speed treadmill training Duration: 30min/d, 3d/wk for 12wk	• 6-Minute Walk Test (-)
Cho et al. (2015) RCT (6) N_{start}=36 N_{end}=36 TPS=Chronic	E1: Treadmill training + FES on gluteus medius and tibialis anterior E2: Treadmill training + FES on tibialis anterior C: Treadmill training Duration: 30min/d, 5d/wk for 4wk	E1 vs E2/C • 6-Minute Walk Test (+exp) • Berg Balance Scale (+exp) • Gait speed (+exp) • Cadence (+exp) • Gait symmetry (+exp) • Single support time (+exp) • Double support time (-) • Stride length (-) E2 vs C • 6-Minute Walk Test (-) • Berg Balance Scale (-) • Gait speed (+exp$_2$) • Cadence (+exp$_2$) • Gait symmetry (-) • Single support time (-) • Double support time (-) • Stride length (-)
Hwang et al. (2015)	E: Treadmill training + FES	• 10-Metre Walk Test (+exp)

RCT (7) N_{start}=32 N_{end}=30 TPS=Chronic	C: Treadmill training + Sham FES Duration: 45min/d, 3d/wk for 8wk	• Timed Up-and-Go Test (+exp) • Berg Balance Scale (+exp)
Robotic-assisted Gait Training with FES vs Gait Training or Robot-assisted Gait Training		
Bae et al. (2014) RCT (8) N_{start}=20 N_{end}=20 TPS=Chronic	E: Robot-assisted (Lokomat) gait training + FES C: Robot-assisted (Lokomat) gait training Duration: 30min/d, 3d/wk for 5wk	• Maximal knee flexion (+exp) • Maximal knee extension (-) • Ankle dorsi/plantarflexion (-) • Pelvic range of motion (-) • Gait speed (-) • Cadence (-)
Tong et al. (2006) RCT (4) N_{start}=46 N_{end}=44 TPS=Subacute	E1: Robot-assisted (Electromechanical gait trainer) gait training + FES E2: Robot-assisted (Electromechanical gait trainer) gait training C: Gait training Duration: 40min/d, 5d/wk for 4wk	E1/E2 vs C • 5-Metre Walk Test (+exp, +exp$_2$) • Elderly Mobility Scale (+exp, +exp$_2$) • Motricity Index (+exp$_1$, +exp$_2$) • Functional Ambulatory Category (+exp, +exp$_2$) E1 vs E2 • 5-Metre Walk Test (-) • Elderly Mobility Scale (-) • Motricity Index (-) • Functional Ambulatory Category (-) • Berg Balance Scale (-) • Barthel Index (-) • Functional Independence Measure (-)
Peurala et al. (2005) RCT (6) N_{start}=45 N_{end}=43 TPS=Chronic	E1: Robot-assisted (Electromechanical gait trainer) gait training + FES E2: Robot-assisted (Electromechanical gait trainer) gait training C: Gait training Duration: 20min/d, 5d/wk for 3wk	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Modified Motor Assessment Scale (-) • Balance (-) • Spasticity (-)
Various Other Training with FES		
Chung et al. (2015) RCT (6) N_{start}=10 N_{end}=10 TPS=Chronic	E: Ankle training + Brain-computer interference-based FES C: Ankle training + FES Duration: 30min/d, 5d/wk for 6wk	• Timed Up and Go Test (-) • Berg Balance Scale (-) • Gait speed (-) • Cadence (-) • Step length (-) • Stride length (-)
Kunkel et al. (2013) RCT (8) N_{start}=21 N_{end}=21 TPS= Acute	E1: Balance training + FES E2: Balance training C: Usual care Duration: 1hr/d, 2d/wk for 4wk	• 10-Metre Walk Test (-) • Berg Balance Scale (-) • Rivermead Mobility Index (-) • Weight-bearing stance (-)
Solopova et al. (2011) RCT (4) N_{start}=61 N_{end}=61 TPS=Acute	E: Functional Electrical Stimulation with Tilt Table C: Conventional Care Duration: 30min, 5x/wk, 2wks	• Maximum Voluntary Contraction of Knee (+exp) • Range of Motion (+exp) • Fugl Meyer Assessment (+exp)
FES vs Electrical Nerve Stimulation		
Sharif et al. (2017) RCT (6) N_{start}=38 N_{end}=38 TPS=NA	E: Functional Electrical Stimulation C: Electrical Muscle Stimulation Duration: 30min/d, 5d/wk for 6wk	• Fugl-Meyer Assessment (+exp) • Timed-Up-and-Go (+exp) • Berg Balance Scale (+exp) • Modified Ashworth Scale (+exp) • Gait Dynamic Index (+exp)
FES vs Ankle Foot Orthoses		

Bethoux et al. (2014) RCT (6) N_{start}=495 N_{end}=399 TPS=Chronic	E: FES C: AFO Duration: 45min/d, 5d/wk for 12wk	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Timed Up and Go Test (-) • Berg Balance Scale (-) • Modified Emory Functional Ambulation Profile (-) • Stroke Impact Scale (-)
Everaert et al. (2013) RCT (7) N_{start}=93 N_{end}=86 TPS=Chronic	E1: FES followed by AFO E2: AFO followed by FES C: AFO only Duration: 30min/d, 5d/wk for 4wk	• 10-Metre Walk Test (-) • Figure-8 Walk Test (-) • Modified Rivermead Mobility Index (-)
Salisbury et al. (2013) RCT (6) N_{start}=16 N_{end}=14 TPS= Subacute	E: FES C: AFO Duration: Not Specified	• 10-Metre Walk Test (-) • Functional Ambulation Classification (-) • Stroke Impact Sale (-)
Kluding et al. (2013) RCT (5) N_{start}=197 N_{end}=162 TPS= Chronic	E: FES C: AFO Duration: 1hr/d, 5d/wk for 30wk	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Fugl-Meyer Assessment (-) • Timed Up and Go Test (-) • Berg Balance Scale (-)
FES Modalities Compared to Each Other		
Zheng et al. (2018) RCT (7) N_{start}=48 N_{end}=48 TPS=Acute	E1: Four-channel Functional Electrical Stimulation E2: Dual-Channel Functional Electrical Stimulation C: Placebo Functional Electrical Stimulation (no electricity) Duration: 5 sec on/off at 30Hz functional electrical stimulation until muscle contraction is observed + 120min/d, 5d/wk, 3wks physiotherapy all groups	E1 Vs C • Postural Assessment Scale for Stroke Patients (+exp1) • Berg Balance Scale (+exp1) • Brunel Balance Assessment (+exp1) • Modified Barthel Index (+exp1) • Fugl-Meyer Assessment (-) E2 Vs C • Postural Assessment Scale for Stroke Patients (-) • Berg Balance Scale (+exp2) • Brunel Balance Assessment (-) • Modified Barthel Index (+exp2) • Fugl-Meyer Assessment (-) E1 Vs E2 • Postural Assessment Scale for Stroke Patients (+exp1) • Berg Balance Scale (+exp1) • Brunel Balance Assessment (-) • Modified Barthel Index (+exp1) • Fugl-Meyer Assessment (-)
Tan et al. (2014) RCT (7) N_{start}=55 N_{end}=53 TPS=Chronic	E1: Gait training + Four-channel FES E2: Gait training + Dual-channel FES C: Gait training + Sham FES Duration: 30min/d, 5d/wk for 3wk	E1 vs E2/C • Postural Assessment Scale for Stroke (+exp) • Modified Barthel Index (+exp) E1 vs C • Fugl-Meyer Assessment (-) • Berg Balance Scale (+exp) E1 vs E2: • Fugl-Meyer Assessment (+exp) • Berg Balance Scale (-) • Functional Ambulation Category (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group

+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Functional Electrical Stimulation

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	There is conflicting evidence about the effect of **functional electrical stimulation** to improve motor function when compared to **conventional therapy, gait training alone or with sham stimulation**.	7	Dujovic et al. 2017; Tan et al. 2014; You et al. 2014; Sheffler et al. 2013; Kojovic et al. 2009; Daly et al. 2006; Bogotai et al. 1995
1a	**Cycling with functional electrical stimulation** may produce greater improvements in motor function than **cycling.**	3	Bustamante Valles et al. 2016; Ambrosini et al. 2011; Ferrante et al. 2008
1b	**Functional electrical stimulation** may produce greater improvements in motor function than **electrical nerve stimulation.**	1	Sharif et al. 2017
1b	**Robot-assisted gait training with functional electrical stimulation** may not have a difference in efficacy compared to **gait training** for improving motor function.	1	Peurala et al. 2005
2	**Functional electrical stimulation** may not have a difference in efficacy compared to **ankle foot orthoses** for improving motor function.	1	Kluding et al. 2013
2	**Functional electrical stimulation with a tilt table** may produce greater improvements in motor function than **conventional care.**	1	Solopova et al. 2011
1a	There is conflicting evidence about the effect of **4 channel functional electrical stimulation** to improve motor function when compared to **dual channel functional electrical stimulation.**	2	Zheng et al. 2018; Tan et al. 2014

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	**Functional electrical stimulation** may produce greater improvements in functional ambulation than **conventional therapy, gait training, and sham stimulation**.	13	Dujovic et al. 2017; Sheffler et al. 2015; Spaich et al. 2014; Sheffler et al. 2013; Morone et al. 2012; Cheng et al. 2010; Embrey et al. 2010; Kojovic et al. 2009; Kottinik et al. 2007; Daly et al. 2006; Yan et al. 2005; Bogatai et al. 1995; MacDonell et al. 1994
1a	**Cycling with functional electrical stimulation** may not have a difference in efficacy compared to **cycling** for improving functional ambulation.	7	Shariat et al. 2019; Bustmante Valles et al. 2016; Peri et al. 2016; Bauer et al. 2015; Ambrosini et al. 2011; Ferrante et al. 2008; Jansen et al. 2008
1a	**Treadmill training with functional electrical stimulation** may produce greater improvements in functional ambulation than **treadmill training with or without sham functional electrical stimulation.**	2	Cho et al. 2015; Hwang et al. 2015

1a	**Functional electrical stimulation with conventional therapy** may produce greater improvements in functional ambulation than **conventional therapy.**	3	Dujovic et al. 2017; Cheng et al. 2010; MacDonell et al. 1994
1a	**Functional electrical stimulation** may not have a difference in efficacy compared to **ankle foot orthoses** for improving functional ambulation.	4	Bethoux et al. 2014; Everaert et al. 2013; Kluding et al. 2013; Salisbury et al. 2013
1b	**Fastest speed treadmill training with functional electrical stimulation** may not have a difference in efficacy compared to **fastest or self-selected speed treadmill training** for improving functional ambulation.	1	Awad et al. 2016
1b	**Robot-assisted gait training with functional electrical stimulation** may not have a difference in efficacy compared to **gait training** for improving functional ambulation.	2	Tong et al. 2006; Peurala et al. 2005
1b	**Balance training with functional electrical stimulation** may not have a difference in efficacy compared to **conventional therapy** for improving functional ambulation.	1	Kunkel et al. 2013
1b	**4 channel functional electrical stimulation** may not have a difference in efficacy compared to **gait training** for improving functional ambulation.	1	Tan et al. 2014

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
2	**Robot-assisted gait training with functional electrical stimulation** may produce greater improvements in functional mobility than **gait training.**	1	Tong et al. 2006
1b	**Cycling with functional electrical stimulation** may not have a difference in efficacy compared to **cycling** for improving functional mobility.	1	Janssen et al. 2008
1a	**Gait training or balance training with functional electrical stimulation** may not have a difference in efficacy compared to **gait training or conventional therapy** for improving functional mobility.	2	Kunkel et al. 2013; Morone et al. 2012
1b	**Functional electrical stimulation** may not have a difference in efficacy compared to **ankle foot orthoses** for improving functional mobility.	1	Everaert et al. 2013

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Functional electrical stimulation** may not have a difference in efficacy when compared to **gait training, conventional therapy or sham stimulation** for improving balance.	5	Dujovic et al. 2017; Tan et al. 2014; You et al. 2014; Cheng et al. 2010; Daly et al. 2006

1a	**Treadmill training with functional electrical stimulation** may produce greater improvements in balance than **treadmill training with or without sham functional electrical stimulation.**	2	Cho et al. 2015; Hwang et al. 2015
1b	**Functional electrical stimulation** may produce greater improvements in balance than **electrical nerve stimulation.**	1	Sharif et al. 2017
1a	There is conflicting evidence about the effect of **cycling with functional electrical stimulation** to improve balance when compared to **cycling with sham functional electrical stimulation.**	6	Shariat et al. 2019; Bustmante Valles et al. 2016; Bauer et al. 2015; Ambrosini et al. 2011; Ferrante et al. 2008; Janssen et al. 2008
1a	**Functional electrical stimulation** may not have a difference in efficacy compared to **ankle foot orthoses** for improving balance.	2	Bethoux et al. 2014; Kluding et al. 2013
1b	**Robot-assisted gait training with functional electrical stimulation** may not have a difference in efficacy compared to **gait training** for improving balance.	2	Tong et al. 2006; Peurala et al. 2005
1b	**Ankle training with brain computer interference-based functional electrical stimulation** may not have a difference in efficacy compared to **ankle training with functional electrical stimulation** for improving balance.	1	Chung et al. 2015
1b	**Balance training with functional electrical stimulation** may not have a difference in efficacy compared to **conventional therapy** for improving balance.	1	Kunkel et al. 2013
1a	There is conflicting evidence about the effect of **4 channel functional electrical stimulation** to improve balance when compared to **dual channel functional electrical stimulation.**	2	Zheng et al. 2018; Tan et al. 2014

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**Functional electrical stimulation** may produce greater improvements in gait than **gait training or conventional therapy**.	7	Sheffler et al. 2015; Spaich et al. 2014; Daly et al. 2011; Cheng et al. 2010; Daly et al. 2006; Bogatai et al. 1995; Cozean et al. 1988
1b	**Treadmill training with functional electrical stimulation** may produce greater improvements in gait than **treadmill training.**	1	Cho et al. 2015
1b	**Functional electrical stimulation** may produce greater improvements in gait than **electrical nerve stimulation**.	1	Sharif et al. 2017
1b	**Cycling with functional electrical stimulation** may not have a difference in efficacy compared to **cycling** for improving gait.	1	Shariat et al. 2019
1b	**Robot-assisted gait training with functional electrical stimulation** may not have a difference in	1	Bae et al. 2014

	efficacy compared to **robot-assisted gait training** for improving gait.		
1b	**Ankle training with brain-computer interference-based functional electrical stimulation** may not have a difference in efficacy compared to **ankle training with functional electrical stimulation** for improving gait.	1	Chung et al. 2015

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Functional electrical stimulation** may produce greater improvements in activities of daily living when compared to **conventional therapy, gait training alone or with sham stimulation**.	6	Dujovic et al. 2017; Tan et al. 2014; You et al. 2014; Morone et al. 2012; Kojovic et al. 2009; MacDonell et al. 1994
1a	**Cycling with functional electrical stimulation** may not have a difference in efficacy compared to **conventional therapy** for improving activities of daily living.	2	De Sousa et al. 2016; Peri et al. 2016
2	**Robot-assisted gait training with functional electrical stimulation** may not have a difference in efficacy compared to **gait training** for improving activities of daily living.	1	Tong et al. 2006
1b	**4 channel functional electrical stimulation** may produce greater improvements in activities of daily living when compared to **dual channel**.	1	Zheng et al. 2018

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Functional electrical stimulation with conventional therapy** may produce greater improvements in range of motion than **conventional therapy.**	1	Yan et al. 2005
1b	**Robot-assisted gait training with functional electrical stimulation** may not have a difference in efficacy compared to **robot-assisted gait training** for improving range of motion.	1	Bae et al. 2014
2	**Functional electrical stimulation with a tilt table** may produce greater improvements in range of motion than **conventional care.**	1	Solopova et al. 2011

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	**Functional electrical stimulation** may produce greater improvements in muscle strength than **gait training or conventional therapy**.	4	Cheng et al. 2010; Yan et al. 2005; Newsam and Baker, 2004; Cozean et al. 1988

2	**Robot-assisted gait training with functional electrical stimulation** may produce greater improvements in muscle strength than **gait training.**	1	Tong et al. 2006
1a	There is conflicting evidence about the effect of **cycling with functional electrical stimulation** to improve muscle strength when compared to **conventional therapy or cycling with or without sham functional electrical stimulation**.	4	De Sousa et al. 2016; Bauer et al. 2015; Ambrosini et al. 2011; Ferrante et al. 2008
2	**Functional electrical stimulation with a tilt table** may produce greater improvements in muscle strength than **conventional care.**	1	Solopova et al. 2011

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence that **functional electrical stimulation** may produce greater improvements in spasticity than **conventional therapy or gait training**.	4	You et al. 2014; Morone et al. 2012; Cheng et al. 2010; Yan et al. 2005
1b	**Functional electrical stimulation** may produce greater improvements in spasticity than **electrical nerve stimulation.**	1	Sharif et al. 2017
1b	**Cycling with functional electrical stimulation** may not have a difference in efficacy compared to **cycling** for improving spasticity.	1	Bauer et al. 2015
1b	**Robot-assisted gait training with functional electrical stimulation** may not have a difference in efficacy compared to **gait training** for improving spasticity.	1	Peurala et al. 2005

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1a	**Functional electrical stimulation** may not have a difference in efficacy compared to **ankle foot orthoses** for improving stroke severity.	2	Bethoux et al. 2014 ; Salisbury et al. 2013

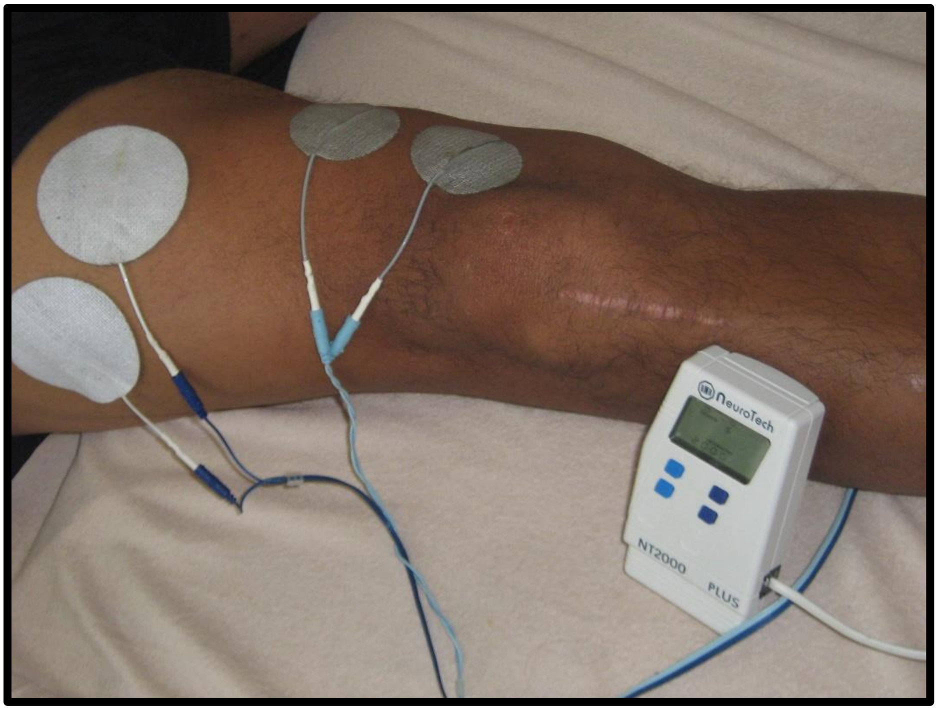
Key Points

Functional electrical stimulation may be beneficial for improving functional ambulation, gait, activities of daily living, and muscle strength.

The literature is mixed concerning the effect of functional electrical stimulation on improving motor function and spasticity.

Functional electrical stimulation may not be beneficial for improving balance, and stroke severity.

Neuromuscular Electrical Stimulation (NMES)



Adopted from: https://swordsphysio.ie/physiotherapy-treatments/neuromuscular-stimulation/

Neuromuscular electrical stimulation (NMES) is a technique used to generate muscle contractions in regions affected by hemiparesis by stimulating lower motor neurons involved in muscle movement through transcutaneous application of electrical currents (Monte-Silva et al. 2019; Allen & Goodman 2014).

1. Cyclic NMES in which a muscle is repetitively stimulated at near maximum contraction on a pre-set schedule and patient participation is passive (Nascimento et al. 2013);
2. Electromyography (EMG) triggered NMES, in which a target muscle is directly controlled or triggered by volitional EMG activity from the target or a different muscle to elicit a desired stimulation (Monte-Silva at al. 2019);

Interferential current therapy (ICT) is a variation of NMES that uses two medium frequency currents to create a 100Hz interference wave across the skin which exerts its maximal effect deeper in the tissue of the treatment area (Goats et al. 1990).

A total of 10 RCTs were found that evaluated different NMES techniques. Three RCTs looked at cyclic NMES compared to conventional therapy, sham stimulation or neurodevelopmental techniques (Bakhtiary & Fatemy, 2008; Yavuzer et al. 2006; Chen et al. 2005). One RCT compared EMG-triggered NMES to conventional therapy (Mesci et al. 2009). A single RCT compared inferential current NMES to sham stimulation (Suh et al. 2014). One RCT compared cyclic NMES with passive movement training to cyclic NMES on its own or passive movement training (Yamaguchi et al. 2012). One RCT compared cyclic NMES with trunk training to cyclic NMES on its own or core training (Ko et al. 2016). One RCT compared various cyclic NMES stimulation intensities (Wang et al. 2016). One RCT compared contralaterally controlled NMES to cyclic NMES (Knutson et al. 2013). One RCT compared NMEs to mirror therapy (Pagilla et al. 2019).

The methodological details and results of all 10 RCTs are presented in Table 29.

Table 29. RCTs Evaluating Neuromuscular Electrical Stimulation Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	**Interventions Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures Result (direction of effect)**
Cyclic NMES vs Conventional Therapy, Sham Stimulation, or Neurodevelopmental Techniques		
Bakhtiary & Fatemy (2008) RCT (8) N_{start}=40 N_{end}=35 TPS=Not reported	E: Cyclic NMES + Bobath C: Bobath Approach Duration: 15min bobath, 9min NMES, 20 daily sessions	• Ankle joint dorsiflexion range of motion (+exp) • Dorsiflexor strength (+exp) • Modified Ashworth Score (+exp)
Yavuzer et al. (2006) RCT (7) N_{start}=25 N_{end}=25 TPS=Subacute	E: Cyclic NMES C: Conventional Therapy Duration: 30min/d, 5d/wk, for 4wk	• Brunnstrom Recovery Stage (-) • Gait kinematics (-)
Chen et al. (2005) RCT (4) N_{start}=24 N_{end}=24 TPS=Chronic	E: Cyclic NMES C: Sham NMES Duration: 20min/d, 6d/wk, for 4wk	• 10-Metre Walk Test (+exp) • Modified Ashworth Scale (+exp)
EMG-triggered NMES vs Conventional Therapy		
Mesci et al. (2009) RCT (5) N_{start}=40 N_{end}=40 TPS=Chronic	E: EMG-triggered NMES C: Conventional therapy Duration: 5d/wk, for 4wk	• Rivermead Motor Assessment (+exp) • Brunnstrom Recovery Stage (+exp) • Functional Independence Measure (+exp) • Functional Ambulation Category (-) • Modified Ashworth Scale (+exp)
Interferential Current NMES vs Sham		
Suh et al. (2014) RCT (8) N_{start}=42 N_{end}=42 TPS=Subacute	E: Interferential current NMES C: Sham NMES Duration: one 60min session	• 10-Meter Walk Test (+exp) • Timed Up-and-Go Test (+exp) • Functional Reach Test (+exp) • Berg Balance Scale (+exp) • Modified Ashworth Scale (+exp)
Cyclic NMES vs Passive Movement Training		
Yamaguchi et al. (2012) RCT (8) N_{start}=27 N_{end}=27 TPS=Subacute	E1: Passive Movement Training + cyclic NMES E2: Cyclic NMES C: Passive Movement Training Duration: 20min sessions	E1 vs E2: • Gait Speed (+exp$_1$) • Modified Ashworth Scale (-) E1 vs C: • Gait Speed (+exp$_1$) • Modified Ashworth Scale (-) E2 vs C: • Gait Speed (-) • Modified Ashworth Scale (-)
Cyclic NMES vs Trunk/Core Training		
Ko et al. (2016) RCT (6) N_{start}=34 N_{end}=30 TPS=Acute	E1: Cyclic NMES + Trunk training E2: Cyclic NMES C: Core Training Duration: 20min/d, 3d/wk, for 3wk	E1 vs C • Trunk Impairment Scale (+exp$_1$) • Berg Balance Scale (+exp$_1$) • Postural Assessment for Stroke Scale (-) • Modified Barthel Index (-) E1 vs E2 • Trunk Impairment Scale (-)

		• Berg Balance Scale (+exp_1) • Postural Assessment for Stroke Scale (-) • Modified Barthel Index (-)
Comparison of Cyclic NMES Stimulation Intensity		
Wang et al. (2016) RCT (7) N_{start}=72 N_{end}=64 TPS=Acute	E1: Full-movement cyclic NMES E2: Sensory threshold cyclic NMES E3: Motor threshold cyclic NMES C: Conventional therapy Duration: 60min/d, 5d/wk, for 4wk	E1 vs E2: • Active Ankle Dorsiflexion (+exp_1) • Composite Spasticity Scale (+exp_1) • Timed Up-and-Go Test (-) E1 vs E3: • Active Ankle Dorsiflexion (+exp_1) • Composite Spasticity Scale (+exp_1) • Timed Up-and-Go Test (-) E1 vs C: • Active Ankle Dorsiflexion (+exp_1) • Composite Spasticity Scale (+exp_1) • Timed Up-and-Go Test (-) E2/E3 vs C: • Active Ankle Dorsiflexion (-) • Composite Spasticity Scale (-) • Timed Up-and-Go Test (-) E2 vs E3: • Active Ankle Dorsiflexion (-) • Composite Spasticity Scale (-) • Timed Up-and-Go Test (-)
Contralaterally Controlled NMES vs Cyclic NMES		
Knutson et al. (2013) RCT (6) N_{start}=26 N_{end}=24 TPS=Chronic	E: Contralaterally controlled NMES C: Cyclic NMES Duration: 10 sessions/wk, for 6wk	• Fugl-Meyer Assessment (-) • Modified Emory Functional Ambulation Profile (-) • Gait speed (-)
NMES vs Mirror Therapy		
Pagilla et al. (2019) RCT (8) N_{start}=30 N_{end}=30 TPS=Acute	E: NMES + Conventional Therapy C: Mirror Therapy + Conventional Therapy Duration: conventional for 60min, mirror/NMES for 30min, 6 consecutive days	• Berg Balance Scale (-) • Barthel Index (-) • Fugl-Meyer Assessment (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Neuromuscular Electrical Stimulation

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Contralaterally controlled NMES** may not have a difference in efficacy compared to **cyclic NMES** for improving motor function.	1	Knutson et al. 2013
1b	**NMES** may not have a difference in efficacy compared to **mirror therapy** for improving motor function.	1	Pagilla et al. 2019

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
2	**Cyclic NMES** may produce greater improvements in functional ambulation than **sham stimulation.**	1	Chen et al. 2005
2	**EMG-triggered NMES** may not have a difference in efficacy compared to **conventional therapy** for improving functional ambulation.	1	Mesci et al. 2009
1b	**Cyclic NMES combined with passive movement training** may produce greater improvements in functional ambulation than **passive movement training or cyclic NMES alone.**	1	Yamaguchi et al. 2012
1b	**Cyclic NMES** may not have a difference in efficacy compared to **passive movement training** for improving functional ambulation.	1	Yamaguchi et al. 2012
1b	**Interferential current NMES** may produce greater improvements in functional ambulation than **sham stimulation.**	1	Suh et al. 2014
1b	**Contralaterally controlled NMES** may not have a difference in efficacy compared to **cyclic NMES** for improving functional ambulation.	1	Knutson et al. 2013

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
2	**EMG-triggered NMES** may produce greater improvements in functional mobility than **conventional therapy.**	1	Mesci et al. 2009

BALANCE

LoE	Conclusion Statement	RCTs	References
1b	**Interferential current NMES** may produce greater improvements in balance than **sham stimulation.**	1	Suh et al. 2014
1b	There is conflicting evidence about the effect of **cyclic NMES combined with trunk training** to improve balance when compared to **cyclic NMES or core training** alone.	1	Ko et al. 2016

1b	There may be no difference in efficacy between **full movement NMES, sensory threshold NMES, motor threshold NMES and conventional therapy** for improving balance.	1	Wang et al. 2016
1b	**NMES** may not have a difference in efficacy compared to **mirror therapy** for improving balance.	1	Pagilla et al. 2019

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Cyclic NMES** may not have a difference in efficacy compared to **conventional therapy** for improving gait.	1	Yavuzer et al. 2006

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
2	**EMG-triggered NMES** may produce greater improvements in activities of daily living than **conventional therapy.**	1	Mesci et al 2009
1b	**Cyclic NMES combined with trunk training** may not have a difference in efficacy compared to **cyclic NMES or core training alone** for improving activities of daily living.	1	Ko et al. 2016
1b	**NMES** may not have a difference in efficacy compared to **mirror therapy** for improving activities of daily living.	1	Pagilla et al. 2019

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Cyclic NMES** may produce greater improvements in range of motion than **the Bobath approach.**	1	Bakhtiary & Fatemy 2008
1b	**Full movement cyclic NMES** may produce greater improvements in range of motion than **conventional therapy, motor threshold cyclic NMES and sensory threshold cyclic NMES.**	1	Wang et al. 2016
1b	There may be no difference in efficacy between **full movement NMES, sensory threshold NMES, motor threshold NMES and conventional therapy** for improving range of motion.	1	Wang et al. 2016

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Cyclic NMES** may produce greater improvements in muscle strength than **the Bobath approach**	1	Bakhtiary & Fatemy 2008

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Cyclic NMES** may produce greater improvements in spasticity than **the Bobath approach or sham stimulation**.	2	Bakhtiary & Fatemy 2008; Chen et al. 2005
2	**EMG-triggered** may produce greater improvements in spasticity than **conventional therapy.**	1	Mesci et al 2009
1b	**Interferential current NMES** may produce greater improvements in spasticity than **sham stimulation.**	1	Suh et al. 2014
1b	**Cyclic NMES combined with passive movement training** may not have a difference in efficacy compared to **cyclic NMES or passive movement training alone** for improving spasticity.	1	Yamaguchi et al 2012
1b	**Cyclic NMES** may not have a difference in efficacy compared to **passive movement training alone** for improving spasticity.	1	Yamaguchi et al 2012
1b	**Full movement cyclic NMES** may produce greater improvements in spasticity than **conventional therapy, motor threshold cyclic NMES and sensory threshold cyclic NMES.**	1	Wang et al. 2016
1b	**Full movement NMES, sensory threshold NMES, motor threshold NMES** may not have a difference in efficacy when compared to **conventional therapy** for improving spasticity.	1	Wang et al. 2016

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1b	**EMG-triggered NMES** may produce greater improvements in stroke severity than **conventional therapy.**	1	Mesci et al. 2009
1b	**Cyclic NMES** may not have a difference in efficacy compared to **conventional therapy** for improving stroke severity.	1	Yavuzer et al. 2006

Key Points

NMES may be beneficial for muscle strength, range of motion and spasticity.

NMES may not be beneficial for improving motor function, functional ambulation and mobility or gait.

Transcutaneous Electrical Nerve Stimulation (TENS)

Adopted from: https://nerve-injury.com/transcutaneous-electrical-nerve-stimulation/

Transcutaneous electrical nerve stimulation (TENS) involves the application of electrical current through surface electrodes on the skin to facilitate activation of nerves (Teoli et al. 2019). TENS units are often small, portable, battery-operated devices, and have been used over antagonist muscles to reduce the spasticity of corresponding agonist muscles in stroke rehabilitation practice (Teoli et al. 2019; Koyama et al. 2016).

One possible neural mechanism underlying the reduced spasticity induced by TENS is improved spinal inhibitory reflexes from the stimulated muscle groups or nerve to the reciprocal muscle groups or nerve (Koyama et al. 2016). The application of afferent electrical stimulation at the sensory level may help to enhance neuroplasticity of the brain, through increased activation and recruitment of cortical networks involving contralesional primary sensory cortex, supplementary motor area, dorsal premotor cortex, posterior parietal cortex, and secondary sensory cortices (Veldman et al. 2015; Sonde et al.1998).

A total of 16 RCTs were found evaluating TENS interventions for lower extremity motor rehabilitation 11 RCTs compared TENS to sham stimulation or no stimulation (Ertzgaard et al. 2018; Gurcan et al. 2015; Park et al. 2014; Cho et al. 2013; Hussain et al. 2013; Tyson et al. 2013; Ng & Hui-Chan 2009; Yan & Hui-Chan 2009; Johansson et al. 2001; Tekeoglu et al. 1998; Levin & Hui-Chan 1992). Three RCTs compared TENS and task-related training to sham TENS and no treatment (Laddha et al. 2016; Chan et al. 2015; Ng & Hui-Chan 2007). One RCT compared unilateral to bilateral TENS (Kwong et al. 2018). One RCT compared TENS to NMES and conventional therapy (Yen et al. 2019)

The methodological details and results of all 16 RCTs are presented in Table 30.

Table 30. RCTs Evaluating Transcutaneous Electrical Stimulation Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
TENS vs Sham Stimulation, Conventional Therapy or No Treatment		
Ertzgaard et al. (2018) (Mixed population, cerebral palsy) RCT crossover (10) N$_{start}$=29 N$_{end}$=27 TPS=Chronic	E: Full-Body TENS (AT Mollii) at home C: Sham Duration: 60min/d, 3-4x/wk, 6wks, 6wk washout	• 10-Meter Walk Test (-) • Timed Up and Go Test (-) • Modified Ashworth Scale (-)
Gurcan et al. (2015) RCT (6) N$_{start}$=32 N$_{end}$=32 TPS= Chronic	E: TENS C: Conventional therapy Duration: 20min/d, 5d/wk, for 3wk	• 10-Metre Walk Test (+exp) • Functional Ambulation Scale (-) • Functional Independence Measure (-) • Brunnstrom Recovery Stage (-) • Modified Ashworth Scale (-)
Park et al. (2014) RCT (7) N$_{start}$=34 N$_{end}$=29 TPS=Chronic	E: TENS C: Sham TENS Duration: 30min/d, 5d/wk for 6wk	• Gait speed (+exp) • Cadence (+exp) • Stride/Step length (+exp) • Static/Dynamic balance (+exp) • Modified Ashworth Scale (+exp)
Cho et al. (2013) RCT (5) N$_{start}$=50 N$_{end}$=42 TPS=Chronic	E: TENS C: Sham TENS Duration: One-time 60min session	• Postural sway (+exp) • Modified Ashworth Scale (+exp)
Hussain et al. (2013) RCT (6) N$_{start}$=35 N$_{end}$=30 TPS=Subacute	E: TENS C: No TENS Duration: 30min/d, 5d/wk for 4wk	• 10-Metre Walk Test (+exp) • Brunnstrom Recovery Stage (+exp) • Dorsiflexion range of motion (+exp) • Dorsiflexion strength (+exp) • Modified Ashworth Scale (+exp)
Tyson et al. (2013) RCT (6) N$_{start}$=29 N$_{end}$=29 TPS=Chronic	E: TENS C: Sham TENS Duration: 2h session	• Gait speed (+exp) • Balance (+exp) • Plantarflexion strength (+exp) • Dorsiflexion strength (-)
Ng & Hui-Chan (2009) RCT (7) N$_{start}$=109 N$_{end}$=109 TPS= Chronic	E1: TENS + Exercise E2: Sham TENS + Exercise E3: TENS C: No active treatment Duration: 60min/d, 5d/wk, for 4wk	E1 vs E2: • Gait speed (+exp) • Timed Up-and-Go Test (+exp) • 6-Minute Walk Test (-) E1 vs E3: • Gait speed (+exp) • Timed Up-and-Go Test (+exp) • 6-Minute Walk Test (+exp) E1 vs C: • Gait speed (+exp) • Timed Up-and-Go Test (+exp) • 6-Minute Walk Test (+exp)
Yan & Hui-Chan (2009) RCT (6) N$_{start}$=62 N$_{end}$=52 TPS=Acute	E1: TENS E2: Sham TENS C: No TENS Duration: 60min/d, 5d/wk for 3wk	E1 vs E2: • Functional mobility (+exp) • Ankle strength (+exp) • Composite Spasticity Scale (+exp) E1 vs C: • Functional mobility (+exp)

		• Ankle strength (+exp) • Composite Spasticity Scale (+exp)
Johansson et al. (2001) RCT (8) N_{start} =150 N_{end}=126 TPS= Acute	E1: TENS E2: Acupuncture C: Sham stimulation Duration: 20 sessions over 10wk	• Rivermead Mobility Index (-) • Walking Ability (-) • Barthel Index (-) • Nottingham Health Profile (-)
Tekeoğlu et al. (1998) RCT (9) N_{start} =60 N_{end}=58 TPS= Subacute	E: TENS C: No TENS Duration: 40 sessions over 8wk	• Barthel Index (+exp) • Ashworth Scale (+exp)
Levin & Hui-Chan (1992) RCT (6) N_{start}=13 N_{end}=13 TPS=Subacute	E: TENS C: Sham TENS Duration: 60min, 5x/wk, 3kws	• Clinical Spasticity Scale (+exp) • H/Mmax response ratio (-) • Vibratory inhibition H reflex (+exp) • Stretch reflex (+exp) • Maximal voluntary isometric plantarflexion (-) • Maximal voluntary isometric dorsiflexion (+exp)
TENS + Task-related Training		
Laddha et al. (2016) RCT (5) N_{start}=52 N_{end}=30 TPS=Chronic	E1: TENS (60min) + Task-related training E2: TENS (30min) + Task-related training C: Task-related training Duration: 30 or 60min/d, 5d/wk for 6wk	E1/E2 vs C: • Modified Ashworth Scale (+exp) • Timed Up-and-Go Test (-)
Chan et al. (2015) RCT (8) N_{start}=37 N_{end}=37 TPS=Chronic	E1: TENS + Task-related training E2: Sham TENS + Task-related training C: No active treatment Duration: 60min/d, 5d/wk, for 6wk	E1/E2 vs C: • Trunk Impairment Scale (+exp) • Dynamic sitting balance (+exp) • Coordination (+exp) E1 vs E2: • Trunk Impairment Scale (+exp) • Dynamic Sitting Balance (+exp) • Coordination (+exp)
Ng & Hui-Chan (2007) RCT (6) N_{start}=88 N_{end}=80 TPS= Chronic	E1: TENS + Task-related training E2: Sham TENS + Task-related training E3: TENS C: No active treatment Duration: 60min/d, 5d/wk for 4wk	E1 vs E2: • Gait speed (+exp) • Dorsiflexion strength (+exp) • Composite Spasticity Scale (+exp) E1 vs E3: • Gait speed (+exp) • Dorsiflexion strength (+exp) • Plantarflexion strength (+exp) • Composite Spasticity Scale (+exp) E1 vs C: • Gait speed (+exp) • Composite Spasticity Scale (+exp)
Unilateral vs Bilateral TENS		
Kwong et al. (2018) RCT (8) N_{start}=80 N_{end}=69 TPS=Chronic	E: Bilateral transcutaneous electrical nerve stimulation C: Unilateral transcutaneous electrical nerve stimulation Duration: 60min/d, 2d/wk for 10wk	• Paretic ankle dorsiflexion strength (+exp) • Paretic ankle plantarflexion (-) • Paretic knee flexion peak torque (+exp) • Paretic knee extension peak torque (-) • Timed-Up-and-Go Test (+exp) • Motor Coordination Test (-) • Berg Balance Scale (-) • Step Test (-)
TENS vs NMES vs Conventional Therapy		

Yen et al. (2019) RCT (7) N_{start}=42 N_{end}=40 TPS=Acute	E1: Transcutaneous Nerve Stimulation + Standard Early Rehabilitation E2: Neuromuscular Electrical Stimulation + Standard Early Rehabilitation C: Standard rehabilitation Duration: 30min/d TENS,NMES, 5d/wk, 2wks in exp groups, 30min/d, 5d/wk, 2wks standard rehabilitation in all groups E1	E1 Vs C • Postural Assessment Scale for Stroke (+exp) • Functional Independence Measure (+exp) E2 Vs C • Postural Assessment Scale for Stroke (-) • Functional Independence Measure (-) E1 Vs E2 • Postural Assessment Scale for Stroke (-) • Functional Independence Measure (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Transcutaneous Electrical Stimulation

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **TENS** to improve motor function when compared to **conventional therapy** or **no treatment**.	2	Gurcan et al. 2015; Hussain et al. 2013
1b	**TENS with task-related training** may produce greater improvements in motor function than **sham stimulation** and **no stimulation**.	1	Chan et al. 2015
1b	**Bilateral TENS** may not have a difference in efficacy compared to **unilateral TENS** for improving motor function.	1	Kwong et al. 2018

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**TENS** may produce greater improvements in functional ambulation than **conventional therapy, sham stimulation,** and **no stimulation**.	6	Ertzgaard et al. 2018; Gurcan et al. 2015; Park et al. 2014; Hussain et al. 2013; Tyson et al. 2013; Ng & Hui-Chan 2009
1b	**TENS + task-related training** may produce greater improvements in functional ambulation than **sham stimulation + task-related training, TENS,** and **no active treatment**.	1	Ng & Hui-Chan 2007

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1a	**TENS** may produce greater improvements in functional mobility when compared to **sham stimulation** and **no stimulation**.	3	Yan & Hui-Chan 2009; Johansson et al. 2001; Levin & Hui-Chan 1992

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**TENS** may produce greater improvements in balance than **sham stimulation** and **no stimulation**.	5	Yen et al. 2019; Ertzgaard et al. 2018; Park et al. 2014; Cho et al. 2013; Tyson et al. 2013; Ng & Hui-Chan 2009
1b	**TENS + task-related training** may produce greater improvements in balance than **sham stimulation + task-related training** and **no active treatment**.	1	Chan et al. 2015
2	**TENS** may not have a difference in efficacy compared to **task-related training** for improving balance.	1	Laddha et al. 2016
1b	There is conflicting evidence about the effect of **bilateral TENS** to improve balance when compared to **unilateral TENS**.	1	Kwong et al. 2018
1b	**TENS** may not have a difference in efficacy compared to **NMES** for improving balance.	1	Yen et al. 2019

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**TENS** may produce greater improvements in gait than **sham stimulation**.	2	Park et al. 2014; Tyson et al. 2013
1b	**Bilateral TENS** may not have a difference in efficacy compared to **unilateral TENS** for improving gait.	1	Kwong et al. 2018

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **TENS** to improve activities of daily living when compared to **conventional therapy** or **no treatment**.	3	Yen et al. 2019; Gurcan et al. 2015; Johansson et al. 2001; Tekeoglu et al. 1999
1b	**TENS** may produce greater improvements in activities of daily living than **no stimulation**.	1	Tekeoglu et al. 1998
1b	**TENS** may not have a difference in efficacy compared to **NMES** for improving activities of daily living.	1	Yen et al. 2019

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1a	**TENS** may produce greater improvements range of motion than **sham stimulation** and **no stimulation**.	2	Hussain et al. 2013; Levin & Hui-Chan 1992

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **TENS** to improve in muscle strength when compared to **sham stimulation** and **no stimulation**.	4	Hussain et al. 2013; Tyson et al. 2013; Yan & Hui-Chan 2009; Levin & Hui-Chan 1992
1b	**TENS + task-related training** may produce greater improvements in muscle strength than **sham stimulation + task-related training** and **TENS alone**.	1	Ng & Hui-Chan 2007
1b	There is conflicting evidence about the effect of **bilateral TENS** to improve muscle strength when compared to **unilateral TENS**.	1	Kwong et al. 2018

SPASTICITY

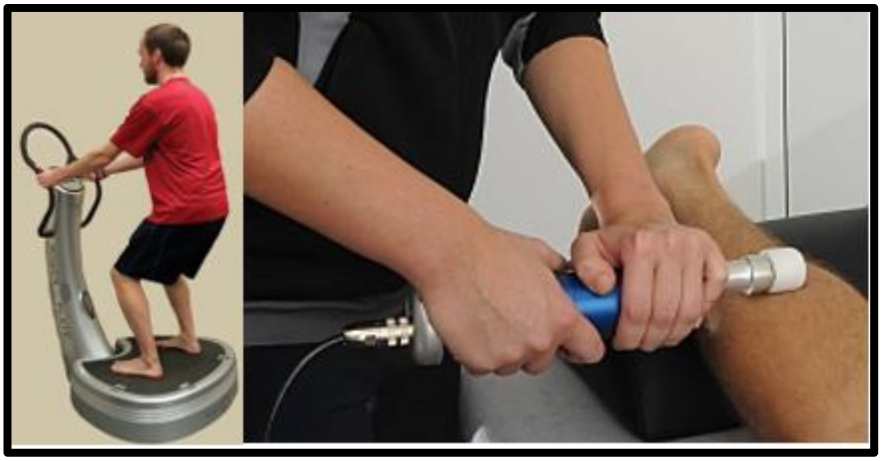
LoE	Conclusion Statement	RCTs	References
1a	**TENS** may produce greater improvements in spasticity than **sham stimulation** and **no stimulation**.	8	Ertzgaard et al. 2018; Gurcan et al. 2015; Park et al. 2014; Cho et al. 2013; Hussain et al. 2013; Yan & Hui-Chan 2009; Tekeoglu et al. 1998; Levin & Hui-Chan 1992
1b	**TENS + task-related training** may produce greater improvements in spasticity than **sham stimulation + task-related training, TENS,** and **no active treatment**.	1	Ng & Hui-Chan 2007
2	**TENS + task-related training** may produce greater improvements in spasticity than **task-related training alone**.	1	Laddha et al. 2016
1b	**TENS** may not have a difference in efficacy compared to **conventional therapy** for improving spasticity.	1	Gurcan et al. 2015

Key Points

TENS may be beneficial for improving functional mobility, functional ambulation, balance, gait and spasticity.

The literature is mixed concerning the effect of TENS on improving motor function, activities of daily living, and muscle strength.

Muscle Vibration



Adopted from: https://accessphysiotherapy.mhmedical.com/content.aspx?bookid=2223&sectionid=173789797; https://www.joint-surgeon.com/rehabilitation/matrix-therapy/matrix-therapy-and-biomechanical-stimulation.html

Whole body muscle vibration is administered through a vibrating platform which stimulates sensory receptors and can facilitate muscle contractions (Brogardh et al. 2012). The patient may stand or perform other movements while on the vibration platform. Whole body muscle vibration is being investigated as a therapeutic method of improving muscle function, muscle strength, and gait function following a stroke (Cochrane 2011; Lee 2015).

Muscle vibration produces an indirect vibration to the whole body which can limit the specificity and strength of the vibratory stimulus (Moran et al. 2007). As such, local muscle vibration has recently been examined as a more specific and direct method of applying a vibration stimulation to targeted muscles with the ability to stimulate either the agonist or antagonist muscles, as opposed to stimulating both as would occur during muscle vibration (Pamukoff et al. 2014; Tankisheva et al. 2014; Custer et al. 2017; Souron et al. 2017).

16 RCTs were found that evaluated muscle vibration for lower extremity motor rehabilitation. 11 RCTs compared whole body vibration to music stimulation, sham stimulation, or no stimulation (Silva et al. 2016; Guo et al. 2015; Lee et al. 2015; Silva et al. 2014; Tankisheva et al. 2014; Marin et al. 2013; Brogardh et al. 2012; Lau et al. 2012; Tihanyi et al. 2010; Tihanyi et al. 2007; Van Nes et al. 2006). Four RCTs compared local muscle vibration to sham stimulation (Unal et al. 2020; Toscano et al. 2019; Lee et al. 2013a; Panloni et al. 2010). One RCT compared low intensity and high intensity whole body vibration (Liao et al. 2016).

The methodological details and results of all 16 RCTs are presented in Table 31.

Table 31. RCTs Evaluating Muscle Vibration Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Whole Body Vibration vs Music Stimulation, Sham Stimulation, or no Stimulation		
Silva et al. (2016) RCT (6) N$_{start}$=35 N$_{end}$=28 TPS=Subacute	E: Whole-body vibration C: No stimulation Duration: 4-8min/d, 3d/wk for 8wk	• 6-Minute Walk Test (+exp) • Plantar impression (-)
Guo et al. (2015) RCT (6) N$_{start}$=30 N$_{end}$=30 TPS=Subacute	E: Whole-body vibration C: Sham stimulation Duration: 80min/d for 8wk	• 10-Metre Walk Test (+exp) • Knee hyperextension (+exp) • Fugl-Meyer Assessment (-)
Lee (2015) RCT (6) N$_{start}$=26 N$_{end}$=21 TPS=Chronic	E: Whole-body vibration C: No stimulation Duration: 15min/d, 3d/wk for 6wk	• Berg Balance Scale (+exp) • Timed Up-and-Go Test (-)

Silva et al. (2014)
RCT (5)
N$_{start}$=43
N$_{end}$=38
TPS=Chronic
	E: Whole Body Vibration Therapy (frequency of 50 Hz and amplitude of 2 mm)
	C: No Vibration Therapy (sham)
	Duration: 1 Session of Vibration Therapy (10min)
		• 6-Minute Walking Time (-)
		• Timed Up and Go Test (-)
		• Stair Climb Test (-)
		• Voluntary Isometric Contraction
		  • Affected Side Rectus Femoris (-)
		  • Affected Side Tibialis Anterior (-)

Tankisheva et al. (2014) RCT (6) N$_{start}$=15 N$_{end}$=13 TPS=Chronic	E: Whole-body vibration C: No stimulation Duration: 19min/d, 3d/wk for 6wk	• Isometric knee extension strength (+exp) • Postural control (-) • Modified Ashworth Scale (-)
Marin et al. (2013) RCT (6) N$_{start}$=20 N$_{end}$=20 TPS=Chronic	E: Whole-body vibration C: Sham stimulation Duration: 2-7min/session for 17sessions	• Berg Balance Scale (-) • Lower limb muscle architecture (-) • Isometric knee extension (-)
Brogårdh et al. (2012) RCT (9) N$_{start}$=31 N$_{end}$=31 TPS=Chronic	E: Whole Body Vibration (3.75mm amplitude) C: Sham Vibration (0.2mm Amplitude) Duration: 1 session/day, 2 sessions/wk, 6wks (12 repetitions of 40-60s WBV per session)	• Ashworth Scale (-) • Berg Balance Scale (-) • Muscle Strength -Knee Extension and Flexion (-) • Timed UP-and-Go (-) • 10-meters comfortable Gait Speed (-) • 10-meters Fast Gait speed (-) • Six-minute walk test (-) • Stroke Impact Scale (-)
Lau et al. (2012) RCT (8) N$_{start}$=82 N$_{end}$=76 TPS=Chronic	E: Whole-body vibration C: No stimulation Duration: 9-15min/d, 3d/wk for 8wk	• 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Berg Balance Scale (-) • Activities-Specific Balance Confidence Scale (-) • Chedoke-McMaster Stroke Assessment (-) • Dynamic postural control (-) • Isometric muscle strength (-)
Tihanyi et al. (2010) RCT (4) N$_{start}$=20 N$_{end}$=20 TPS=Acute	E: Whole Body Vibration C: Conventional Care Duration: 3x/wk, 4wks	• Maximum Isometric Contraction (-) • Maximum Eccentric Contraction (-)

Tihanyi et al. (2007) RCT (5) N_{start}=16 N_{end}=16 TPS=Acute	E: Whole-body vibration C: No stimulation Duration: 6min session	• Voluntary force (+exp) • Muscle activation (+exp)
Van Nes et al. (2006) RCT (9) N_{start}=53 N_{end}=51 TPS=Subacute	E: Whole-body vibration C: Music stimulation Duration: 3min/d, 5d/wk for 6wk	• Berg Balance Scale (-) • Trunk Control Test (-) • Rivermead Mobility Index (-) • Functional Ambulation Category (-) • Barthel Index (-)
Local Muscle Vibration vs Sham Stimulation		
Unal et al. (2020) RCT (6) N_{start}=32 N_{end}=30 TPS=Chronic	E: Matrix Rhythm Therapy with Bobath Techniques C: Bobath Techniques Alone Duration: 60min, 3x/wk, 4wks	• Modified Ashworth Scale (+exp) • Range of Motion (+exp) • Single Leg Stance Test (+exp) • Timed Up and Go Test (+exp) • Cadence (+exp) • Velocity (+exp) • Stride Length (-) • Step Length (-) • Stance Phase (-) • Swing Phase (-) • Double Support Phase (+exp) • Single support Phase (-) • Gait Symmetry (-)

Toscano et al. (2019)
RCT (8)
N_{start}=22
N_{end}=22
TPS=Acute
	E: Repetitive Focal Muscle Vibration
	C: Sham Muscle Vibration Duration: 30min/d, 3d/wk 1 wk + 60min/d, 3d/wk, 1wk physiotherapy
		• National Index Health Status Score (+exp)
		• Fugl-Meyer (+exp)
		  • Arm (+exp)
		  • Leg (+exp)
		• Motricity Index (+exp)
		• Ashworth Scale (-)

Lee et al. (2013a) RCT (7) N_{start}=34 N_{end}=31 TPS=Chronic	E: Local vibration C: Sham stimulation Duration: 30min/d, 5d/wk for 6wk	• Gait speed (+exp) • Cadence (+exp) • Postural sway distance (+exp) • Postural sway velocity (+exp) • Single limb support time (+exp)
Paoloni et al. (2010) RCT (8) N_{start}=44 N_{end}=44 TPS=Chronic	E: Segmental Muscle Vibration C: Conventional Therapy Duration: 50min/d, 3d/wk, 4wks general therapy both groups + 30min 3xwk, 4wks SMV in experimental	• Gait Characteristics Overall (-) • Kinematic Characteristics During Stance Phase (-) • Kinematic Characteristics During Swing Phase (-)
Low-Intensity Whole-Body Vibration vs High-Intensity Whole Body Muscle Vibration or No Stimulation		
Liao et al. (2016) RCT (8) N_{start}=84 N_{end}=84 TPS=Chronic	E1: Low-intensity whole-body vibration E2: High-intensity whole-body vibration C: No stimulation Duration: 12-18min/d, 3d/wk for 10wk	• Timed Up-and-Go Test (-) • 6-Minute Walk Test (-) • Mini Balance Evaluation Systems Test (-) • Activities-Specific Balance Confidence Scale (-) • Modified Ashworth Scale (-) • Muscle strength (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Muscle Vibration

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Whole-body vibration** may not have a difference in efficacy compared to **sham stimulation** for improving motor function.	1	Guo et al. 2015
1b	**Local muscle vibration** may produce greater improvements in motor function than **sham stimulation.**	1	Toscano et al. 2019

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	**Whole-body vibration** may not have a difference in efficacy compared to **music stimulation or no stimulation** for improving functional ambulation.	6	Silva et al. 2016; Guo et al. 2015; Silva et al. 2014; Brogardh et al. 2012; Lau et al. 2012; Van Nes et al. 2006
1b	**Local muscle vibration** may produce greater improvements in functional ambulation than **sham stimulation.**	1	Lee et al. 2013a
1b	**High intensity whole-body vibration** may not have a difference in efficacy compared to **low intensity whole-body vibration** for improving functional ambulation.	1	Liao et al. 2016

FUNCTIONAL MOBILITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Whole-body vibration** may not have a difference in efficacy compared to **music stimulation or no stimulation** for improving functional mobility.	1	Van Nes et al. 2006

BALANCE			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	**Whole-body vibration** may not have a difference in efficacy compared to **music stimulation, sham stimulation, or no stimulation** for improving balance.	8	Liao et al. 2016; Lee et al. 2015; Silva et al. 2014; Tankisheva et al. 2014; Marin et al. 2013; Brogardh et al. 2012; Lau et al. 2012; Van Nes et al. 2006
1b	**Local muscle vibration** may produce greater improvements in balance than **sham stimulation.**	1	Unal et al. 2020
1b	**High intensity whole-body vibration** may not have a difference in efficacy compared to **low intensity whole-body vibration** for improving balance.	1	Liao et al. 2016

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **local muscle vibration** to improve gait when compared to **sham stimulation**.	2	Unal et al. 2020; Lee et al. 2013a
1b	There is conflicting evidence about the effect of **whole-body vibration** to improve gait when compared to **sham stimulation or no stimulation**.	2	Silva et al. 2016; Guo et al. 2015

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Whole-body vibration** may not have a difference in efficacy compared to **sham stimulation** for improving activities of daily living.	2	Brogardh et al. 2012; Van Nes et al. 2006

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Local muscle vibration** may produce greater improvements in range of motion than **sham stimulation.**	1	Unal et al. 2020

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	**Whole-body vibration** may not have a difference in efficacy compared to **sham stimulation** for improving muscle strength.	5	Silva et al. 2014; Brogardh et al. 2012; Lau et al. 2012; Tihanyi et al. 2010; Tihanyi et al. 2007
1b	**Local muscle vibration** may produce greater improvements in muscle strength than **sham stimulation.**	1	Toscano et al. 2019
1b	**High intensity whole-body vibration** may not have a difference in efficacy compared to **low intensity whole-body vibration** for improving muscle strength.	1	Liao et al. 2016

SPASTICITY

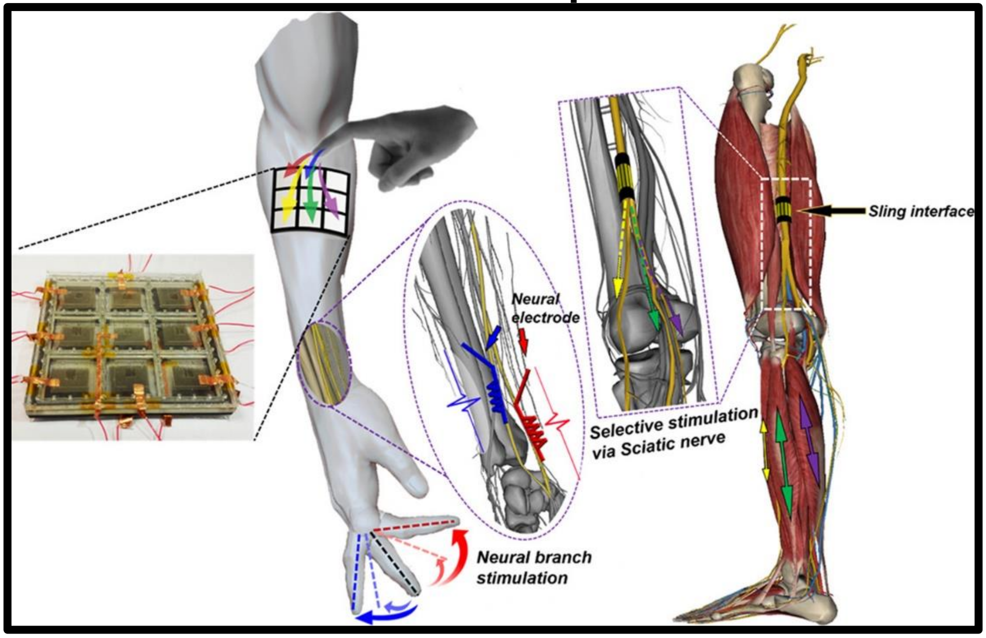
LoE	Conclusion Statement	RCTs	References
1a	**Whole-body vibration** may not have a difference in efficacy compared to **no stimulation** for improving spasticity.	2	Liao et al. 2016; Tankisheva et al. 2014
1a	There is conflicting evidence about the effect of **local muscle vibration** to improve spasticity when compared to **sham stimulation**.	2	Unal et al. 2020; Toscano et al. 2019
1b	**High intensity whole-body vibration** may not have a difference in efficacy compared to **low intensity whole-body vibration** for improving spasticity.	1	Liao et al. 2016

STROKE SEVERITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Local muscle vibration** may produce greater improvements in measures of stroke severity than **sham stimulation.**	1	Toscano et al. 2019

Key Points

Whole-body vibration may not be beneficial for improving balance, and functional ambulation, and muscle strength.

Additional Afferent and Peripheral Stimulation Methods



Adopted from: https://www.sciencedirect.com/science/article/abs/pii/S2211285518302337

Additional sensory stimulation methods evaluated for motor rehabilitation included short wave therapy, repetitive peripheral magnetic stimulation, intermittent pneumatic compression and other sensory stimulation techniques. Short-wave therapy is a non-invasive intervention in which electromagnetic radiation is applied to the region of the body typically at 27.12MHz in a continuous or pulse fashion (Wang et al. 2017). In repetitive peripheral magnetic stimulation coils are placed over paralysed muscles that generates a magnetic field that passes through the skin, and in turn can depolarize neurons to allow a muscle contraction (Momosaki et al. 2017). Repetitive peripheral magnetic stimulation can stimulate painlessly deep muscle structures that are out of range of traditional electrical stimulation (Momosaki et al. 2017). Intermittent pneumatic compression is the application of inflatable splints where pressure is applied intermittently to increase sensory input (Cambier et al. 2003).

Six RCTs were found that evaluated additional afferent and peripheral stimulation for lower extremity rehabilitation. Two RCTs compared tactile sensory stimulation to conventional care or sham (Goliwas et al. 2015; Lynch et al. 2007). Two RCTs compared peroneal nerve stimulation to conventional care (Kottink et al. 2012; Sheffler et al. 2006). One RCT compared afferent electrical stimulation and mirror to sham mirror therapy and sham stimulation (Lee et al. 2018). One RCT compared photobiomodulation therapy to sham (Casalechi et al. 2020).

The methodological details and results of all six RCTs are presented in Table 32.

Table 32. RCTs Evaluating Afferent and Peripheral Stimulation Interventions for Upper Extremity Motor Rehabilitation

Authors (Year) **Study Design (PEDro Score)** **Sample Size$_{start}$** **Sample Size$_{end}$** **Time post stroke category**	**Interventions** **Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures** **Result (direction of effect)**
Tactile Sensory Stimulation vs Conventional Care or Sham		
Goliwas et al. (2015) RCT (6) N_{start}=27 N_{end}=20 TPS=Subacute	E: Sensorimotor Foot Stimulation Training C: Conventional Care Duration: 20min, 5x/wk, 5wks	• Weight Distribution (+exp)
Lynch et al. (2007) RCT (6) N_{start}=21 N_{end}=19 TPS=Subacute	E: Sensory Training Program C: Relaxation Control Duration: 30min, 5x/wk, 2wks	• Two-Point Discrimination (-) • Distal Proprioception Test (-) • Berg Balance Scale (-) • 10-Meter Walk Test (-)
Peroneal Nerve Stimulation		
Kottink et al. (2012) RCT (4) N_{start}=29 N_{end}=21 TPS=Chronic	E: Peroneal Nerve Stimulation (Implantable 2-Channel Peroneal Nerve Stimulator) C: Conventional Therapy (Conventional Walking Device) Duration: 5 sessions over 26 weeks	• Waking Speed (-) • Step Length (-) • Stance Phase (+exp) • First Double Support Phase (+exp) • First Single Support Phase (-)
Sheffler et al. (2006) RCT crossover (5) N_{start}=14 N_{end}=14 TPS=Chronic	E1: Odstock Dropped-foot Stimulator (peroneal nerve) E2: Ankle-foot Orthosis Duration: single session	• Modified Emory Functional Ambulation Profile (-)
Afferent Electrical Stimulation vs Mirror Therapy		

Lee et al. (2019)
RCT (7)
N_{start}=30
N_{end}=30
TPS=Chronic
	E: Afferent Electrical Stimulation during Mirror Therapy + Gait Training
	C: Sham Mirror Therapy and Sham Afferent Electrical Stimulation
	Duration: 30min, 5d/wk, 4wks Mirror Therapy + 30min, 5d/wk, 4wks Afferent Electrical Stimulation (60min/d, 5d/wk, 4wks) 20 sessions total
		• Muscle Strength (+exp)
		• Modified Ashworth Scale (-)
		• Berg Balance Scale (+exp)
		• Gait
		  • Velocity (+exp)
		  • Cadence (-)
		  • Step length (+exp)
		  • Stride Length (+exp)
		  • Single Support Time (-)
		  • Double Support Time (-)

Laser Photo-biomodulation vs Sham		
Casalechi et al. (2020) RCT crossover (10) N_{start}=10 N_{end}=10 TPS=Mixed	E1: Photobiomodulation Therapy (low-level laser therapy, light-emitting diode therapy, magnetic field therapy) - 50 Jules E2: Photobiomodulation Therapy - 30 Jules E3: Photobiomodulation Therapy 10 Jules C: 0 Jules (Sham) Duration: single session - 1-week washout	E1 vs C • 6-Minute Wak Test (-) • Timed up and Go Test (-) E2 vs C • 6-Minute Wak Test (+exp2) • Timed up and Go Test (+exp2) E3 vs C • 6-Minute Walk Test (-) • Timed up and Go Test (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group

+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Additional Afferent and Peripheral Stimulation

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Tactile stimulation** may not have a difference in efficacy compared to **no stimulation** for improving functional ambulation.	1	Lynch et al. 2007
2	**Peroneal nerve stimulation** may not have a difference in efficacy compared to **no stimulation** for improving functional ambulation.	2	Kottinik et al. 2012; Sheffler et al. 2006
1b	**Electrical stimulation with mirror therapy** may produce greater improvements in functional ambulation than **sham mirror and sham stimulation.**	1	Lee et al. 2019
1b	**Photobiomodulation therapy at 30 Jules** may produce greater improvements in functional ambulation than **at 50 Jules, 10 Jules or 0 Jules (sham).**	1	Casalechi et al. 2020

BALANCE			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	There is conflicting evidence about the effect of **tactile stimulation** to improve balance when compared to **no stimulation**.	1	Lynch et al. 2007
1b	**Electrical stimulation with mirror therapy** may produce greater improvements in balance than **sham mirror and sham stimulation.**	1	Lee et al. 2019
1b	**Photobiomodulation therapy at 30 Jules** may produce greater improvements in balance than **at 50 Jules, 10 Jules or 0 Jules (sham).**	1	Casalechi et al. 2020

GAIT			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	There is conflicting evidence about the effect of **peroneal nerve stimulation** to improve gait when compared to **no stimulation**.	1	Kottinik et al. 2012
1b	There is conflicting evidence about the effect of **electrical stimulation with mirror therapy** to improve gait when compared to **sham mirror and sham stimulation**.	1	Lee et al. 2019

MUSCLE STRENGTH			
LoE	Conclusion Statement	RCTs	References
1b	**Electrical stimulation with mirror therapy** may produce greater improvements in muscle strength than **sham mirror and sham stimulation.**	1	Lee et al. 2019

SPASTICITY			
LoE	Conclusion Statement	RCTs	References
1b	**Electrical stimulation with mirror therapy** may not have a difference in efficacy compared to **sham mirror and sham stimulation** for improving spasticity.	1	Lee et al. 2019

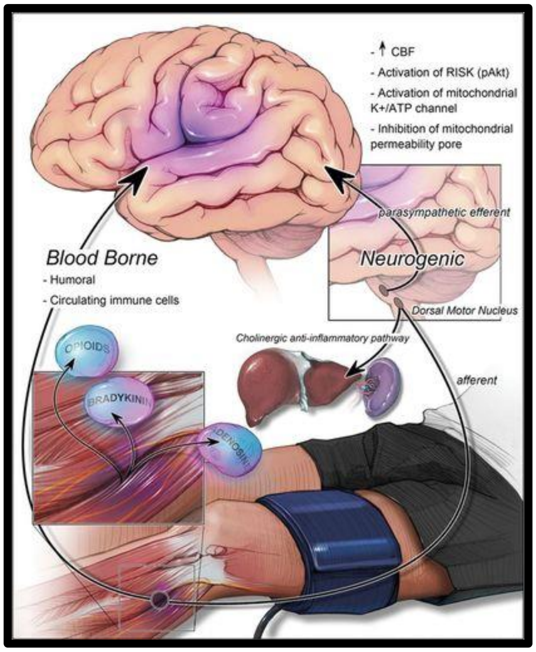
PROPRIOCEPTION			
LoE	Conclusion Statement	RCTs	References
1b	**Tactile stimulation** may not have a difference in efficacy compared to **no stimulation** for improving proprioception.	1	Lynch et al. 2007

Key Points

Electrical stimulation with mirror therapy may be beneficial for improving functional ambulation, balance and muscle strength

Tactile and peroneal nerve stimulation may not be beneficial for improving functional ambulation.

Remote Ischemic Conditioning



Adopted from: https://www.ahajournals.org/cms/asset/0b2be4cb-6f1a-4b56-a2ab-591da6bf2b5c/1191fig02.jpg

Remote ischemic conditioning (RIC) is a procedure that aims to trigger the body's natural responses against ischemic injury after a stroke and reduce the severity of the damage from the injury (Murray et al. 1997). RIC is accomplished by multiple temporary reductions of blood flow to an upper or lower extremity vascular bed by chemical, mechanical or electrical stimulus (Heusch et al. 2015). After the induced ischemic procedure, physiological and homeostatic process' will upregulate natural protective factors and it is believed that this may benefit the initial injury site. It is sometimes referred to as a synthetic form of aerobic exercises as the cardio-protective benefits from both interventions share some overlap. RIC remains a controversial intervention with some benefits being observed in animal studies but little to no clinical evidence in large human trials.

Three RCTs were found that remote ischemic conditioning for lower extremity motor rehabilitation. All three RCTs compared remote ischemic conditioning to sham or conventional therapy (Pico et al. 2020, Durand et al. 2019, Hyngstrom et al. 2018).

The methodological details and results of all three RCTs are presented in Table 33.

Table 33. RCTs Evaluating Remote Ischemic Conditioning Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) **Study Design (PEDro Score)** **Sample Size$_{start}$** **Sample Size$_{end}$** **Time post stroke category**	**Interventions** **Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures** **Result (direction of effect)**
Remote Ischemic Conditioning compared to Sham or Conventional Therapy		

Pico et al. (2020)
RCT (6)
N$_{start}$=188
N$_{end}$=147
TPS=Acute
	E: Remote Ischemic Preconditioning and Conventional Care
	C: Conventional Care
	Duration: (preconditioning 6hrs after symptom onset), 90d follow up
		• 24hrs post-stroke
		  • Infarct Volume (-)
		  • National Institutes of Health Stroke Scale (-)
		• 90 day follow up
		  • Barthel Index (-)
		  • Modified Rankin Score (-)

Durand et al. (2019) RCT (5) N$_{start}$=22 N$_{end}$=20 TPS=Chronic	E: Ischemic Conditioning Training (225 mmHg) C: Sham Duration: 30min, 7x over 2wks	• 10-Meter Walk Test (+exp)
Hyngstrom et al. (2018) RCT (7) N$_{start}$=10 N$_{end}$=10 TPS=Chronic	E: Ischemic Conditioning (5x, 5min compression) C: Sham ischemic conditioning (5x, 5min sham) Duration: 1d, 5x 5min compression or sham with 5min rest in-between (50min total)	• Maximum voluntary contraction in knee extensor (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Remote Ischemic Conditioning Interventions

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**Remote ischemic conditioning** may produce greater improvements in functional ambulation than **sham stimulation** or **conventional care**.	1	Durand et al. 2019

ACTIVITIES OF DAILY LIVING			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Remote ischemic conditioning** may not have a difference in efficacy when compared to **sham stimulation** or **conventional care** for improving activities of daily living.	1	Pico et al. 2020

MUSCLE STRENGTH			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	There is conflicting evidence about the effect of **remote ischemic conditioning** to improve muscle strength when compared to **sham stimulation** or **conventional care**.	2	Durand et al. 2019 ; Hyngstrom et al. 2018

STROKE SEVERITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Remote ischemic conditioning** may not have a difference in efficacy when compared to **sham stimulation** or **conventional care** for improving stroke severity.	1	Pico et al. 2020

Key Points

The literature is mixed concerning the effects of remote ischemic conditioning on improving muscle strength

Thermal Stimulation

Adopted from: https://premierhealthmn.com/services/benefits-of-ice-heat-therapy/

Thermal stimulation is a neurologic rehabilitation strategy used to facilitate sensorimotor function by applying thermal stimulation in a noxious or innocuous form on sensory receptors in the body (Lin et al. 2017). Thermal gradations can be distinguished by three types of receptors: cold, warmth, and pain receptors (Tai et al. 2014). Thermal stimulation stimulates innocuous or noxious receptors, which send the signals to several areas in the somatosensory cortex. Imaging studies show that innocuous and noxious stimulation may activate different regions of the brain: whereas innocuous stimulation seems to activate the primary and secondary somatosensory cortex, thalamus, and insula, noxious stimulation induces larger sensory and motor-cortical activations in the brain (Tai et al. 2014). Innocuous thermal stimulation has also been found to induce greater corticomotor excitability, and as such has been suggested to influence cortical reorganization and neuroplasticity (Lin et al. 2017).

Five RCTs were found evaluating thermal stimulation interventions for lower extremity motor rehabilitation. Four RCTs compared thermal stimulation to sham or stimulation (Matsumoto et al. 2014; Hsu et al. 2013; Liang et al. 2012; Chen et al. 2011). A single RCT compared cyrotherapy stimulation to sham stimulation (Alcantara et al. 2019).

The methodological details and results of all five RCTs are presented in Table 34.

Table 34. RCTs Evaluating Thermal Stimulation Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample $Size_{start}$ Sample $Size_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Thermal Stimulation vs Sham or No Stimulation		
Matsumoto et al. (2014) RCT (8) N_{start}=22 N_{end}=22 TPS=Subacute	E: Thermal stimulation C: No stimulation Duration: 15min session	• Modified Ashworth Scale (+exp)
Hsu et al. (2013) RCT (7) N_{start}=34 N_{end}=23 TPS=Chronic	E: Thermal stimulation C: Sham thermal stimulation Duration: 30min/d, 3d/wk for 8wk	• Stroke Rehabilitation Assessment of Movement (+exp) • Modified Ashworth Scale (+exp) • Barthel Index (+exp) • Postural Assessment Scale for Stroke (-)
Liang et al. (2012) RCT (7) N_{start}=30 N_{end}=26 TPS=Acute	E: Thermal stimulation C: No stimulation Duration: 5d/wk for 6wk	• Fugl-Meyer Assessment (+exp) • Functional Ambulation Classification (+exp) • Modified Motor Assessment Scale (-) • Medical Research Council Scale (-) • Berg Balance Scale (-) • Barthel Index (-)
Chen et al. (2011) RCT (7) N_{start}=35 N_{end}=33 TPS=Acute	E: Thermal stimulation C: No stimulation Duration: 30-40min/d, 5d/wk for 6wk	• Fugl-Meyer Assessment (+exp) • Modified Motor Assessment Scale (+exp) • Functional Ambulation Classification (+exp) • Medical Research Council Scale - Lower (+exp) • Berg Balance Scale (-) • Modified Ashworth Scale (-)
Cryotherapy vs Sham		
Alcantara et al (2019) RCT crossover (8) N_{start}=16 N_{end}=16 TPS=Chronic	E: Cryotherapy (ice pack) C: Sham Duration: 20min, 2d - 2wk washout	• Modified Ashworth Scale (+exp) • Strength (-) • Gait Kinematics (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp₂ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Thermal Stimulation Intervention

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	**Thermal stimulation** may produce greater improvements in motor function than **sham stimulation** and **no stimulation**.	2	Liang et al. 2012; Chen et al. 2011

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Thermal stimulation** may produce greater improvements in functional ambulation than **sham stimulation** and **no stimulation**.	2	Liang et al. 2012; Chen et al. 2011

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Thermal stimulation** may produce greater improvements in functional mobility than **no stimulation**	1	Hsu et al. 2013

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Thermal stimulation** may not have a difference in efficacy compared to **sham stimulation** or **no stimulation** for improving balance.	3	Hsu et al. 2013; Liang et al. 2012; Chen et al. 2011

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Cryotherapy stimulation** may not have a difference in efficacy compared to **sham stimulation** for improving gait.	1	Alcantara et al. 2019

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Thermal stimulation** may produce greater improvements in activities of daily living than **no, or sham stimulation**.	3	Hsu et al. 2013; Liang et al. 2012; Chen et al. 2011

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **thermal stimulation** to improve muscle strength when compared to **no stimulation**.	2	Liang et al. 2012; Chen et al. 2011
1b	**Cryotherapy stimulation** may not have a difference in efficacy compared to **sham stimulation** for improving muscle strength.	1	Alcantara et al. 2019

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **thermal stimulation** to improve spasticity when compared to **no stimulation**.	2	Matsumoto et al. 2014; Hsu et al. 2013; Chen et al. 2012
1b	**Cryotherapy stimulation** may produce greater improvements in spasticity than **sham stimulation**	1	Alcantara et al. 2019

Key Points

Thermal stimulation may be beneficial for improving motor function, functional ambulation, and activities of daily living.

The literature is mixed concerning the effect of thermal stimulation on improving muscle strength and spasticity.

Thermal stimulation may not be beneficial for improving balance.

Extracorporeal Shockwave Therapy

Adopted from: https://www.sportsmedbiologic.com.au/shockwave-therapy.html

Extracorporeal shockwave therapy involves the delivery of high-intensity ultrasound waves to affected soft tissue regions of the body. When it comes to stroke treatment, this therapy is used to alleviate spasticity in stroke patients (Taheri et al. 2017)

Five RCTs were found evaluating extracorporeal shockwave therapy for lower extremity rehabilitation. Three RCTs compared extracorporeal shockwave therapy to sham or conventional therapy (Lee et al. 2019; Taheri et al. 2017; Ansari et al. 2007). One RCT compared focused and radial shockwave therapy (Wu et al. 2018). One RCT compared different locations of shockwave therapy (Yoon et al. 2017).

The methodological details and results of the five RCTs evaluating extracorporeal shockwave therapy for lower extremity motor rehabilitation are presented in Table 35.

Table 35. RCTs Evaluating Extracorporeal Shockwave Therapy Intervention for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	**Interventions Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures Result (direction of effect)**
Extracorporeal Shockwave Therapy vs Sham or Conventional Therapy		
Lee et al. (2019) RCT (8) N_{start}=20 N_{end}=18 TPS=Chronic	E: Extracorporeal Shockwave Therapy C: Sham Duration: Single Session	• Modified Ashworth Scale (+exp) • Passive Range of Motion (-)
Taheri et al. (2017) RCT (5) N_{start}=28 N_{end}=25 TPS=Chronic	E: Extracorporeal Shock Wave Therapy C: Conventional Therapy including stretching Duration: 1d/wk for 3wk	• Modified Ashworth Scale (+exp) • Range of Motion (+exp) • 3-Meter Walk Duration (+exp) • Lower Extremity Functional Score (+exp)
Ansari et al. (2007) RCT (5) N_{start}=12 N_{end}=12 TPS=Chronic	E: Therapeutic ultrasound C: Sham therapeutic ultrasound Duration: 30min/d, 5d/wk for 4wk	• Ashworth Scale (-)
Focused vs Radial Shockwave Therapy		
Wu et al. (2018) RCT (7) N_{start}=32 N_{end}=31 TPS=Chronic	E: Focused Shockwave Therapy C: Radial Shockwave Therapy Duration: 1 session per day, 1d/wk, 3wks.	• Modified Ashworth Scale (-) • Ankle Passive Range of Motion (+con) • Tardieu Scale (-) • Ten Meter Walk Test (-)
Location of Extracorporeal Shockwave Therapy		
Yoon et al. (2017) RCT (5) N_{start}=54 N_{end}=44 TPS=Chronic	E1: Extracorporeal Shock-wave Therapy on Muscle Belly (0.068 0.093 mJ/mm², 1,500 shots) E2: Extracorporeal Shock-wave Therapy on Myotendinous Junction (0.068 0.093 mJ/mm², 1,500 shots) C: Sham Extracorporeal Shock-wave Therapy Duration: 1 session/d, 1d/wk, 3weeks (3 sessions total)	E1 Vs C • Modified Ashworth (+exp1) • Modified Tardieu Scale (+exp1) E2 Vs C • Modified Ashworth (+exp2) • Modified Tardieu Scale (+exp2) E1 Vs E2 • Modified Ashworth (-) • Modified Tardieu Scale (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Extracorporeal Shockwave Therapy

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**Extracorporeal shockwave therapy** may produce greater improvements in motor function than **conventional therapy**.	1	Taheri et al. 2017

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
2	**Extracorporeal shockwave therapy** may produce greater improvements in functional ambulation than **conventional therapy**.	1	Taheri et al. 2017
1b	**Focused extracorporeal shockwave therapy** may not have a difference in efficacy compared to **radial extracorporeal shockwave therapy** for improving functional ambulation.	1	Wu et al. 2018

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
2	**Extracorporeal shockwave therapy** may produce greater improvements in activities of daily living than **conventional therapy**.	1	Taheri et al. 2017

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **extracorporeal shockwave therapy** to improve range of motion when compared to **conventional therapy.**	2	Lee et al. 2019; Taheri et al. 2017
1b	**Focused extracorporeal shockwave therapy** may not have a difference in efficacy compared to **radial extracorporeal shockwave therapy** for improving range of motion.	1	Wu et al. 2018

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Extracorporeal shockwave therapy** may produce greater improvements in spasticity than **conventional therapy**.	3	Lee et al. 2019; Taheri et al. 2017; Ansari et al. 2007
1b	**Focused extracorporeal shockwave therapy** may not have a difference in efficacy compared to **radial extracorporeal shockwave therapy** for improving spasticity.	1	Wu et al. 2018
2	**Extracorporeal shockwave therapy on muscle belly** may not have a difference in efficacy compared to **extracorporeal shockwave therapy on myotendinous junction** for improving spasticity.	1	Yoon et al. 2017

Key Points

Extracorporeal shockwave therapy may be beneficial for improving spasticity.

The literature is mixed concerning the effect extracorporeal shockwave therapy on improving range of motion.

Repetitive Peripheral Magnetic Stimulation

Adopted from: https://www.youtube.com/watch?v=h7O5z-_eydw

Repetitive peripheral magnetic stimulation is a treatment that stimulates deep tissue through the usage of magnetic waves (Beaulieu et al. 2017). This can help patients regain function of their limbs which may have been compromised by a traumatic event such as an accident or a stroke (Beaulieu et al. 2015).

Two RCTs were found that evaluated repetitive peripheral magnetic stimulation for lower extremity motor rehabilitation. One of the RCTs compared repetitive peripheral magnetic stimulation to neuromuscular electrical stimulation, muscle tendon vibration and occupational therapy (Beaulieu et al. 2017). The other RCT compared repetitive peripheral magnetic stimulation to sham stimulation (Beaulieu et al. 2015).

The methodological details and results of the two RCTs evaluating stimulant interventions for lower extremity motor rehabilitation are presented in Table 36.

Table 36. RCTs Evaluating Repetitive Peripheral Magnetic Stimulation for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	**Interventions Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures Result (direction of effect)**
Repetitive Peripheral Magnetic Stimulation vs Sham		
Beaulieu et al. (2017) RCT Crossover (6) N$_{start}$=15 N$_{end}$=15 TPS=Chronic	E1: Neuromuscular Electrical Stimulation E2: Repetitive Peripheral Magnetic Stimulation E3: Muscle Tendon Vibration C: Occupational Therapy Duration: 2.5-3h/d, 1d/wk x 4wk	E1/E2/E3 vs C • Ankle active motor threshold (exp2) • Intracortical inhibition (exp 2) • Isometric Eversion Strength (exp2, exp3) • Range of Motion (-) • Stretch reflex of plantar flexors (-)
Beaulieu et al. (2015) RCT (7) N$_{start}$=32 N$_{end}$=32 TPS=Chronic	E: Repetitive peripheral magnetic stimulation C: Sham stimulation Duration: not specified	• Plantarflexor resistance to stretch (+exp) • Dorsiflexor range of motion (+exp) • Maximal isometric strength (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Repetitive Peripheral Magnetic Stimulation

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Repetitive peripheral magnetic stimulation** may produce greater improvements in muscle strength than **sham stimulation**	2	Beaulieu et al. 2017 Beaulieu et al. 2015

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Repetitive peripheral magnetic stimulation** may produce greater improvements in range of motion than in **sham stimulation**	1	Beaulieu et al. 2015
1b	**Repetitive peripheral magnetic stimulation** may not have a difference in efficacy compared to **neuromuscular electric stimulation, muscle tendon vibration** and **occupational therapy** for improving range of motion.	2	Beaulieu et al. 2017 Beaulieu et al. 2015

Key Points

Repetitive peripheral magnetic stimulation may be beneficial for improving muscle strength.

Non-invasive brain stimulation

Repetitive Transcranial Magnetic Stimulation (rTMS)

Adopted from: https://www.rtmscentre.co.uk/rtms-treatment-in-the-uk/

Transcranial magnetic stimulation is a painless and non-invasive method of affecting neural activity through the exogenous generation of an electromagnetic field through a coil placed on the scalp, that consequently induces a change in the electrical fields of the brain (Peterchev et al. 2012). The voltage and current of the electromagnetic field generated are dependent on the parameters of the stimulation device, which is not distorted by the biological tissues in which it is applied in (Peterchev et al. 2012). The neuromodulatory effects of transcranial magnetic stimulation are attributed largely to neural membrane polarization shifts that can lead to changes in neuron activity, synaptic transmission, and activation of neural networks (Peterchev et al. 2012). Repetitive transcranial magnetic stimulation (rTMS) is the application of repetitive trains of transcranial magnetic stimulation at regular intervals.

After a stroke, interhemispheric competition is altered; with cortical excitability increasing in the unaffected hemisphere increasing and decreasing in the affected hemisphere (Zhang et al. 2017). rTMS can be used to help modulate this interhemispheric competition, with low stimulation frequencies (≤1Hz) decreasing cortical excitability and inhibiting activity of the contralesional hemisphere, while high frequency (>1Hz) stimulation increases excitability and have a facilitatory effect on activity of the ipsilesional hemisphere (Dionisio et al. 2018).

19 RCTs were found evaluating rTMS for lower extremity motor rehabilitation. Seven RCTs compared low frequency rTMS to sham stimulation (Huang et al. 2018; Cha et al. 2017; Meng & Song, 2017; Du et al. 2016; Rastgoo et al. 2016; Lin et al. 2015; Wang et al. 2012). Seven RCTs compared high frequency rTMS to sham stimulation (Guan et al. 2017; Sasaki et al. 2017; Du et al. 2016; Choi et al. 2016; Chieffo et al. 2014; Kakuda et al. 2013; Khedr et al. 2005). Two RCTs compared high frequency rTMS to low frequency rTMS (Du et al. 2016; Cha et al. 2014). One RCT compared low frequency rTMS to anodal tDCS (Jayaram & Stinear, 2009). Two RCTs compared high frequency rTMS with treadmill training to treadmill training alone (Lee et al. 2020; Wang et al. 2019). One RCT compared high frequency rTMS with cathodal tDCS to rTMS alone (Cho et al. 2017). One RCT compared ankle strengthening exercises with high frequency rTMS (Cha et al. 2017a).

The methodological details and results of all 19 RCTs evaluating rTMS for lower extremity motor rehabilitation are presented in Table 37.

Table 37. RCTs Evaluating Low and High Frequency rTMS Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) **Study Design (PEDro Score)** **Sample Size$_{start}$** **Sample Size$_{end}$** **Time post stroke category**	**Interventions** **Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures** **Result (direction of effect)**
Low frequency (1Hz) rTMS vs Sham Stimulation		
Huang et al. (2018) RCT (9) N_{Start}=38 N_{End}=38 TPS=Acute	E: Low frequency (1Hz) Repetitive Transcranial Magnetic Stimulation (rTMS) C: Sham rTMS Duration: 15min/d for 15d	• Timed Up and Go Test (-) • Postural Assessment Scale for Stroke (-) • Barthel Index (-) • Fugl-Meyer Assessment (-)
Cha et al. (2017) RCT (8) N_{Start}=62 N_{End}=30 TPS=Subacute	E: Low frequency (1Hz) Repetitive Transcranial Magnetic Stimulation (rTMS) C: Sham rTMS Duration: 15min/d, 5d/wk for 4wk	• Postural Sway (+exp) • Wisconsin Gait Scale (+exp) • 6-Minute Walk Test (+exp) • Timed Up and Go Test (+exp)
Meng & Song (2017) RCT (9) N_{Start}=20 N_{End}=20 TPS=Not reported	E: Low frequency (1Hz) Repetitive Transcranial Magnetic Stimulation (rTMS) C: Sham rTMS Duration: 30min/d for 14d	• National Institute of Health Stroke Scale (+exp) • Barthel Index (+exp) • Fugl-Meyer Assessment (+exp)
Du et al. (2016) RCT (7) N_{Start}=69 N_{End}=55 TPS=Acute	E1: Ipsilesional rTMS (3Hz) E2: Contralesional rTMS (1Hz) C: Sham rTMS Duration: 5d	E1/E2 vs C • Fugl-Meyer Assessment (+exp, +exp2) • Medical Record Council (+exp, +exp2) • Barthel Index (+exp, +exp2) • Modified Rankin Scale (+exp, +exp2) • NIH Stroke Scale (+exp, +exp2)
Rastgoo et al. (2016) RCT (5) N_{Start}=20 N_{End}=14 TPS=Chronic	E: Low frequency (1Hz) rTMS C: Sham rTMS Duration: 20min/d for 5d	• Fugl-Meyer Assessment (-) • Timed Up and Go Test (-) • Modified Ashworth Scale (-)
Lin et al. (2015) RCT (9) N_{Start}=32 N_{End}=31 TPS=Subacute	E: Low frequency (1Hz) rTMS C: Sham rTMS Duration: 15min/d for 15d	• Postural Assessment Scale for Stroke (+exp) • Performance-Oriented Mobility Assessment (+exp) • Timed Up and Go Test (+exp) • Barthel Index (+exp) • Fugl-Meyer Assessment (-)
Wang et al. (2012) RCT (8) N_{Start}=24 N_{End}=24 TPS=Chronic	E: Low frequency (1Hz) rTMS C: Sham rTMS Duration: 30min/d for 5d/wk for 2wk	• Fugl-Meyer Assessment (+exp) • Gait speed (+exp) • Cadence (+exp) • Bilateral step length (+exp) • Single-leg support time (+exp) • Double-leg support time (+exp) • Spatial asymmetry ratio (+exp)
High Frequency (>1Hz) rTMS vs Sham Stimulation		
Guan et al. (2017) RCT (10) N_{Start}=42 N_{End}=27 TPS=Acute	E: High frequency (5Hz) Repetitive Transcranial Magnetic Stimulation (rTMS) C: Sham rTMS Duration: 10 consecutive days	• National Institutes of Health Stroke Scale (+exp) • Barthel Index (+exp) • Modified Rankin Score (-) • Fugl-Meyer Assessment (-)
Sasaki et al. (2017) RCT (9) N_{Start}=21 N_{End}=21	E: High-frequency (10Hz) Repetitive Transcranial Magnetic Stimulation (rTMS) C: Sham rTMS	• Brunnstrom Recovery Stages (+exp) • Ability for Basic Movement Scale Revised (+exp)

TPS=Acute	Duration: 2session/d for 5d	
Du et al. (2016) RCT (7) N_{Start}=69 N_{End}=55 TPS=Acute	E1: Ipsilesional rTMS (3Hz) E2: Contralesional rTMS (1Hz) C: Sham rTMS Duration: 5d	E1/E2 vs C • Fugl-Meyer Assessment (+exp, +exp2) • Medical Record Council (+exp, +exp2) • Barthel Index (+exp, +exp2) • Modified Rankin Scale (+exp, +exp2) • NIH Stroke Scale (+exp, +exp2)
Choi et al. (2016) RCT (7) N_{Start}=30 N_{End}=30 TPS=Chronic	E: High frequency (10Hz) rTMS C: Sham rTMS Duration: 10min/d, 5d/wk for 2wk	• Berg Balance Scale (+exp) • On-axis velocity (+exp)
Chieffo et al. (2014) RCT (10) N_{Start}=10 N_{End}=9 TPS=Chronic	E: High frequency (10Hz) rTMS C: Sham rTMS Duration: 30min/d, 3-5d/wk for 3wk	• Fugl-Meyer Assessment (+exp) • 6-Minute Walk Test (-) • 10-Metre Walk Test (-)
Kakuda et al. (2013) RCT (7) N_{Start}=18 N_{End}=18 TPS=Chronic	E: High frequency (10Hz) rTMS C: Sham rTMS Duration: 20min session	• Gait speed (+exp)
Khedr et al. (2005) RCT (8) N_{Start}=52 N_{End}=52 TPS=Acute	E: High frequency (3Hz) rTMS C: Sham rTMS Duration: 100s/d for 10d	• Barthel Index (+exp) • NIH Stroke Scale (+exp)
High vs Low Frequency rTMS		
Du et al. (2016) RCT (7) N_{Start}=69 N_{End}=55 TPS=Acute	E1: Ipsilesional rTMS (3Hz) E2: Contralesional rTMS (1Hz) C: Sham rTMS Duration: 5d	E1/E2 vs C • Fugl-Meyer Assessment (+exp1, +exp2) • Medical Record Council (+exp1, +exp2) • Barthel Index (+exp1, +exp2) • Modified Rankin Scale (+exp1, +exp2) • NIH Stroke Scale (+exp1, +exp2)
Cha et al. (2014) RCT (7) N_{Start}=24 N_{End}=24 TPS=Subacute	E: High-frequency (10Hz) rTMS C: Low-frequency (1Hz) rTMS Duration: 20min/d, 5d/wk for 4wk	• Balance Index (+exp) • Berg Balance Scale (+exp)
Low Frequency rTMS vs Anodal tDCS		
Jayaram & Stinear (2009) RCT (5) N_{Start}=9 N_{End}=9 TPS=Chronic	E1: Low frequency (1Hz) rTMS E2: Anodal tDCS E3: Paired associative stimulation Duration: 30min	• Motor Evoked Potentials (-)
High Frequency rTMS Combined with Treadmill Training		
Lee et al. (2020) RCT (9) N_{Start}=13 N_{End}=13 TPS=Chronic	E: High frequency rTMS + Treadmill Training C: Sham rTMS + Treadmill Training Duration: 15min/d, 5d,wk, 4wks rTMS or sham, 20min/d, 5d/wk, 4wks treadmill training	• 10-Meter Walk Test (+exp) • 6-Minute Walk Test (+exp) • Timed Up and Go Test (+exp)
Wang et al. (2019) RCT (6) N_{Start}=14 N_{End} =14 TPS=Chronic	E: High Frequency rTMS (5Hz) + Treadmill Training C: Sham rTMS + Treadmill Training Duration: 30min, 3x/wk, 3wks	• Walking Speed (+exp) • Spatial Asymmetry Ratio (+exp) • Temporal Asymmetry Ratio (-) • Fugl-Meyer Assessment (+exp)
Ankle Strengthening Exercises With rTMS		
Cha et al. (2017) RCT (9)	E1: Ankle Strengthening	E2 vs E1/C: • Plantarflexion muscle strength (+exp2)

N_{Start}=30 N_{End}=30 TPS=Subacute	E2: Ankle Strengthening with high frequency (10Hz) Repetitive Transcranial Magnetic Stimulation (rTMS) C: rTMS Duration: 10min/d, 5d/wk for 8wk	• Dorsiflexion muscle strength (+exp2) • 10-Minute Walk Test (+exp2)
High Frequency rTMS with Cathodal tDCS vs rTMS		
Cho et al. (2017) RCT (6) N_{Start}=30 N_{End}=30 TPS=Acute	E: Simultaneous rTMS (10Hz) + cathodal tDCS (2mA) C: rTMS (10Hz) Duration: 20min/d, 5x/wk for 2 wks (10 sessions total)	• Fugl-Meyer Assessment (+exp)

Abbreviations and table notes: ANCOVA=analysis of covariance; ANOVA=analysis of variance; C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Low and High Frequency rTMS

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **low frequency rTMS** to improve motor function when compared to **sham stimulation.**	6	Huang et al. 2018; Meng & Song, 2017; Du et al. 2016; Rastgoo et al. 2016; Lin et al. 2015; Wang et al. 2012
1a	There is conflicting evidence about the effect of **high frequency rTMS** to improve motor function when compared to **sham stimulation**.	3	Guan et al. 2017; Du et al. 2016; Chieffo et al. 2014
1b	**High frequency rTMS** may not have a difference in efficacy compared to **low frequency rTMS** for improving motor function**.**	1	Du et al. 2016
1b	**High frequency rTMS combined with treadmill training** may produce greater improvements in motor function than **sham stimulation combined with treadmill training**	1	Wang et al. 2019
1b	**High frequency rTMS combined with cathodal tDCS** may produce greater improvements in motor function than **high frequency rTMS alone**.	1	Cho et al. 2017

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Low frequency rTMS** may produce greater improvements in functional ambulation than **sham stimulation.**	2	Cha et al. 2017; Wang et al. 2012
1a	There is conflicting evidence about the effect of **high frequency rTMS** to improve functional ambulation when compared to **sham stimulation**.	2	Chieffo et al. 2014; Kakuda et al. 2013
1a	**High frequency rTMS combined with treadmill training** may produce greater improvements in	2	Lee et al. 2020; Wang et al. 2019

	functional ambulation than **sham stimulation combined with treadmill training**.		
1b	**High frequency rTMS combined with ankle strengthening** may produce greater improvements in functional ambulation than **ankle strengthening or high frequency rTMS alone.**	1	Cha et al. 2017b

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Low frequency rTMS** may produce greater improvements in functional mobility than **sham stimulation**.	1	Lin 2015

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **low frequency rTMS** to improve balance when compared to **sham stimulation**.	4	Huang et al. 2018; Cha et al. 2017; Rastgoo et al. 2016; Lin et al. 2015
1b	**High frequency rTMS** may produce greater improvements in balance than **sham stimulation.**	1	Choi et al. 2016
1b	**High frequency rTMS** may produce greater improvements in balance than **low frequency rTMS.**	1	Cha et al. 2014
1b	**High frequency rTMS combined with treadmill training** may produce greater improvements in balance than **sham stimulation combined with treadmill training.**	1	Lee et al. 2020

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**Low frequency rTMS** may produce greater improvements in gait than **sham stimulation.**	2	Cha et al. 2017; Wang et al. 2012
1b	**High frequency rTMS combined with treadmill training** may produce greater improvements in gait than **sham stimulation combined with treadmill training.**	1	Wang et al. 2019

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Low frequency rTMS** may produce greater improvements in performance of activities of daily living than **sham stimulation.**	4	Huang et al. 2018; Meng & Song 2017; Du et al 2016; Lin et al. 2015
1a	**High frequency rTMS** may produce greater improvements in performance of activities of daily living than **sham stimulation.**	4	Guan et al. 2017; Sasaki et al. 2017; Du et al. 2016; Khedr et al. 2005;

1a	There is conflicting evidence about the effect of **high frequency rTMS** to improve activities of daily living when compared to **low frequency rTMS.**	2	Du et al. 2016; Cha et al. 2014

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Low frequency rTMS** may produce greater improvements in muscle strength than **sham stimulation.**	1	Du et al. 2016
1b	**High frequency rTMS** may produce greater improvements in muscle strength than **sham stimulation.**	1	Du et al. 2016
1b	**High frequency rTMS** may not have a difference in efficacy compared to **low frequency rTMS** for improving muscle strength.	1	Du et al. 2016
1b	**High frequency rTMS combined with ankle strengthening** may produce greater improvements in muscle strength than **ankle strengthening or high frequency rTMS alone.**	1	Cha et al. 2017

SPASTICITY

LoE	Conclusion Statement	RCTs	References
2	**Low frequency rTMS** may not have a difference in efficacy compared to **sham stimulation** for improving spasticity.	1	Rastgoo et al. 2016

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1a	**Low frequency rTMS** may produce greater improvements in stroke severity than **sham stimulation.**	2	Meng & Song 2017; Du et al. 2016
1a	**High frequency rTMS** may produce greater improvements in stroke severity than **sham stimulation.**	4	Guan et al 2017; Sasaki et al 2017; Du et al 2016; Khedr et al 2005
1b	**High frequency rTMS** may not have a difference in efficacy compared to **low frequency rTMS** for improving stroke severity.	1	Du et al. 2016

Key Points

rTMS may be beneficial for improving functional ambulation, gait, activities of daily living, muscle strength, and stroke severity.

The literature is mixed concerning the effect of rTMS on improving motor function, and balance.

Theta Burst Stimulation (TBS)

Adopted from: https://www.psychiatryadvisor.com/home/depression-advisor/intermittent-theta-burst-stimulation-for-major-depressive-disorder-treatment/

Theta Burst Stimulation (TBS) is an emerging treatment modality that is a patterned form of rTMS where stimulation pulses are delivered in triplets or bursts at a high frequency (50Hz), and in a short interval (200ms), intending to mimic naturally occurring theta brain oscillations (Schwippel et al. 2019). TBS can also be used to adjust interhemispheric rivalry after a stroke and promote motor recovery through the delivery of continuous TBS (cTBS) to reduce cortical excitability in the contralesional hemisphere (600 pulses over 40 seconds); or intermittent TBS (iTBS) to increase cortical excitability in the ipsilesional hemisphere (600 pulses over 190 seconds) (Schwippel et al. 2019; Cotoi et al. 2019).

Two RCTs were found evaluating TBS for lower extremity motor rehabilitation. Both RCTs compared iTBS to sham stimulation (Liao et al. 2020; Lin et al. 2019).

The methodological details and results of the two RCTs evaluating TBS for lower extremity motor rehabilitation are presented in Table 38.

Table 38. RCTs Evaluating TBS Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size_{start} Sample Size_{end} Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
TBS vs Sham Stimulation		
Liao et al. (2020) RCT (9) N_{Start}=30 N_{End} =30 TPS=Subacute	E: Cerebellar iTBS C: Sham iTBS Duration: 50min/d, 5d/wk, 2wks	• Berg Balance Scale (+exp) • Trunk Impairment Scale (-) • Fugl-Meyer Assessment (-) • Barthel Index (-)
Lin et al. (2019) RCT (8) N_{Start}=20 N_{End} =20 TPS=Chronic	E: Intermittent Theta Burst Stimulation (5Hz) + Physiotherapy C: Sham + Physiotherapy Duration: 2x/wk 5wks (45min physiotherapy)	• Berg Balance Scale (-) • Timed Up and Go Test (-) • 10-Meter Walk Test (-) • Fugl-Meyer Assessment (-) • Barthel Index (-) • Overall Balance Index (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about TBS Interventions

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	**TBS** may not have a difference in efficacy compared to **sham stimulation** for improving motor function**.**	2	Liao et al. 2020; Lin et al. 2019

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**TBS** may not have a difference in efficacy compared to **sham stimulation** for improving functional ambulation**.**	1	Lin et al. 2019

BALANCE			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	There is conflicting evidence about the effect of **TBS** to improve balance when compared to **sham stimulation**.	2	Liao et al. 2020; Lin et al. 2019

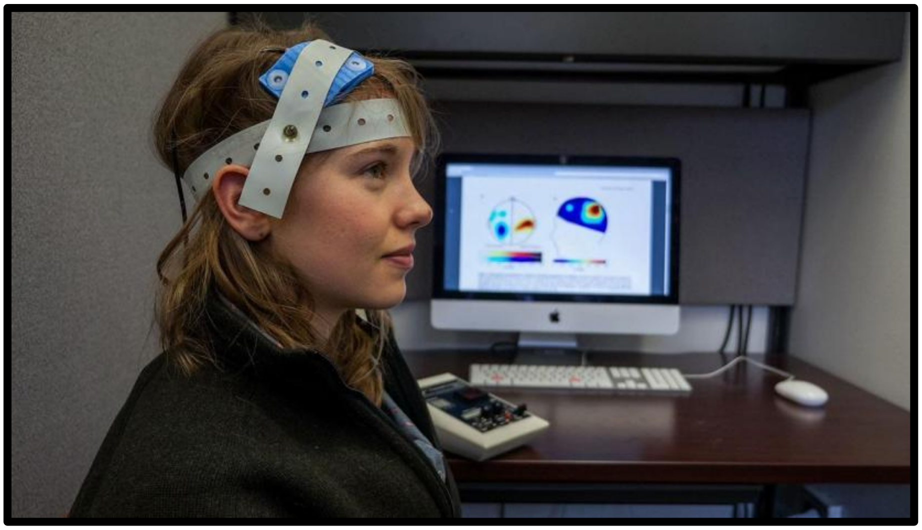
ACTIVITIES OF DAILY LIVING			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	**TBS** may not have a difference in efficacy compared to **sham stimulation** for improving activities of daily living**.**	2	Liao et al. 2020; Lin et al. 2019

Key Points

The literature is mixed concerning the effect of TBS on improving balance.

TBS may not be beneficial for improving motor function, functional ambulation, or activities of daily living.

Transcranial Direct Current Stimulation (tDCS)



Adopted from: https://tryniakaufman.com/2018/01/11/transcranial-direct-current-stimulation-the-drug-of-the-future/

Another form of non-invasive brain stimulation is transcranial direct-current stimulation (tDCS). This procedure involves the application of mild electrical currents (1-2 mA) conducted through two saline-soaked, surface electrodes applied to the scalp, overlaying the area of interest and the contralateral forehead above the orbit. Anodal stimulation is performed over the affected hemisphere and increases cortical excitability, while cathodal stimulation is performed over the unaffected hemisphere and decreases cortical excitability (Alonso-Alonso et al. 2007). Additionally, tDCS can be applied on both hemispheres concurrently, this is known as dual tDCS. In contrast to transcranial magnetic stimulation, tDCS does not induce action potentials, but instead modulates the resting membrane potential of the neurons (Alonso-Alonso et al. 2007).

A total of 19 RCTs were found evaluating tDCS interventions for lower extremity motor rehabilitation. Eight RCTs compared anodal tDCS to sham stimulation (Ojardias et al. 2020; Bornheim et al. 2019; Cattagni et al. 2019; Utarapichat et al. 2018; Andrade et al. 2017; Van Asseldonk & Boonstra, 2016; Chang et al. 2015; Tanaka et al. 2011). Four RCTs looked at dual tDCS (Klomjai et al. 2018; Andrade et al. 2017; Saeys et al. 2015; Tahtis et al. 2014). Four RCTs investigated tDCS with robot assisted gait training (Leon et al. 2017; Seo et al. 2017; Danzl et al. 2013; Geroin et al. 2011). One RCT investigated anodal tDCS with cathodal spinal direct current stimulation and robot assisted gait training (Picelli et al. 2015). One RCT compared tDCS with body weight supported treadmill training to body weight supported treadmill training alone (Manji et al. 2018), and one RCT compared tDCS with task-related training to sham stimulation and task-related training (Park et al. 2015). One RCT compared cathodal tDCS and rTMS to rTMS alone (Cho et al. 2017)

The methodological details and results of all 19 RCTs evaluating tDCS interventions for lower extremity motor rehabilitation are presented in Tables 39.

Table 39. RCTs Evaluating tDCS Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Anodal tDCS vs Sham Stimulation		
Ojardias et al. (2020) RCT crossover (8) N$_{Start}$=20 N$_{End}$=18 TPS=Chronic	E: Anodal tDCS (2 mA, 20 min) over M1-LL C: Sham tDCS Duration: 1 session 20min, 1wk washout between sessions	• 6-Minute Walk Test (+exp) • Balance Assessment (-) • Gait assessment (-) • Wade Test (-)
Bornheim et al. (2019) RCT (9) N$_{Start}$=50 N$_{End}$=46 TPS=Not Reported	E: Anodal tDCS + physical therapy C: Sham tDCS + physical therapy Duration: 20min/day, 5x/wk tDCS or sham for 4 wks + 120min/d, 5d/wk for 4 wks physical therapy	• Fugl-Meyer Assessment (+exp)
Cattagni et al. (2019) RCT crossover (8) N$_{Start}$=24 N$_{End}$=24 TPS=Chronic	E: Anodal tDCS 2mA C: Sham tDCS Duration: 30min 1x session sham or tDCS	• Gait Speed (-) • Step Length (-) • Swing Phase (-) • Stance Phase (-)
Utarapichat et al. (2018) RCT crossover (7) N$_{Start}$=10 N$_{End}$=10 TPS=Chronic	E: Anodal tDCS (2 mA, 10 minutes) C: Sham Stimulation (2 mA 30 seconds) Duration: 1x session 10min in exp, 30 seconds con group. 48 hr washout period.	• Timed Up and Go (-)
Andrade et al. (2017) RCT (10) N$_{Start}$=60 N$_{End}$=60 TPS=Subacute	E1: Anodal tDCS E2: Dual tDCS E3: Cathodal tDCS C: Sham tDCS Duration: 5d/wk for 2wk	E1/E2/E3 vs. C • Rate of falls (+exp, +exp2, +exp3) • Four Square Step Test (+exp, +exp2, +exp3) • Overall Stability Index (+exp, +exp2, +exp3) • Falls Efficacy Scale (+exp, +exp2, +exp3) • Berg Balance Scale (+exp, +exp2, +exp3) • 6-Minute Walk Test (+exp, +exp2, +exp3) • Sit-to-Stand Test (+exp, +exp2, +exp3) E2 vs E1/E3 • Rate of falls (-) • Four Square Step Test (-) • Overall Stability Index (-) • Falls Efficacy Scale (+exp2) • Berg Balance Scale (+exp2) • 6-Minute Walk Test (+exp2) • Sit-to-Stand Test (+exp2)
Van Asseldonk & Boonstra (2016) RCT crossover (7) N$_{Start}$=10 N$_{End}$ =10 TPS=Chronic	E1: Anodal tDCS E2: Dual tDCS C: Sham Stimulation Duration: 10min, single session, 1-week washout	• Gait Kinematics (-) • Step Length (-)
Chang et al. (2015) RCT (8) N$_{Start}$=24 N$_{End}$=24 TPS=Acute	E: Anodal tDCS + conventional therapy C: Sham tDCS + conventional therapy Duration: 10min/d, 5d/wk for 2wk	• Motricity Index (+exp) • Fugl-Meyer Assessment (+exp) • Functional Ambulation Category (-) • Balance Berg Scale (-) • Gait speed (-) • Cadence (-) • Stride length (-) • Step time/length (-)
Tanaka et al. (2011)	E: Anodal tDCS (single session)	• Maximal knee extension force (+exp)

RCT Crossover (6) N_{Start}=8 N_{End}=8 TPS=Chronic	C: Sham tDCS (single session) Duration: 2 sessions	
Dual tDCS vs Sham Stimulation		
Klomjai et al. (2018) RCT Crossover (9) N_{Start}=19 N_{End}=19 TPS=Subacute	E: Dual Transcranial Direct Current Stimulation (tDCS) C: Sham tDCS Duration: 20min/d, 2d/wk for 1wk	• Timed Up and Go Test (-) • Five Times Sit to Stand Test (+exp) • Maximum Voluntary Contraction of knee extensor (-)
Andrade et al. (2017) RCT (10) N_{Start}=60 N_{End}=60 TPS=Subacute	E1: Anodal tDCS E2: Dual tDCS E3: Cathodal tDCS C: Sham tDCS Duration: 5d/wk for 2wk	E1/E2/E3 vs. C • Rate of falls (+exp, +exp2, +exp3) • Four Square Step Test (+exp, +exp2, +exp3) • Overall Stability Index (+exp, +exp2, +exp3) • Falls Efficacy Scale (+exp, +exp2, +exp3) • Berg Balance Scale (+exp, +exp2, +exp3) • 6-Minute Walk Test (+exp, +exp2, +exp3) • Sit-to-Stand Test (+exp, +exp2, +exp3) E2 vs E1/E3 • Rate of falls (-) • Four Square Step Test (-) • Overall Stability Index (-) • Falls Efficacy Scale (+exp2) • Berg Balance Scale (+exp2) • 6-Minute Walk Test (+exp2) • Sit-to-Stand Test (+exp2)
Saeys et al. (2015) RCT (8) N_{Start}=31 N_{End}=31 TPS=Subacute	E: Dual tDCS + Rehabilitation C: Sham tDCS + Rehabilitation Duration: 20min/d, 4d/wk for 4wk	• Tinetti Balance Scale (-) • Tinetti Gait Scale (-) • Rivermead Motor Assessment (-) • Trunk Impairment Scale (-)
Tahtis et al. (2014) RCT (7) N_{Start}=14 N_{End} =14 TPS=Acute	E: Bi-cephalic tDCS C: Sham tDCS Duration: 1 session	• Timed Up and Go (+exp) • Performance Oriented Mobility Assessment (-)
tDCS with Robot-assisted Gait Training		
Leon et al. (2017) RCT (6) N_{Start}=50 N_{End}=49 TPS=Subacute	E1: Robot-assisted gait training and anodal tDCS over the leg motor cortex area E2: Robot-assisted gait training and anodal tDCS over the hand motor cortex area C: Robot-assisted gait training only Duration: 5h/d, 5d/wk for 4wk	• Functional Ambulation Category (-) • 10-Metre Walk Test (-)
Seo et al. (2017) RCT (8) N_{Start}=21 N_{End}=17 TPS=Chronic	E: Robot-assisted gait training and anodal tDCS C: Robot-aided gait training and sham tDCS Duration: 20min/d of tDCS and 45min/d of gait training for 10d	• Functional Ambulation Category Score (+exp) • 10-Meter Walk Test (-) • 6-Minute Walk Test (+exp) • Berg Balance Scale (-) • Fugl-Meyer Assessment (-) • Medical Research Council Scale (-)
Danzl et al. (2013) RCT (6) N_{Start}=10 N_{End}=8 TPS=Chronic	E: Anodal tDCS + Robot-assisted gait training C: Sham tDCS + Robot-assisted gait training Duration: 20min/d, 3d/wk for 4wk	• Functional Ambulation Category (+exp) • Berg Balance Scale (-) • Timed Up and Go Test (-) • 10-Metre Walk Test (-) • Stroke Impact Scale (-)

Geroin et al. (2011) RCT (6) N_{Start}=30 N_{End}=30 TPS=Chronic	E1: Anodal tDCS + Robot-assisted gait training E2: Sham tDCS + Robot-assisted gait training C: Gait training Duration: 10min/d, 5d/wk for 2wk	E1 vs E2: • 10-Meter Walk Test (-) • 6-Minute Walk Test (-) E1/E2 vs C: • 10-Meter Walk Test (+exp) • 6-Minute Walk Test (+exp)
Anodal tDCS and Cathodal Transcutaneous Spinal Direct Current Stimulation and Robot-assisted Gait Training		
Picelli et al. (2015) RCT (9) N_{Start}=30 N_{End}=30 TPS=Chronic	E1: Anodal tDCS + sham transcutaneous spinal direct current stimulation (tsDCS) + Robot-assisted gait training E2: Cathodal tsDCS + sham tDCS + Robot-assisted gait training E3: Anodal tDCS + Cathodal tsDCS + robotic gait training Duration: 20min/d, 5d/wk for 2wk	E1/E2 vs E3: • 6-Minute Walk Test (+exp$_3$) • Cadence (+exp$_3$) • Functional Ambulation Category (-) • Motricity Index (-) • Ashworth Scale (-) • Support Duration (-)
tDCS with Other Training		
Manji et al. (2018) RCT Crossover (9) N_{Start}=30 N_{End}=30 TPS=Subacute	E: Body weight supported treadmill training with anodal tDCS C: Body weight supported treadmill training with sham tDCS Duration: 20min/d, 7d/wk for 1wk	• 10-Meter Walk Test (+exp) • Timed Up and Go Test (+exp) • Fugl-Meyer Assessment (-) • Performed Oriented Mobility Assessment (-) • Trunk Control Test (-)
Park et al. (2015) RCT (4) N_{Start}=24 N_{End}=24 TPS=Chronic	E1: tDCS + Task-related training E2: Sham tDCS + Task-related training C: Task-related training Duration: 30min/d, 3d/wk for 4wk	E1 vs C: • Gait speed (+exp) • Stance symmetry (+exp) • Swing symmetry (+exp) • Step length (-)
Cathodal tDCS Combined with High Frequency rTMS vs rTMS		
Cho et al. (2017) RCT (6) N_{Start}=30 N_{End}=30 TPS=Acute	E: Simultaneous rTMS (10Hz) + cathodal tDCS (2mA) C: rTMS (10Hz) Duration: 20min/d, 5x/wk for 2 wks (10 sessions total)	• Fugl-Meyer Assessment (+exp)

Abbreviations and table notes: ANCOVA=analysis of covariance; ANOVA=analysis of variance; C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about tDCS

MOTOR FUNCTION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1a	**Anodal tDCS** may produce greater improvements in motor function than **sham stimulation.**	2	Bornheim et al. 2019; Chang et al. 2015
1b	**Dual tDCS** may not have a difference in efficacy when compared to **sham tDCS** for improving motor function.	1	Saeys et al. 2015
1b	**Anodal tDCS with robot-assisted gait training** may not have a difference in efficacy when compared to **sham tDCS with robot-assisted gait training** for improving motor function.	1	Seo et al. 2017

1b	**Anodal tDCS with body weight support training** may not have a difference in efficacy when compared to **sham tDCS with body weight support training** for improving motor function.	1	Manji et al. 2018
1b	**rTMS with cathodal tDCS** may produce greater improvements in motor function than **rTMS alone.**	1	Cho et al. 2017

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Anodal tDCS** may not have a difference in efficacy when compared to **sham stimulation** for improving functional ambulation.	4	Ojardias et al. 2020; Cattagni et al. 2019; Andrade et al. 2017; Chang et al. 2015
1a	**Anodal tDCS with robot-assisted gait training** may not have a difference in efficacy when compared to **sham tDCS with robot-assisted gait training** for improving functional ambulation.	4	Leon et al. 2017; Seo et al. 2017; Danzl et al. 2013; Geroin et al. 2011
1b	**Dual tDCS** may not have a difference in efficacy when compared to **sham stimulation** for improving functional ambulation.	1	Andrade et al. 2017
1b	There is conflicting evidence about the effect of **Anodal tDCS with cathodal transcranial spinal cord direct current stimulation with robotic gait training** to improve functional ambulation when compared to either **anodal tDCS or cathodal transcranial spinal cord direct current stimulation with robotic gait training**.	1	Picelli et al. 2015
1b	**Anodal tDCS with body weight supported treadmill training** may produce greater improvements in functional ambulation than **sham tDCS with body weight supported treadmill training**.	1	Manji et al. 2018
2	**Anodal tDCS with task-related training** may produce greater improvements in functional ambulation than **task-related training alone**.	1	Park et al. 2015

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Dual tDCS** may not have a difference in efficacy when compared to **sham stimulation** for improving functional mobility.	1	Tahtis et al. 2014

BALANCE

LoE	Conclusion Statement	RCTs	References
1a	**Anodal tDCS** may not have a difference in efficacy when compared to **sham stimulation** for improving balance.	4	Ojardias et al. 2020; Utarapichat et al. 2018; Andrade et al. 2017; Chang et al. 2015

1a	There is conflicting evidence about the effect of **dual tDCS** to improve balance when compared to **sham stimulation**.	4	Klomjai et al. 2018; Andrade et al. 2017; Sayes et al. 2015; Tahtis 2014
1a	**Anodal tDCS with robot-assisted gait training** may not have a difference in efficacy when compared to **sham tDCS with robot-assisted gait training** for improving balance.	2	Seo et al. 2017; Danzl et al. 2013
1b	There is conflicting evidence about the effect of **anodal tDCS with body weight supported treadmill training** to improve balance when compared to **sham tDCS with body weight supported treadmill training**.	1	Manji et al. 2018

GAIT

LoE	Conclusion Statement	RCTs	References
1a	**Anodal tDCS** may not have a difference in efficacy when compared to **sham stimulation** for improving gait.	4	Ojardias et al. 2020; Cattagni et al. 2019; Van Asseldonk & Boonstra 2016; Chang et al. 2015
1b	There is conflicting evidence about the effect of **Anodal tDCS with cathodal transcranial spinal cord direct current stimulation with robotic gait training** to improve gait when compared to either **anodal tDCS or cathodal transcranial spinal cord direct current stimulation with robotic gait training**.	1	Picelli et al. 2015
2	There is conflicting evidence about the effect of **anodal tDCS with task-related training** to improve gait when compared to **task-related training alone**.	1	Park et al. 2015

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1b	**Anodal tDCS with robot-assisted gait training** may not have a difference in efficacy when compared to **sham tDCS with robot-assisted gait training** for improving activities of daily living.	1	Danzl et al. 2013

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1a	**Anodal tDCS** may produce greater improvements in muscle strength than **sham stimulation**.	2	Chang et al. 2015; Tanaka et al. 2011
1b	**Dual tDCS** may not have a difference in efficacy when compared to **sham stimulation** for improving muscle strength.	1	Klomjai et al. 2018
1b	**Anodal tDCS with robot-assisted gait training** may not have a difference in efficacy when compared to	1	Seo et al. 2017

	sham tDCS with robot-assisted gait training for improving muscle strength.		
1b	**Anodal tDCS with cathodal transcranial spinal cord direct current stimulation with robotic gait training** may not have a difference in efficacy when compared to **anodal tDCS or cathodal transcranial spinal cord direct current stimulation with robotic gait training** for improving muscle strength.	1	Picelli et al. 2015

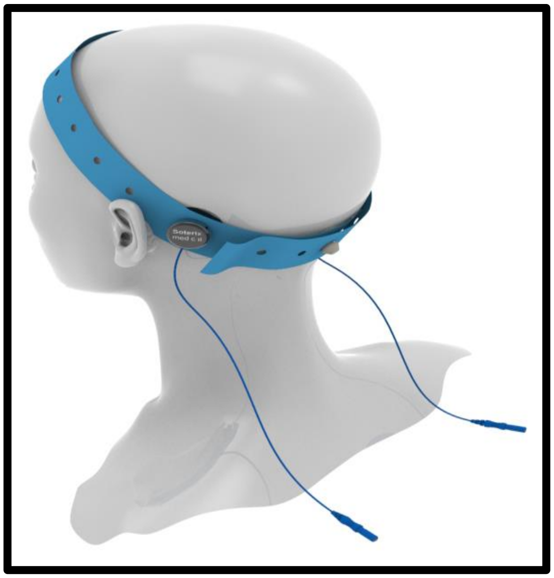
SPASTICITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Anodal tDCS with cathodal transcranial spinal cord direct current stimulation with robotic gait training** may not have a difference in efficacy when compared to **anodal tDCS or cathodal transcranial spinal cord direct current stimulation with robotic gait training** for improving spasticity.	1	Picelli et al. 2015

Key Points

tDCS may be beneficial for improving motor function and muscle strength.

tDCS may not be beneficial in improving functional ambulation, gait and balance.

Galvanic Vestibular Stimulation (GVS)



Adopted from: https://soterixmedical.com/research/vestibular

Galvanic vestibular stimulation (GVS) is a variant of transcranial direct current stimulation (tDCS). It is a non-invasive neuromodulation technique that involves placing electrodes directly over the vestibular nerve (which is responsible for the patient's sense of balance) and sending electrical signals through the skull (Krewer et al. 2013a). These signals stimulate the vestibular nerve which in turn can help the patient regain their balance (Krewer et al. 2013a). In healthy individuals, it has been shown that targeted GVS modulation during mechanical perturbations reduced sway and improved balance (Scinicariello et al., 2001).

One RCT was found evaluating galvanic vestibular stimulation for lower extremity motor rehabilitation. This RCT compared galvanic vestibular simulation to Lokomat training and physiotherapy with visual feedback (Krewer et al. 2013a).

The methodological details and results for the 1 RCTs evaluating galvanic vestibular stimulation (GVS) interventions for lower extremity motor rehabilitation are presented in Tables 40.

Table 40. RCTs Evaluating Galvanic Vestibular Stimulation Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	**Interventions Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures Result (direction of effect)**
Krewer et al. (2013a) RCT (8) N$_{start}$=25 N$_{end}$=24 TPS=Chronic	E1: Galvanic vestibular stimulation E2: Lokomat training E3: Physiotherapy with visual feedback Duration: 20min session	E1 vs E2/E3: • Burke Lateropulsion Scale (-) • Scale for Contraversive Pushing (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Galvanic Vestibular Stimulation

BALANCE			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Galvanic vestibular stimulation** may not have a difference in efficacy compared to **Lokomat training** and **physiotherapy with visual feedback** for improving balance.	1	Krewer et al. 2013a

Key Points

Galvanic vestibular stimulation may not be beneficial for improving balance.

Pharmaceuticals

Antidepressants

Adopted from https://www.abc.net.au/news/2018-09-18/common-antidepressants-may-fuel-growth-of-super-bugs-study-says/10246000

Antidepressants of various kinds are available for medical use, including tricyclics (TCAs), monoamine oxidase inhibitors (MAOIs), selective serotonin reuptake inhibitors (SSRIs), serotonin-noradrenaline reuptake inhibitors (SNRIs, such as venlafaxine, duloxetine and milnacipran), and other agents (mirtazapine, reboxetine, bupropion). SSRIs and SNRIs are two commonly prescribed agents that work by acting to inhibit the reuptake of serotonin and norepinephrine, respectively, from the synaptic cleft (Cipriani et al. 2012). Fluoxetine, citalopram and escitalopram are commonly prescribed selective serotonin reuptake inhibitors (SSRI). There has been interest in examining the effectiveness of pharmacological interventions for motor recovery after stroke (Acler et al. 2009). Antidepressants may be helpful in recovery after stroke through improving mood, which may in turn improve activity and functional outcome, but also through modulating cerebral sensory-motor activation (Acler et al. 2009).

Seven RCTs were found evaluating antidepressants for lower extremity motor rehabilitation.

Five RCTs compared fluoxetine to placebo (Robinson et al. 2000; Chollet et al. 2011; Fruehwald et al. 2003; Dam et al. 1996; Shah et al. 2016). One RCT compared Citalopram to placebo (Acler et al. 2009). One RCT compared Escitalopram to placebo (Gourab et al. 2015).

The methodological details and results of all seven RCTs are presented in Table 41.

Table 41. RCTs Evaluating Antidepressant Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Fluoxetine vs Placebo		
Shah et al. (2016) RCT (8) N_{start}=89 N_{end}=84 TPS=Acute	E: Fluoxetine (20mg/d) C: Placebo Duration: 3mo	• Fugl-Meyer Assessment (+exp)
Robinson et al. (2000) Mikami et al. (2011) (1 yr follow-up) RCT (8) N_{start}=104 N_{end}=83 TPS=Subacute	E1: Fluoxetine (40mg/d, 3mo) E2: Nortriptyline (100mg/d, 3mo) C: Placebo Duration: 12wk	E2 vs E1/C: • Functional Independence Measure (+exp$_2$) E1 vs C: • Functional Independence Measure (-)
Chollet et al. (2011) RCT (9) N_{start}=118 N_{end}=113 TPS=Acute	E: Fluoxetine (20mg/d) C: Placebo Duration: 90d	• Fugl-Meyer Assessment (+exp) • Modified Rankin Scale (+exp) • NIH Stroke Scale (-)
Fruehwald et al. (2003) RCT (9) N_{start}=54 N_{end}=50 TPS=Chronic	E: Fluoxetine (20mg/d) C: Placebo Duration: 4wk	• Scandinavian Stroke Scale (-)
Dam et al. (1996) RCT (5) N_{start}=52 N_{end}=51 TPS=Subacute	E1: Fluoxetine (20mg/d) E2: Maprotiline (150mg/d) C: Placebo Duration: 12wk	E1 vs E2: • Barthel Index (+exp$_1$) • Hemispheric Stroke Scale Gait score (+exp$_1$) E1/E2 vs C: • Barthel Index (-) • Hemispheric Stroke Scale (-)
Citalopram vs Placebo		
Acler et al. (2009) RCT (6) N_{start}=20 N_{end}=20 TPS=Acute	E: Citalopram (10mg/d) C: Placebo Duration: 4wk	• National Institute of Health Stroke Scale (+exp) • Barthel Index (-)
Escitalopram vs Placebo		
Gourab et al. (2015) RCT (7) N_{start}=10 N_{end}=10 TPS=Chronic	E: Escitalopram (10mg) C: Placebo Duration: one dose	• Stretch reflex (+exp) • Fugl-Meyer Assessment (-) • 10-Metre Walk Test (-) • 6-Minute Walk Test (-) • Muscle strength (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Antidepressants

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	**Fluoxetine** may produce greater improvements in motor function than **placebo.**	2	Shah et al. 2016; Chollet et al. 2011
1b	**Escitalopram** may not have a difference in efficacy when compared to **placebo** for improving motor function.	1	Gourab et al. 2015

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	**Escitalopram** may not have a difference in efficacy when compared to **placebo** for improving functional ambulation.	1	Gourab et al. 2015

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **Fluoxetine** to improve activities of daily living when compared to **placebo**.	4	Chollet et al. 2011; Robinson et al. 2000; Fruehwald et al. 2003; Dam et al. 1996
1b	**Citalopram** may not have a difference in efficacy when compared to **placebo** for improving activities of daily living.	1	Acler et al. 2009

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **Escitalopram** to improve muscle strength when compared to **placebo**.	1	Gourab et al. 2015

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1a	**Fluoxetine** may not have a difference in efficacy when compared to **placebo** for improving stroke severity.	3	Chollet et al. 2011; Fruehwald et al. 2003; Dam et al. 1996
1b	**Citalopram** may produce greater improvements in stroke severity than **placebo.**	1	Acler et al. 2009

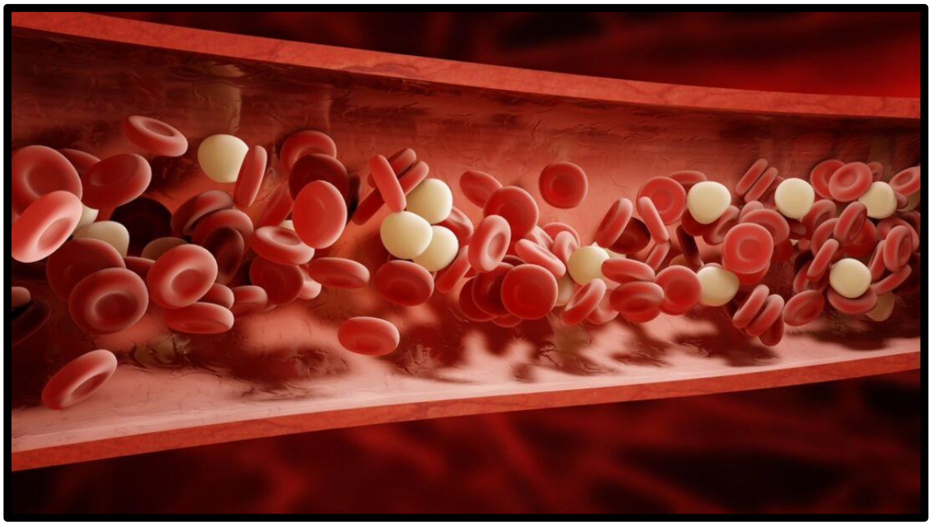
Key Points

The use of antidepressants may be beneficial for improving motor function.

The literature is mixed regarding use of antidepressants for improving activities of daily living and muscle strength.

The use of antidepressants may not be helpful in improving functional ambulation and stroke severity.

Secondary Prevention Medications



Adopted from: https://www.medgadget.com/2020/04/anticoagulants-market-size-industry-report-2019-2025.html

Approximately 25% of stroke patients will face a second stroke (Esenwa et al. 2015). In addition, many stroke patients face reduced mobility which can lead to increased risk of muscle atrophy in the chronic phase, even if a secondary event does not occur (Naritomi et al. 2010). As such, recovery and secondary prevention is critical for reducing the likelihood of a further injury and increasing quality of life.

Secondary prevention is often a comprehensive approach to managing cardiovascular risk factors such as hypertension, diabetes, dyslipidemia, and smoking cessation. Changes in lifestyle like a healthy diet and aerobic exercise are also recommended strategies (Esenwa et al. 2015). Pharmaceuticals such as antithrombotic agents and vasodilators can be deployed to help address these risk factors and manage disease while promoting recovery.

Antithrombotic agents aim to reduce the likelihood of blood clot formation by modulating the clotting cascade, but can pose risk to causing a hemorrhagic event. As such, care must be taken in selecting the appropriate agent in a case-by-case basis. However, there is evidence that they can be beneficial for preventing secondary recurrence (Del Brutto et al. 2019).

Vasodilators are a class of medications that help open blood vessels all around the body. This causes increased blood flow to targeted areas of the body which can lead to increased strength and endurance thereby promoting recovery (Di Cesare et al. 2016).

Three RCTs were found evaluating secondary prevention medication for lower extremity motor rehabilitation. One RCT compared a vasodilator PF-3049423 to a placebo (Di Ceasere et qal. 2016). One RCT compared Olmesartan with Amlodipine (Matsumoto et al. 2009). One RCT compared heparin use to aspirin (Jiyad et al. 2012).

The methodological details and results of the three RCTs are presented in Table 42.

Table 42. RCTs evaluating Secondary Prevention Medications For Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
PF-3049423 vs Placebo		
Di Cesare et al. (2016) RCT (6) N_{start}=139 N_{end}=94 TPS=Acute	E: PF-3049423 (6mg) C: Placebo Duration: 90d	• 10-Metre Walk Test (-)
Olmesartan vs Amlodipine		
Matsumoto et al. (2009) RCT (8) N_{start}=35 N_{end}=35 TPS=Subacute	E1: Olmesartan (10mg) E2: Amlodipine (2.5mg with dose increase as needed) Duration: 8wks	• Brunnstrom Lower Extremity (+exp1) • Barthel Index (-) • Muscle Power - Lower Limbs (+exp)
Heparin vs Aspirin		
Jivad et al. (2012) RCT (5) N_{start}=60 N_{end}=60 TPS=Not Reported	E: Heparin (5000-10000 BID) with aspirin C: Aspirin (acetylsalicylic acid) 100-325mg, 1x injection and/or dose/d for 3d	• Muscle Power - Lower Limbs (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Secondary Prevention Medication

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Olmesartan** may produce greater improvements in motor function than **amlodipine**.	1	Matsumoto et al. 2009

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	**Vasodilators** may not have a difference in efficacy when compared to a **dosage-matched placebo** for improving functional ambulation.	1	Di Cesare et al. 2016

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1b	**Olmesartan** may not have a difference in efficacy compared to **amlodipine** for improving activities of daily living.	1	Matsumoto et al. 2009

MUSCLE STRENGTH			
LoE	Conclusion Statement	RCTs	References
2	**Heparin** may produce greater improvements in muscle strength than **aspirin.**	1	Jiyad et al. 2012

Key Points

Vasodilators may be beneficial for improving motor function after stroke.

Edaravone

Adopted from: https://www.newswire.ca/news-releases/mitsubishi-tanabe-pharma-canada-announces-that-company-s-treatment-for-amyotrophic-lateral-sclerosis-als-has-been-added-to-the-provincial-drug-plan-in-alberta-816188000.html

Edaravone (Radicava, Radicut) is a small-molecule drug that with anti-oxidant properties and has been hypothesized to be beneficial for stroke recovery. It is thought to act as a free-radical scavenger and reduce the oxidative stress that accompanies muscle paralysis following stroke and subsequently improve leg locomotor function (Petrov et al. 2017). However, the precise mechanism of action remains unknown. Edaravone has been approved for use early-stage ALS patients in Japan and is seeking approval for acute stroke in other nations. There remains very limited clinical data for stroke recovery despite some promising pre-clinical studies.

One RCTs was found evaluating Edaravone for lower extremity motor rehabilitation. One RCT was found investigating One RCT compared long-term Edaravone use to short-term Edaravone use (Naritomi et al. 2010).

The methodological details and results of the single RCT are presented in Table 43.

Table 43. RCTs Evaluating Edaravone For Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Long-Term Edaravone vs Short-Term Edaravone		
Naritomi et al. (2010) RCT (5) N$_{start}$=47 N$_{end}$=41 TPS=Acute	E1: Long-term Edaravone (30mg , 2x/d) 10-15 days C: Short Term Edaravone (30mg , 2x/d) 3 days Duration: 30mg 2x/d, 3 days for short term, 10-14 days for long term	• Muscle Atrophy • Paretic Leg (+exp) • Nonparetic leg (-) • Maximum Walking Speed (+exp) • Brunstroom Lower Limb Recovery Scale (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Secondary Prevention Medication

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
2	**Long-term edaravone** may not have a difference in efficacy when compared to **short-term edaravone** for improving motor function.	1	Naritomi et al. 2010

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
2	**Long-term edaravone** may produce greater improvements in functional ambulation than **short-term edaravone.**	1	Naritomi et al. 2010

Key Points

Long-term edaravone may be beneficial for improving functional ambulation.

Stimulants

Adopted from: https://www.verywellmind.com/is-ritalin-addictive-21911

Stimulants are drugs that increase cortical excitability in the central nervous system (CNS), often by blocking reuptake and increasing the synaptic concentration and transmission of dopamine, serotonin, and noradrenaline throughout the brain. The neurobehavioral gains ascribed to CNS stimulants include enhanced arousal, mental processing speed, and/or motor processing speed (Herrold et al. 2014).

Two stimulants that are commonly used in rehabilitation include amphetamines and methylphenidates. Amphetamines are sympathomimetic agents that possess potent CNS stimulant effects by releasing monoamines from presynaptic neurons in the brain (Martinsson & Eksborg 2004). They have been shown to improve motor recovery after brain injury in animal studies, and there is increasing evidence that they may provide symptomatic management for some deficits after brain injury in humans (Walker-Batson et al. 1995). Methylphenidates stimulate the CNS by increasing synaptic concentrations of norepinephrine and dopamine, and are thought to modulate cerebral reorganization and improve motor function in stroke patients (Wang et al. 2014)

10 RCTs were found evaluating stimulant interventions for lower extremity motor rehabilitation. Eight RCTs compared amphetamine use to placebo (Sond & Lokk 2007; Gladstone et al. 2006; Marinsson et al. 2003; Martinsson & Wahlgren 2003; Treig et al. 2003; Sonde et al. 2001; Walker-Baston 1995; Crisostomo et al. 1998). Two RCTs compared methylphenidate to placebo (Lokk et al.2011; Grade et al. 1998).

The methodological details and results of all 10 RCTs evaluating stimulant interventions for lower extremity motor rehabilitation are presented in Table 44.

Table 44. RCTs Evaluating Amphetamine Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Amphetamines vs Placebo		
Sonde & Lokk (2007) RCT (7) N$_{start}$=30 N$_{end}$=25 TPS=Acute	E1: Amphetamine (10mg/d) + Levodopa (50mg/d) E2: Amphetamine (20mg/d) + Levodopa placebo E3: Amphetamine placebo + Levodopa (100mg/d) E4: Amphetamine placebo + Levodopa placebo Duration: 5d/wk for 2wk	• Fugl-Meyer Assessment (-) • Barthel Index (-)
Gladstone et al. (2006) RCT (7) N$_{start}$=71 N$_{end}$=67 TPS=Acute	E: Amphetamine (10mg/d) C: Placebo Duration: 2d/wk for 5wk	• Fugl-Meyer Assessment (-) • Clinical Outcome Variable Scale (-) • Functional Independence Measure (-) • Modified Rankin Scale (-) • Chedoke-McMaster Disability Inventory (-)
Martinsson et al. (2003) RCT (7) N$_{start}$=30 N$_{end}$=16 TPS=Acute	E: Amphetamine (20mg/d) + Intensive physiotherapy (60-90min/d) E2: Amphetamine (20mg/d) + Conventional physiotherapy (15min/d) Duration: 5d	• Lindmark Motor Assessment Chart (-) • Activities Index (-) • NIH Stroke Scale (-)
Martinsson & Wahlgren (2003) RCT (7) N$_{start}$=45 N$_{end}$=41 TPS=Acute	E: Amphetamine (20mg/d) C: Placebo Duration: 5d	• Lindmark Motor Assessment Chart (+exp) • 10-Metre Walk Test (-) • Activities Index (-) • Barthel Index (-) • Scandinavian Stroke Scale (-)
Treig et al. (2003) RCT (9) N$_{start}$=24 N$_{end}$=22 TPS=Acute	E: D-Amphetamine (10mg/d) C: Placebo Duration: every fourth day for 36d	• Rivermead Motor Assessment (-) • Barthel Index (-)
Sonde et al. (2001) RCT (9) N$_{start}$=40 N$_{end}$=36 TPS=Subacute	E: Amphetamine (10mg/d) C: Placebo Duration: 2d/wk for 5wk	• Fugl-Meyer Assessment (-) • Barthel Index (-)
Walker-Baston (1995) RCT (7) N$_{start}$=10 N$_{end}$=10 TPS=Acute	E: Amphetamine (10mg/d) C: Placebo Duration: every fourth day for 10 sessions	• Fugl-Meyer Assessment (+exp)
Crisostomo et al. (1988) RCT (7) N$_{start}$=8 N$_{end}$=8 TPS=Acute	E: Amphetamine (10mg) C: Placebo Duration: one session	• Fugl-Meyer Assessment (+exp)
Methylphenidate vs Placebo		
Lokk et al. (2011) RCT (8) N$_{start}$=100	E1: Methylphenidate (20mg/d) E2: Levadopa (125mg/d) E3: Methylphenidate + Levadopa	E1 vs C: • Barthel Index (+exp) • NIH Stroke Scale (+exp)

N_{end}=78 TPS=Subacute	C: Placebo Duration: 5d/wk for 3wk	E2 vs C: • Barthel Index (+exp$_2$) • NIH Stroke Scale (+exp$_2$) E3 vs C: • Barthel Index (+exp$_3$) • NIH Stroke Scale (+exp$_3$)
Grade et al. (1998) RCT (7) N_{start}=21 N_{end}=21 TPS=Acute	E: Methylphenidate (30mg/d) C: Placebo Duration: 7d/wk for 3wk	• Functional Independence Measure (+exp) • Fugl-Meyer Assessment (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Stimulants

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	**Amphetamine** may not have a difference in efficacy when compared to **placebo** for improving motor function.	8	Sond & Lokk 2007; Gladstone et al. 2006; Marinsson et al. 2003; Martinsson & Wahlgren 2003; Treig et al. 2003; Sonde et al. 2001; Crisostomo et al. 1998; Walker-Baston 1995
1a	**Methylphenidate** may not have a difference in efficacy when compared to **placebo** for improving motor function.	2	Lokk et al. 2011; Grade et al. 1998

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	**Amphetamine** may not have a difference in efficacy when compared to **placebo** for improving functional ambulation.	1	Martinsson & Wahlgren 2003

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Amphetamine** may not have a difference in efficacy when compared to **placebo** for improving functional mobility.	1	Gladstone et al. 2006

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Methylphenidate** may produce greater improvements in activities of daily living than **placebo**.	2	Lokk et al. 2011; Grade et al. 1998

1a	**Amphetamine** may not have a difference in efficacy when compared to **placebo** for improving activities of daily living.	6	Sond & Lokk 2007; Gladstone et al. 2006; Marinsson et al. 2003; Martinsson & Wahlgren 2003; Treig et al. 2003; Sonde et al. 2001
1b	**Methylphenidate + Levadopa** may produce greater improvements in activities of daily living than **placebo**.	1	Lokk et al. 2011

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1a	**Amphetamines** may not have a difference in efficacy when compared to **placebo** for improving stroke severity.	3	Gladstone et al. 2006; Marinsson et al. 2003; Martinsson & Wahlgren 2003
1b	**Methylphenidate and Methylphenidate + Levadopa** may produce greater improvements in stroke severity than **placebo**.	1	Lokk et al. 2011

Key Points

Stimulants may not be beneficial for improving motor function, functional ambulation, functional mobility, activities of daily living, and stroke severity.

Levodopa and Ropinirole (Parkinsonian Drugs)

Adopted from: https://medium.com/parkinsons-uk/how-do-levodopa-medications-work-ac6a6e58e143

Parkinsonian drugs are effective at controlling motor symptoms in patients with Parkinson's disease, with Levodopa being the current gold standard treatment (Antonini 2007). While levodopa is possibly the most potent of the Parkinsonian drugs, its prolonged use can cause a variety of side effects, thus dopamine agonists are also commonly used in therapy (Kulisevsky & Pagonabarraga 2010). Dopamine agonists have shown the ability to delay the initiation of levodopa therapy and have even been shown to modify the course of certain motor complications associated with levodopa use, such as dyskinesia (Kulisevsky & Pagonabarraga 2010). Ropinirole is one such dopamine agonist used in therapy.

Five RCTs were found evaluating Parkinsonian drug interventions for lower extremity motor rehabilitation. Two RCTs compared levodopa use to placebo or no medication (Shamsaei et al. 2015; Scheidtmann et al. 2001). Two RCTs compared levodopa use and levodopa + stimulant use to placebo (Lokk et al. 2011; Sonde & Lokk 2007). One RCT compared ropinirole use to placebo (Cramer et al. 2009).

The methodological details and results of all five RCTs evaluating stimulant interventions for lower extremity motor rehabilitation are presented in Table 45.

Table 45. RCTs Evaluating Levodopa and Ropinirole Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
	Levadopa vs Placebo	
Shamsaei et al. (2015) RCT (4) N$_{start}$=114 N$_{end}$=113 TPS=Not reported	E: Levodopa (100mg/d) C: No medication Duration: 3wk	• Rivermead Mobility Index (+exp) • Barthel Index (+exp)
Scheidtmann et al. (2001) RCT (7) N$_{start}$=53 N$_{end}$=47 TPS=Subacute	E: Levodopa (100mg, 1x) C: Placebo Duration: 7d/wk for 3wk	• Rivermead Motor Assessment (+exp)
	Levodopa with Stimulants	
Lokk et al. (2011) RCT (8) N$_{start}$=100 N$_{end}$=78 TPS=Subacute	E1: Methylphenidate (20mg/d) E2: Levadopa (125mg/d) E3: Methylphenidate + Levadopa C: Placebo Duration: 5d/wk for 3wk	E1 vs C: • Barthel Index (+exp) • NIH Stroke Scale (+exp) E2 vs C: • Barthel Index (+exp) • NIH Stroke Scale (+exp) E3 vs C: • Barthel Index (+exp) • NIH Stroke Scale (+exp)
Sonde & Lokk (2007) RCT (7) N$_{start}$=30 N$_{end}$=21 TPS=Acute	E1: Levodopa (50mg/d) + Amphetamine (10mg/d) E2: Levodopa (100mg/d) + Amphetamine placebo E3: Levodopa placebo + Amphetamine (20mg/d) E4: Amphetamine placebo + Levodopa placebo Duration: 5d/wk for 2wk	• Fugl-Meyer Assessment (-) • Barthel Index (-)
	Ropinirole vs Placebo	
Cramer et al. (2009) RCT (7) N$_{start}$=33 N$_{end}$=33 TPS=Subacute	E: Ropinirole (4mg/d) C: Placebo Duration: 7d/wk for 9wk	• Fugl-Meyer Assessment (-) • Gait speed (-) • Gait endurance (-) • Stroke Impact Scale (-) • Barthel Index (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Levodopa and Ropinirole

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	**Levodopa** may produce greater improvements in motor function than **no medication** and **placebo**.	2	Shamsaei et al. 2015; Scheidtmann et al. 2001
1a	**Levodopa with methylphenidate or amphetamine** may not have a difference in efficacy compared to **placebo** for improving motor function.	2	Lokk et al. 2011; Sonde & Lokk 2007
1b	**Ropinirole** may not have a difference in efficacy compared to **placebo** for improving motor function.	1	Cramer et al. 2009

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	**Roniprole** may not have a difference in efficacy compared to **placebo** for improving functional ambulation.	1	Cramer et al. 2009

GAIT

LoE	Conclusion Statement	RCTs	References
1b	**Ropinirole** may not have a difference in efficacy compared to **placebo** for improving gait.	1	Cramer et al. 2009

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **Levodopa, Levodopa with methylphenidate** and **Levodopa with amphetamine** to improve activities of daily living when compared to **no medication** and **placebo**.	3	Shamsaei et al. 2015; Lokk et al. 2011; Sonde & Lokk 2007
1b	**Ropinirole** may not have a difference in efficacy compared to **placebo** for improving activities of daily living.	1	Cramer et al. 2009
1b	**Methylphenidate with Levodopa** may produce greater improvements in activities of daily living than **placebo**.	1	Lokk et al.2011

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1b	**Levodopa** and **Levodopa with Methylphenidate** may produce greater improvements in stroke severity than **placebo**.	1	Lokk et al.2011

Key Points

Parkinsonian drug intervention may be beneficial for improving stroke severity.

The literature is mixed regarding Parkinsonian drug intervention for improving motor function and activities of daily living.

Parkinsonian drug intervention may not be beneficial for improving gait or functional ambulation.

Nerve Block Agents

Adopted from: https://www.acnr.co.uk/2012/12/phenol-nerve-block-for-management-of-lower-limb-spasticity/

Nerve blocks are a locally acting treatment for spasticity that have the advantage of reducing harmful spasticity in one area, while preserving useful spasticity in another area (Kirazli et al. 1998). Motor nerve blocks can be used to evaluate the potential role of muscle overactivity in abnormal movements. Depending on the pharmacological agent used, the temporary effect of a nerve block reverses within 1–12 h (Gross et al. 2014). Phenol is a commonly used nerve block agent that denatures protein and causes generalized neurolysis that affects both motor and sensory nerve fibers, thus reducing muscle tone by reducing abnormal neural signals. Phenol is effective in spasticity of large proximal leg muscles or as a nerve block in spastic foot drop (Fu et al. 2013). Radiofrequency thermocoagulation is another nerve block agent in which nerve fibres are blocked via thermal damage (Shen et al. 2017).

Four RCTs were found evaluating nerve block agent interventions for lower extremity motor rehabilitation. Two RCTs compared phenol to botulinum toxin (On et al. 1999; Kirazli et al. 1998). One RCT compared phenol to ethyl alcohol (Kocabas et al. 2010). One RCT compared thermocoagulation with AFO to sham thermocoagulation with AFO, thermocoagulation with sham AFO, and sham thermocoagulation with sham AFO (Beckerman et al. 1996).

The methodological details and results of all four RCTs evaluating nerve block agent interventions for lower extremity motor rehabilitation are presented in Table 46.

Table 46. RCTs Evaluating Nerve Block Agent Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Phenol vs Botulinum Toxin		
On et al. (1999) RCT (4) N$_{start}$=20 N$_{end}$=20 TPS=Chronic	E: Botulinium Toxin A (400 U) C: Phenol Duration: 12wks	• Modified Ashworth Scale (-)
Kirazli et al. (1998) RCT (8) N$_{start}$=20 N$_{end}$=17 TPS=Chronic	E1: Phenol E2: BTx (400U) Duration: 45min/d, 3d/wk for 6wk	E2 vs E1 • Ashworth Scale: (+exp$_2$) • Global Assessment Scale: (+exp$_2$)
Phenol vs Ethyl Alcohol		
Kocabas et al. (2010) RCT (4) N$_{start}$=20 N$_{end}$=20 TPS=Chronic	E1: Phenol E2: Ethyl alcohol Duration: 30min/d, 5d/wk for 3wk	• Modified Ashworth Scale (-) • Passive Range of Motion (-) • Ankle clonus (-) • Ankle strength (-) • Medical Research Council (-)
Nerve Block with AFO Device		
Beckerman et al. (1996) RCT (8) N$_{start}$=60 N$_{end}$=52 TPS=Chronic	E1: Tibial nerve block through thermocoagulation + AFO E2: Sham thermocoagulation + AFO E3: Thermocoagulation + Sham AFO E4: Sham thermocoagulation + Sham AFO Duration: 1hr/d, 3d/wk for 4wk	E1/E3 vs E2/E4 • Modified Ashworth Scale (+exp) • Clonus score (+exp) • Deep tendon reflex (+exp) • Muscle tone (+exp) • Range of motion (-) • Fugl-Meyer Assessment (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Nerve Block Agent Intervention

MOTOR FUNCTION			
LoE	Conclusion Statement	RCTs	References
1b	**Tibial nerve block through thermocoagulation with ankle foot orthosis** may not have a difference in efficacy when compared to **sham thermocoagulation with ankle foot orthosis, thermocoagulation with sham ankle foot orthosis,** or **sham thermocoagulation with sham ankle foot orthosis** for improving motor function.	1	Beckerman et al. 1996

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Tibial nerve block through thermocoagulation with ankle foot orthosis** may not have a difference in efficacy when compared to **sham thermocoagulation with ankle foot orthosis, thermocoagulation with sham ankle foot orthosis,** or **sham thermocoagulation with sham ankle foot orthosis** for improving range of motion.	1	Beckerman et al. 1996
2	**Phenol** may not have a difference in efficacy when compared to **ethyl alcohol** for improving range of motion.	1	Kocabas et al. 2010

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
2	**Phenol** may not have a difference in efficacy when compared to **ethyl alcohol** for improving muscle strength.	1	Kocabas et al. 2010

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Tibial nerve block through thermocoagulation with ankle foot orthosis** and **thermocoagulation with sham ankle foot orthosis** may produce greater improvements in spasticity than **sham thermocoagulation with ankle foot orthosis** and **sham thermocoagulation with sham ankle foot orthosis**.	1	Beckerman et al. 1996
1b	There is conflicting evidence about the effect of **phenol** to improve spasticity when compared to **botulinum toxin**.	2	On et al. 1999; Kirazli et al. 1998
2	**Phenol** may not have a difference in efficacy when compared to **ethyl alcohol** for improving spasticity.	1	Kocabas et al. 2010

Key Points

The literature is mixed regarding nerve block agent intervention for improving spasticity.

Nerve block agent intervention may not be beneficial for improving motor function, range of motion or muscle strength.

Botulinum Toxin

Adopted from: https://www.pointperformance.com/managing-pain-with-botox/

Botulinum toxin is a pharmacological agent, administered through injections, which reduces muscle tone and overactivity in spastic muscles. It exerts a therapeutic effect by presynaptically blocking the release of acetylcholine at the neuromuscular junction. The benefits of botulinum toxin injections are generally dose-dependent and last approximately 2 to 4 months before nerve resprouting reverses the functional blockade (Brashear et al. 2002; Francisco et al. 2002; Simpson et al. 1996; Smith et al. 2000; Pandyan et al. 2002). One of the advantages of botulinum toxin is that it reduces spasticity only in the injected muscles as opposed to other systemic treatments, which can have more widespread antispastic effects (Pandyan et al. 2002). Unlike chemodenervation and neurolytic procedures like phenol or alcohol, botulinum toxin is not associated with skin sensory loss, dysesthesia, or other side effects like fatigue and weakness (Suputtitada & Suwanwela, 2005; Pandyan et al. 2002). The most widely used type of botulinum toxin is botulinum toxin A, which has two further variations known as abobotulinum toxin A and onabotulinum toxin A. Both types share the same pharmacology and are used for similar purposes, however they differ with respect to their unit potency and nontoxin protein content, making their pharmacodynamic properties unique (Nestor & Ablon 2011). Dynamic EMG studies can be helpful in determining which muscles should be injected (Bell & Williams, 2003).

A total of 35 RCTs were found evaluating botulinum toxin interventions for lower extremity motor rehabilitation. 11 RCTs compared botulinum toxin to placebo (Kerzoncuf et al. 2020; Patel et al. 2020; Esquenazi et al. 2019; Wein et al. 2018; Tao et al. 2015; Fietzek et al. 2014; Ward et al. 2014; Dunne et al. 2012; Kaji et al. 2010; Pittock et al. 2003; Burbaud et al. 1996). Five RCTs compared botulinum toxin with various orthotic devices (Ding et al. 2015; Carda et al. 2011; Karadag-Saygi et al. 2010; Farina et al. 2008; Reiter et al. 1998). Five RCTs compared botulinum toxin to other stimulation including TENS and FES (Baricich et al. 2019; Lannin et al. 2018; Picelli et al. 2014; Baricich et al. 2008; Bayram et al. 2006). Two RCTs compared it to other antispastic interventions including neurotomy (Bollens et al. 2013) and phenol (Kirazli et al. 1998). Three RCTs compared botulinum toxin injections by location of injection (Im et al.

2014; Picelli et al. 2012; Childers et al. 1996). Five RCTs compared the dosage of injection (Ding et al. 2017; Gracies et al. 2017; Li et al. 2017; Pimentel et al. 2014; Mancini et al. 2005). One RCT compared the injection in combination with conventional therapy to the injection alone (Roche et al. 2015). Two RCTs investigated botulinum toxin in combination with robotic therapy (Erbil et al. 2017; Picelli et al. 2016). One RCT compared the timing of the injections (Oh et al. 2018).

The methodological details and results of all 35 RCTs are presented in Table 47.

Table 47. RCTs Evaluating Botulinum Toxin Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) **Study Design (PEDro Score)** **Sample Size$_{start}$** **Sample Size$_{end}$** **Time post stroke category**	**Interventions** **Duration: Session length, frequency per week for total number of weeks**	**Outcome Measures** **Result (direction of effect)**
Botulinum Toxin A Compared to Placebo		
Kerzoncuf et al. (2020) RCT (8) N_{start}=49 N_{end}=40 TPS=Chronic	E: Botox A® (Allergan ©) maximum dose 300U or 6 U/kg in soleus (87.6%) and gastrocnemius (73.4%) C: Placebo Duration: 4-6wks post injection	• Postural Sway Area • Dual Task (+exp) • Eyes Open (-) • Eyes Closed (+exp) • Modified Ashworth Scale (+exp) • Range of Motion (-)
Patel et al. (2020) RCT (8) N_{start}=468 N_{end}=450 TPS=Chronic	E: OnabotulinumtoxinA (300U-400U) C: Placebo Duration: 6 weeks	• Ankle Modified Ashworth Scale (+exp)
Esquenazi et al. (2019) RCT (8) N_{start}=468 N_{end}=450 TPS=Chronic	E: Onabotuliniumtoxin A (300 U) C: Placebo Duration: 6wks	• Modified Ashworth Scale (+exp) • Gait Speed (-)
Wein et al. (2018) RCT (8) N_{start}=468 N_{end}=450 TPS=Chronic	E: Onabotulinumtoxin A C: Placebo Duration: 6wks	• Modified Ashworth Scale (+exp)
Tao et al. (2015) RCT (6) N_{start}=23 N_{end}=23 TPS=Acute	E: Botulinum toxin A (200U) C: Placebo Duration: 8wks	• Modified Ashworth Scale (+exp) • Fugl-Meyer Assessment (+exp) • Modified Barthel Index (+exp) • 6-Minute Walk Test (+exp) • Gait speed (+exp) • Step length (+exp) • Cadence (+exp)
Fietzek et al. (2014) RCT (7) N_{start}=52 N_{end}=52 TPS=Subacute	E: Botulinum toxin A (230U, 460U) C: Placebo Duration: 12wks	• Modified Ashworth Scale (+exp)
Ward et al. (2014) RCT (7) N_{start}=274 N_{end}=273 TPS=Chronic	E: OnabotulinumtoxinA (600U) C: Placebo Duration: 24wks	• Modified Ashworth Scale (-)
Dunne et al. (2012) RCT (7) N_{start}=85 N_{end}=77 TPS=Chronic	E: OnabotulinumtoxinA (200U, 300U) C: Placebo Duration: 12wks	• Spasm Frequency Scale (+exp) • Gait quality (+exp) • Ashworth Scale (-)
Kaji et al. (2010) RCT (9) N_{start}=120 N_{end}=113 TPS=Chronic	E: Botulinum toxin A (300U) C: Placebo Duration: 12wks	• Modified Ashworth Scale (+exp) • Gait speed (-)

Pittock et al. (2003) RCT (8) N_{start}=234 N_{end}=221 TPS=Chronic	E: Botulinum toxin A (500U, 1000U, 1500 U) C: Placebo Duration: 12wks	• Modified Ashworth Scale (+exp) • 2-Minute Walk Test (-) • Stepping rate (-) • Step length (-)
Burbaud et al. (1996) RCT crossover (7) N_{start}=23 N_{end}=23 TPS=NR	E: Botulinum toxin (200U) C: Placebo Duration: 3mo one condition + 1mo other	• Ashworth Scale (+exp) • Fugl-Meyer Assessment (+exp) • Gait speed (-)
Botulinum Toxin A with Various Orthotic Devices		
Ding et al. (2015) RCT (6) N_{start}=103 N_{end}=103 TPS=NR	E1: Botulinum toxin A + ankle foot brace (AFO) E1: Botulinum toxin A C: No treatment Duration: 6mo	E1 vs E2/C • Clinic Spasticity Influx (+exp) • Berg Balance Scale (+exp) • Fugl-Meyer Assessment (+exp) • Functional Independence Measure (+exp)
Carda et al. (2011) RCT crossover (6) N_{start}=69 N_{end}=69 TPS=Chronic	E1: Botulinum toxin A (100U) + AFO E2: Botulinum toxin A (100U) + Taping E3: Botulinum toxin A (100U) + Stretching Duration: 1wk/condition	• 10-Metre Walk Test (-) • Functional Ambulation Category (-) • Ankle Strength (-) E1 vs E2: • Modified Ashworth Scale (+exp) • Passive Range of Motion (+exp) • 6-Minute Walk Test (-) E1 vs E3: • Modified Ashworth Scale (+exp) • Passive Range of Motion (+exp) • 6-Minute Walk Test (+exp) E2 vs E3: • Modified Ashworth Scale (-) • Passive Range of Motion (-) • 6-Minute Walk Test (-)
Karadag-Saygi et al. (2010) RCT (7) N_{start}=20 N_{end}=20 TPS=Chronic	E: Botulinum toxin A (75-100U) + Kinesio Taping C: Botulinum toxin A (75-100U) + Sham taping Duration: 6mo	• Modified Ashworth Scale (-) • Gait speed (-) • Step length (-)
Farina et al. (2008) RCT (5) N_{start}=13 N_{end}=13 TPS=Chronic	E: Botulinum toxin A (190-320U) + AFO C: Botulinum toxin A (190-320U) Duration: 4mo	• Modified Ashworth Scale (+exp) • 10-Metre Walk Test (-)
Reiter et al. (1998) RCT (5) N_{start}=18 N_{end}=18 TPS=Chronic	E: Botulinum toxin A (100U) + AFO C: Botulinum toxin A (190-320U) Duration: 1mo tape, 3mo follow up	• Ashworth Scale (-) • Passive Range of Motion (-) • Gait speed (-) • Step length (-)
Botulinum Toxin A Compared to Stimulation Methods		
Baricich et al. (2019) RCT (7) N_{start}=30 N_{end}=30 TPS=Chronic	E: Botox Injections (50U-120U)+ Electrical Stimulation of Antagonist and Injected Agonist Muscles C: Botox Injections (50U-120U) + Electrical Stimulation of Injected Agonist Muscles Duration: Physiotherapy 60min/d, 5d/wk, 2wks - Electrical Stimulation 60min, 1 session for agonist, 5 for antagonist	• 10-Meter Walk Test (-) • Modified Ashworth Scale (-) • Passive Range of Motion (-) • Medical Research Council (-) • 2-Minute Walk Test (-)

Lannin et al. (2018) RCT (8) N_{start}=37 N_{end}=34 TPS=Chronic	E1: Single dose of botulinum toxin-A + Casting + Intensive therapy (Electrical Stimulation and Task Specific Training) E2: Single dose of botulinum toxin-A C: Intensive therapy (Electrical Stimulation and Task Specific Training) Duration: 60min/d, 12 sessions, 6 wks supervised physio, 180min/d, 26 sessions, 6wks self directed	E1 Vs C • Six Minute Walk test (-) • Tardieu Scale (-) E2 Vs C • Six Minute Walk test (-) • Tardieu Scale (-) E1 Vs E2 • Six Minute Walk test (-) • Tardieu Scale (-)
Picelli et al. (2014) RCT (8) N_{start}=30 N_{end}=30 TPS=Chronic	E1: Botulinum toxin A (200U) E2: TENS E3: Therapeutic Ultrasound Duration: TENS (15min) /ultrasound (10min) 5d/wk, 2wks, follow up 3mo	E1 vs E2/E3: • Modified Ashworth Scale (+exp) • Passive Range of Motion (+exp) E2 vs E3: • Modified Ashworth Scale (-) • Passive Range of Motion (-)
Baricich et al. (2008) RCT (5) N_{start}=24 N_{end}=23 TPS=Chronic	E1: Botulinum toxin A (500U) + FES E2: Botulinum toxin A (500U) + Taping E3: Botulinum toxin A (500U) + Stretching Duration: FES (60min), Tape, Stretch (60min), 1wks, follow up 3mo	E1 vs E3: • Modified Ashworth Scale (+exp) • Passive Range of Motion (+exp) E2 vs E3: • Modified Ashworth Scale (+exp2) • Passive Range of Motion (-)
Bayram et al. (2006) RCT (6) N_{start}=12 N_{end}=11 TPS=Chronic	E1: Botulinum toxin (100U) + FES E2: Botulinum toxin (500U) + Sham FES Duration: FES 30min, 6x/d, 3d, follow up 12 wks	• Modified Ashworth Scale (-) • Global Assessment of Spasticity Scale (-) • Passive Range of Motion (-) • Clonus Score (-) • Brace Wear Scale (-) • 10-Metre Walk Test (-)
Botox Vs Other Antispastic Methods		
Bollens et al. (2013) RCT (8) N_{start}=16 N_{end}=16 TPS=Chronic	E1: Botulinum toxin (200U) E2: Neurotomy Duration: 6mo	• Modified Ashworth Scale (+exp2) • Stroke Impairment Assessment Scale (+exp2) • Passive Range of Motion (-) • 10-Metre Walk Test (-) • Medical Research Council (-)
Kirazli et al. (1998) RCT (8) N_{start}=20 N_{end}=20 TPS=Chronic	E1: Botulinum toxin A (400U) E2: Phenol Duration: 12wks	• Ashworth Scale (+exp) • Global Assessment Scale (+exp)
Location of Injection		
Im et al. (2014) RCT (9) N_{start}=40 N_{end}=38 TPS=Chronic	E1: Botulinum toxin A (200U) at 1/5 calf length E2: Botulinum toxin A (200U) at 1/2 calf length Duration: 8wks	• Modified Ashworth Scale (-) • Clonus Scale (-) • Modified Tardieu Scale (-) • Passive Range of Motion (-) • 10-Metre Walk Test (-) • Functional Ambulatory Category (-) • Locomotion Ability for Adults with Lower Limb Impairments Assessment (-)
Picelli et al. (2012) RCT (6) N_{start}=49 N_{end}=47 TPS=Chronic	E1: Botulinum toxin A (200U) by ultrasonography E2: Botulinum toxin A (200U) by electrical stimulation E3: Botulinum toxin A (200U) by palpation Duration: 4wks	E1 vs E2: • Modified Ashworth Scale (-) • Passive Range of Motion (+exp) • Tardieu Scale (-) E1 vs E3: • Modified Ashworth Scale (+exp) • Passive Range of Motion (+exp) • Tardieu Scale (-)

		E2 vs E3: • Modified Ashworth Scale (-) • Passive Range of Motion (-) • Tardieu Scale (-)
Childers et al. (1996) RCT (7) N_{start}=17 N_{end}=15 TPS=Chronic	E1: Botulinum toxin A (100U) at proximal location E2: Botulinum toxin A (100U) at distal location Duration: 4wks	• Ashworth Scale (-) • Fugl-Meyer Assessment (-) • Passive Range of Motion (-) • 50-Feet Walk Test (-)
Dosage of Injection		
Ding et al. (2017) RCT (7) N_{Start}=80 N_{End}=80 TPS=NA	E: Botulinum toxin A injection with spasmodic muscle therapeutic instrument C: Botulinum toxin A injection Duration: 12wks	• Fugl-Meyer Assessment (+exp) • Modified Ashworth Scale (+exp) • Modified Barthel Index (+exp) • Walking Speed (+exp) • Step Side (+exp)
Gracies et al. (2017) RCT(8) N_{Start}=388 N_{End}=366 TPS=Chronic	E1: Abobotulinum toxin A: 1000U E2: Abobotulinum toxin A: 1500U C: Placebo Duration: 4wks	E1 vs C: • Modified Ashworth Scale (-) • Physician Global Assessment (-) E2 vs C: • Modified Ashworth Scale (+exp2) • Physician Global Assessment (-)
Li et al. (2017) RCT (8) N_{Start}=104 N_{End}=89 TPS=NA	E1: Low-dose/low-concentration Botulinum toxin A (BTX-A) E2: Low-dose/high-concentration BTX-A E3: High-dose/low-concentration BTX-A E4: High-dose/high-concentration BTX-A Duration: 12wks	• Modified Ashworth Scale (+exp4) • 10-Meter Walk Test (+exp4) • Holden Grading (+exp4) • Visual Analogue Scale for Walking Function (-) • Timed Up and Go Test (+exp4)
Pimentel et al. (2014) RCT (6) N_{start}=21 N_{end}=21 TPS= Chronic	E1: Botulinum toxin A (300U) E2: Botulinum toxin A (100U) Duration: 12wks	• Modified Ashworth Scale (+exp) • 10-Metre Walk Test (-) • Functional Independence Measure (-)
Mancini et al. (2005) RCT (6) N_{start}=45 N_{end}=45 TPS=Chronic	E1: Botulinum toxin A (167U) E2: Botulinum toxin A (322U) E3: Botulinum toxin A (540U) Duration: 4wks	E1 vs E2: • Modified Ashworth Scale (+exp2) • Gait speed (+exp2) E1 vs E3: • Modified Ashworth Scale (+exp3) • Gait speed (+exp3) E2 vs E3: • Modified Ashworth Scale (-) • Gait speed (-)
Botulinum Toxin In Addition to Conventional Therapy		
Roche et al. (2015) RCT (6) N_{start}=35 N_{end}=35 TPS=Chronic	E: Rehabilitation + Botulinum Toxin A Injections C: Botulinum Toxin Injections Duration: 40min/d, 5d/wk for 4wk	• 10-Metre Walk Test (+exp) • 6-Minute Walk Test (+exp) • Time Up & Down Stairs (+exp) • Timed Up & Go Test (-) • Modified Ashworth Scale (-)
Botox Combined with Robotics Vs Botox and Conventional Therapy		
Erbil et al. (2017) RCT (5) N_{start}=48 N_{end}=43	E: Botulinum toxin A (BoNTA) + Robot assisted Gait Training (RoboGait) C: Botulinum toxin A (BoNTA) + Conventional therapy	• Timed up-and-go (+exp) • Berg Balance Scale (+exp) • Rivermead Visual Gait Assessment (+exp) • Modified Ashworth Scale (-)

TPS=Chronic	Duration: 30min RoboGait + 60min physical therapy 1x/d, 5x/wk, 3wks or 90min physical therapy 1x/d, 5x/wk, 3wks	• Tardieu Scale (-)
Picelli et al. (2016) RCT (8) N_{start}=22 N_{end}=22 TPS=Chronic	E: Botox (250U) With Robot-Assisted Gait Therapy C: Botox Alone Duration: robot, 30min for 5 days, outcomes at 1mo post-injection	• Modified Ashworth Scale (-) • 6-Minute Walking Test (+exp) • Tardieu Scale (-)
Comparison of Timing of Botox Administration		
Oh et al. (2018) RCT (5) N_{start}=28 N_{end}=28 TPS=Mixed	E1: Botox (200 units of BT-A) Early (140 Days Post Stroke) E2: Botox (200 units of BT-A) Middle (247 Days Post Stroke) E3: Botox (200 units of BT-A) Late (537 Days Post Stroke) Duration: 4 (2 medial, 2 lateral) Injections given 1x in Gastrocnemius at varying phases post-stroke	• Modified Ashworth Scale (-) • R1 angle of catch following fast-velocity stretch (-) • R2 passive range of movement following a slow-velocity stretch (-) • ABILOCO, a measure of locomotion ability (-) • Functional Ambulatory Category (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; FES=functional electrical stimulation; H=hours; Min=minutes; RCT=randomized controlled trial; TENS=transcutaneous electrical nerve stimulation; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp_2 indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Botulinum Toxin Interventions

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	**Botulinum toxin A** may produce greater improvements in motor function than **placebo**.	2	Tao et al. 2015; Burbaud et al. 1996
1a	**Botulinum toxin A with AFO** and **botulinum toxin A with spasmodic muscle therapeutic instrument** may produce greater improvements in motor function than **botulinum toxin A alone**.	2	Ding et al. 2017; Ding et al. 2015
1b	**Botulinum toxin** may produce greater improvements in motor function than **neurotomy**.	1	Bollens et al. 2013
1b	**Botulinum toxin A at proximal location** may not have a difference in efficacy compared to **botulinum toxin A at distal location** for improving motor function.	1	Childers et al. 1996

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **botulinum toxin A** to improve functional ambulation when compared to **placebo**.	4	Tao et al. 2015; Kaji et al. 2010; Pittock et al. 2003; Burbaud et al. 1996

1a	**Botulinum toxin A with AFO** may not have a difference in efficacy compared to **botulinum toxin A with taping, botulinum toxin A with stretching,** or **botulinum toxin A alone** for improving functional ambulation.	3	Carda et al. 2011; Farina et al. 2008; Reiter et al. 1998
1a	There is conflicting evidence about the effect of **high dose botulinum toxin A** to improve functional ambulation when compared to **low dose botulinum toxin A**.	2	Pimentel et al. 2014; Mancini et al. 2005
1b	**Botulinum toxin A with electrical stimulation** may not have a difference in efficacy compared **botulinum toxin or electrical stimulation alone** for improving functional ambulation.	1	Lannin et al. 2018
1b	**Botulinum toxin A with electrical stimulation of agonist muscles** may not have a difference in efficacy compared **botulinum toxin with electrical stimulation of antagonist muscles** for improving functional ambulation.	1	Baricich et al. 2019
1a	**Botulinum toxin A at 1/5 calf length and at proximal location** may not have a difference in efficacy compared to **botulinum toxin A at 1/2 calf length and at distal location** for improving functional ambulation.	2	Im et al. 2014; Childers et al. 1996
1b	**Botulinum toxin A with spasmodic muscle therapeutic instrument** may produce greater improvements in functional ambulation than **botulinum toxin A alone**.	1	Ding et al. 2017
1b	**Botulinum toxin A with rehabilitation** may produce greater improvements in functional ambulation than **botulinum toxin A alone**.	1	Roche et al. 2015
1b	There is conflicting evidence about the effect of **high dose high concentration botulinum toxin A** to improve functional ambulation when compared to **low dose high concentration botulinum toxin A, high dose low concentration botulinum toxin A, and low dose low concentration botulinum toxin A**.	1	Li et al. 2017
1b	**Botulinum toxin A with kinesio taping** may not have a difference in efficacy compared to **botulinum toxin A with sham taping** for improving functional ambulation.	1	Karadag-Saygi et al. 2010
1b	**Botulinum toxin A with FES** may not have a difference in efficacy compared to **botulinum toxin alone** for improving functional ambulation.	1	Bayram et al. 2006
1b	**Botulinum toxin** may not have a difference in efficacy compared to **neurotomy** for improving functional ambulation.	1	Bollens et al. 2013
1b	**Botulinum toxin A with robotic gait training** may produce greater improvements in functional ambulation than **botulinum toxin A alone**.	1	Picelli et al. 2016

2	**Early botulinum toxin administration** may not have a difference in efficacy compared to **middle or late administration** for improving functional ambulation.	1	Oh et al. 2018

BALANCE

LoE	Conclusion Statement	RCTs	References
1b	**Botulinum toxin A** may produce greater improvements in balance than **placebo.**	1	Kerzoncuf et al. 2020
1b	**High dose high concentration botulinum toxin A** may produce greater improvements in balance than **low dose high concentration botulinum toxin A, high dose low concentration botulinum toxin A,** and **low dose low concentration botulinum toxin A**.	1	Li et al. 2017
1b	**Botulinum toxin A with AFO** may produce greater improvements in balance than **botulinum Toxin A alone**.	1	Ding et al. 2015
1b	**Botulinum toxin A with rehabilitation** may not have a difference in efficacy compared to **botulinum toxin A alone** for improving balance.	1	Roche et al. 2015
2	**Botulinum toxin A with robotic gait training** may produce greater improvements in balance than **botulinum toxin A alone**.	1	Erbil et al. 2017

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **botulinum toxin A** to improve gait when compared to **placebo**.	4	Esquenazi et al. 2019; Tao et al. 2015; Dunne et al. 2012; Pittock et al. 2003
2	**Botulinum toxin A with AFO** may not have a difference in efficacy compared to **botulinum toxin A alone** for improving gait.	1	Reiter et al. 1998
1b	**Botulinum toxin A with spasmodic muscle therapeutic instrument** may produce greater improvements in gait than **botulinum toxin A alone**.	1	Ding et al. 2017
1b	**Botulinum toxin A with kinesio taping** may not have a difference in efficacy compared to **botulinum toxin A with sham taping** for improving gait.	1	Karadag-Saygi et al. 2010
2	**Botulinum toxin A with robotic gait training** may produce greater improvements in gait than **botulinum toxin A alone**.	1	Erbil et al. 2017

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Botulinum toxin A with AFO** and **botulinum toxin A with spasmodic muscle therapeutic instrument**	2	Ding et al. 2017; Ding et al. 2015

	may produce greater improvements in activities of daily living than **botulinum toxin A alone**.		
1b	**Botulinum toxin A** may produce greater improvements in activities of daily living than **placebo**.	1	Tao et al. 2015
1b	**High dose botulinum toxin A** may not have a difference in efficacy compared to **low dose botulinum toxin A** for improving activities of daily living.	1	Pimentel et al. 2014

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References
1b	**Botulinum toxin A** may not have a difference in efficacy compared to **placebo** for improving range of motion.	1	Kerzoncuf et al. 2020
1a	**Botulinum toxin A at 1/5 calf length and at proximal location** may not have a difference in efficacy compared to **botulinum toxin A at 1/2 calf length and at distal location** for improving range of motion.	2	Im et al. 2014; Childers et al. 1996
1b	There is conflicting evidence about the effect of **botulinum toxin with FES** may not to improve range of motion when compared to **botulinum toxin alone.**	2	Baricich et al. 2008; Bayram et al. 2006
1b	**Botulinum toxin A with TENS** may produce greater improvements in range of motion than **botulinum toxin alone.**	1	Picelli et al. 2014
1b	**Botulinum toxin A with electrical stimulation of agonist muscles** may not have a difference in efficacy compared **botulinum toxin with electrical stimulation of antagonist muscles** for improving range of motion.	1	Baricich et al. 2019
1b	**Botulinum toxin A with AFO** may produce greater improvements in range of motion than **botulinum toxin A alone**.	1	Carda et al. 2011
1b	**Botulinum toxin A by ultrasonography** may produce greater improvements in range of motion than **botulinum toxin A by electrical stimulation** and **botulinum toxin A by palpation**.	1	Picelli et al. 2012
1b	**Botulinum toxin A with AFO** may not have a difference in efficacy compared to b**otulinum toxin A with taping** and **botulinum toxin A with stretching** for improving range of motion.	1	Reiter et al. 1998
1b	**Botulinum toxin** may not have a difference in efficacy compared to **neurotomy** for improving range of motion.	1	Bollens et al. 2013

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Botulinum toxin A with electrical stimulation of agonist muscles** may not have a difference in efficacy compared **botulinum toxin with electrical stimulation of antagonist muscles** for improving muscle strength.	1	Baricich et al. 2019
1b	**High dose high concentration** botulinum toxin A may produce greater improvements in muscle strength than **low dose high concentration botulinum toxin A, high dose low concentration botulinum toxin A,** and **low dose low concentration botulinum toxin A**.	1	Li et al. 2017
1b	**Botulinum toxin** may not have a difference in efficacy compared to **neurotomy** for improving muscle strength.	1	Bollens et al. 2013
1b	**High dose botulinum toxin A** may not have a difference in efficacy compared to **low dose** b**otulinum toxin A** for improving muscle strength.	1	Mancini et al. 2005

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1a	**Botulinum toxin** may produce greater improvements in spasticity than **placebo**.	11	Kerzoncuf et al. 2020; Patel et al. 2020; Esquenazi et al. 2019; Wein et al. 2018; Tao et al. 2015; Fietzek et al. 2014; Ward et al. 2014; Dunne et al. 2012; Kaji et al. 2010; Pittock et al. 2003; Burbaud et al. 1996
1a	**Botulinum toxin A with AFO** may produce greater improvements in spasticity when than **botulinum toxin A with taping, botulinum toxin A with stretching,** and **botulinum toxin A alone**.	4	Ding et al. 2015; Carda et al. 2011; Farina et al. 2008; Reiter et al. 1998
1a	**High dose** b**otulinum toxin A** may produce greater improvements in spasticity than **low dose** b**otulinum toxin A**.	2	Pimentel et al. 2014; Mancini et al. 2005
1b	There is conflicting evidence about the effect of **botulinum toxin with FES** may not to improve spasticity when compared to b**otulinum toxin alone.**	2	Baricich et al. 2008; Bayram et al. 2006
1b	**Botulinum toxin A with TENS** may produce greater improvements in spasticity than **botulinum toxin alone.**	1	Picelli et al. 2014
1b	**Botulinum toxin A with electrical stimulation** may not have a difference in efficacy compared **botulinum toxin or electrical stimulation alone** for improving spasticity.	1	Lannin et al. 2018
1b	**Botulinum toxin A with electrical stimulation of agonist muscles** may not have a difference in efficacy compared **botulinum toxin with electrical**	1	Baricich et al. 2019

	stimulation of antagonist muscles for improving spasticity.		
1a	**Botulinum toxin A at 1/5 calf length and at proximal location** may not have a difference in efficacy compared to b**otulinum toxin A at 1/2 calf length and at distal location** for improving spasticity.	2	Im et al. 2014; Childers et al. 1996
1b	**Botulinum toxin A with spasmodic muscle therapeutic instrument** may produce greater improvements in spasticity than **botulinum toxin A alone**.	1	Ding et al. 2017
1b	**High dose abobotulinum toxin A** may produce greater improvements in spasticity than **low dose abobotulinum toxin A**.	1	Gracies et al. 2017
1b	**High dose high concentration Botulinum Toxin A** may produce greater improvements in spasticity than **low dose high concentration botulinum toxin A, high dose low concentration botulinum toxin A, and low dose low concentration botulinum toxin A**.	1	Li et al. 2017
1b	**Botulinum toxin A** may produce greater improvements in spasticity than **phenol**.	1	Kirazli et al. 1998
1a	**Botulinum toxin** may produce greater improvements in spasticity than **neurotomy**.	1	Bollens et al. 2013
1b	**Botulinum toxin A with rehabilitation** may not have a difference in efficacy compared to **botulinum toxin A alone** for improving spasticity.	1	Roche et al. 2015
1b	**Botulinum toxin A with kinesio taping** may not have a difference in efficacy compared **botulinum toxin A with sham taping** for improving spasticity.	1	Karadag-Saygi et al. 2010
1b	There is conflicting evidence about the effect of **botulinum toxin A by ultrasonography** may not to improve spasticity when compared to **botulinum toxin A by electrical stimulation and botulinum toxin A by palpation**.	1	Picelli et al. 2012
1b	**Botulinum toxin A with robotic gait training** may not have a difference in efficacy compared **botulinum toxin alone** for improving spasticity.	2	Erbil et al. 2017; Picelli et al. 2016
2	**Early botulinum toxin administration** may not have a difference in efficacy compared to **middle or late administration** for improving spasticity.	1	Oh et al. 2018

Key Points

Botulinum Toxin A is beneficial for improving activities of daily living, motor function, and spasticity.

The literature is mixed regarding the modalities, location and intensity of treatment of Botulinum Toxin A for improving other lower extremity outcomes after stroke.

Botulinum Toxin A may not be beneficial for improving gait.

Antispastic Drugs

Adopted from: https://www.indiamart.com/proddetail/baclofen-ip-20249295097.html

Antispastic drugs are used for spastic hypertonia of cerebral origin, usually in oral form, and often include baclofen and tizanidine. These non-selective agents mimic the effects of neurotransmitters in the central nervous system. Tolperisone is a centrally acting muscle relaxant that decreases the frequency and amplitude of action potentials in the membrane. Tizanidine and dantrolene are other oral medications used for management of spasticity. When oral medicines are not adequate, injections of intrathecal baclofen may also be used (Rushton et al. 2002).

Six RCTs were found evaluating antispastic drug interventions for lower extremity motor rehabilitation. One RCT compared tolperisone to placebo (Stanebiva et ak, 2005). Two RCTs compared inrathecal baclofen to placebo (Creamer et al. 2018; Meythaler et al. 2001). Two RCTs compared dantrolene to placebo (Katrak et al. 1992; Detel & Kolb 1984). One RCT compared tizanidine to baclofen (Medici et al. 1989).

The methodological details and results of all six RCTs evaluating antispastic drug interventions for lower extremity motor rehabilitation are presented in Table 48.

Table 48. RCTs Evaluating Antispastic Drugs for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Tolperisone vs Placebo		
Stamenova et al. (2005) RCT (8) N_{start}=120 N_{end}=106 TPS=Chronic	E: Tolperisone (300-900mg) C: Placebo Duration: 300-900mg of Tolperisone, 1x/d for 20d	• Ashworth Scale (+exp) • Modified Barthel Index (+exp)
Intrathecal Baclofen vs Placebo		
Creamer et al. (2018) RCT (6) N_{start}=60 N_{end}=48 TPS=Chronic	E: Intrathecal Baclofen Pump C: Conventional Medical Management Duration: 6mo	• Ashworth Scale (+exp) • Functional Independence Measure (-)
Meythaler et al. (2001) RCT (7) N_{start}=21 N_{end}=19 TPS=Chronic	E: Intrathecal baclofen (50µg) C: Placebo Duration: 50µg intrathecal baclofen daily for 1yr	• Modified Ashworth Scale (+exp) • Penn Spasm Frequency Scale (+exp) • Reflex Scale (+exp)
Dantrolene vs Placebo		
Katrak et al. (1992) RCT (7) N_{start}=31 N_{end}=31 TPS=Chronic	E: Dantrolene (200mg) C: Placebo Duration: 50mg of Dantrolene (4x/d) for 2wk	• Modified Ashworth Scale (-) • Barthel Index (-)
Ketel & Kolb (1984) RCT (3) N_{start}=18 N_{end}=18 TPS=Chronic	E: Dantrolene (165mg) C: Placebo Duration: 165mg of Dantrolene per day for 6wk	• Spasticity (+exp) • Independence (+exp)
Tizanidine vs Baclofen		
Medici et al. (1989) RCT (6) N_{start}=30 N_{end}=30 TPS=Chronic	E1: Tizanidine (20mg) E2: Baclofen (50mg) Duration: 20mg Tizanidine per day OR 50mg Baclofen per day for 50wk	• Ashworth Scale (-) • Pedersen Scale (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Antispastic Drugs

ACTIVITIES OF DAILY LIVING			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Tolperisone** may produce greater improvements in activities of daily living than **placebo**.	1	Stamenova et al. 2005
1b	**Intrathecal baclofen** may not have a difference in efficacy compared to **baclofen** for improving activities of daily living.	1	Creamer et al. 2018

1b	There is conflicting evidence about the effect of **dantrolene** to improve activities of daily living when compared to **placebo**.	2	Katrak et al. 1992; Ketel & Kolb 1984

SPASTICITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Tolperisone** may produce greater improvements in spasticity than **placebo**.	1	Stamenova et al. 2005
1a	**Intrathecal baclofen** may produce greater improvements in spasticity than **placebo**.	2	Creamer et al. 2018; Meythaler et al. 2001
1b	There is conflicting evidence about the effect of **dantrolene** to improve spasticity when compared to **placebo**.	2	Katrak et al. 1992; Ketel & Kolb 1984
1b	**Tizanidine** may not have a difference in efficacy compared to **baclofen** for improving spasticity.	1	Medici et al. 1989

Key Points

Some antispastic drugs may be beneficial for improving spasticity.

The literature is mixed regarding antispastic drug intervention for improving activities of daily living.

Cerebrolysin

Adopted from: http://www.gerovitalshop.eu/it/home/18-cerebrolysin-5ml.html

Cerebrolysin is a medication that is a mixture of distinct swine brain-derived peptides that have shown similar pharmacodynamic properties with endogenous neurotrophic factors (Plosker & Gauthier, 2009). It has shown neuroprotective effects both *in vitro* and in neurodegenerative animal models (Plosker & Gauthier, 2009). In humans, there has been some conflicting evidence, but some studies suggest it could help with cognitive rehabilitation in a number of neurological conditions (Zhang et al., 2015; Ladurner, Kalvach & Moessler, 2005). These peptides could act on the molecular level to also help improve motor outcomes in the lower extremity (Chang et al. 2016).

A total of one RCT was found that evaluated cerebrolysin for lower extremity motor rehabilitation. This RCT compared cerebrolysin to a dosage matched placebo (Chang et al. 2016).

The methodological details and results for this RCT are presented in Table 49.

Table 49. RCTs Evaluating Cerebrolysin Intervention for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Chang et al. (2016) RCT (6) N$_{start}$=70 N$_{end}$=66 TPS=Acute	E: Cerebrolysin (30ml) C: Placebo Duration: 7d/wk for 21d	• Fugl-Meyer Assessment (-)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

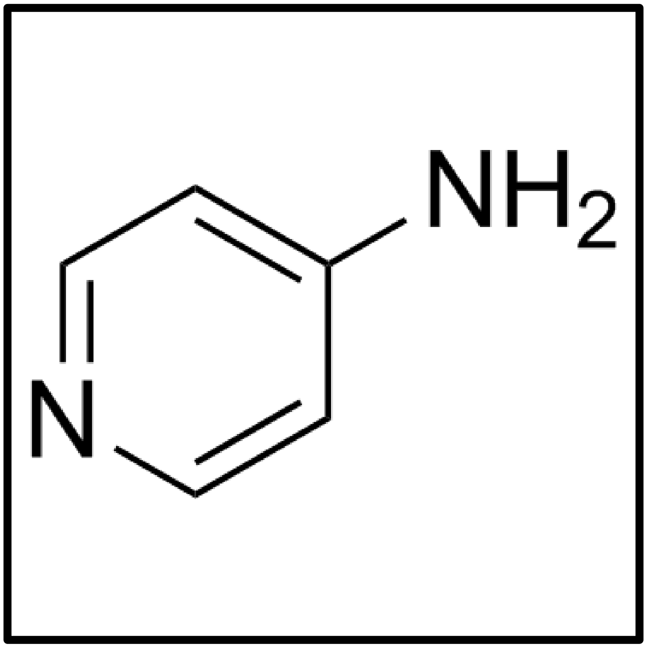
Conclusions about Cerebrolysin

MOTOR FUNCTION			
LoE	Conclusion Statement	RCTs	References
1b	**Cerebrolysin** may not have a difference in efficacy when compared to a **dosage matched placebo** for improving motor function.	1	Chang et al. 2016

Key Points

Cerebrolysin may not be beneficial for improving motor function.

4-Aminopyridine



Adopted from: https://www.adooq.com/4-aminopyridine.html

4-aminopyridine (fampridine, dalfampridine) is an organic pyridine that blocks the opening of intercellular potassium channels, ultimately prolonging neuronal repolarization (Simpson et al. 2015). This can increase neuron excitability and conduction strength, particularly in unmyelinated fibers. In mammalian motor neurons, it greatly potentiates the transmitter release at the unmyelinated neuromuscular junction (Sherratt, Bostock & Sears, 1980). Although often used for the treatment of multiple sclerosis, its ability to improve neuromuscular signaling could prove effaceable for lower limb rehabilitation in stroke survivors as well.

One RCT was found that evaluated 4-aminopyridine for lower extremity motor rehabilitation. This RCT compared 4-aminopyridine to a placebo (Simpson et al. 2015).

The methodological details and results for this RCT are presented in Table 50.

Table 50. RCTs Evaluating 4-Aminopyridine Treatment for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Simpson et al. (2015) RCT (5) N$_{start}$=83 N$_{end}$=70 TPS=Chronic	E: 4-Aminopyridine (10mg x 2/d) C: Placebo Duration: 2wk	• 25-Feet Walk Test (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about 4-Aminopyridine Treatment

FUNCTIONAL AMBULATION			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	The **4-aminopyridine treatment** may produce greater improvements in functional ambulation than **dosage-matched placebo**.	1	Simpson et al. 2015

Key Points

4-aminopyridine may be beneficial for improving functional ambulation.

Complementary and alternative medicine

Acupuncture

Adopted from: https://www.mccaffreyhealth.com/acupuncture-for-chronic-pain/

The use of acupuncture has recently gained attention as an adjunct to stroke rehabilitation in Western countries even though acupuncture has been a primary treatment method in China for about 2000 years (Baldry, 2005). In China, acupuncture is an acceptable, time-efficient, simple, safe and economical form of treatment used to ameliorate motor, sensation, verbal communication and further neurological functions in post-stroke patients," (Wu et al. 2002). According to Rabinstein and Shulman (2003), "Acupuncture is a therapy that involves stimulation of defined anatomic locations on the skin by a variety of techniques, the most common being stimulation with metallic needles that are manipulated either manually or that serve as electrodes conducting electrical currents". There is a range of possible acupuncture mechanisms that may contribute to the health benefits experienced by stroke patients (Park et al. 2006). For example, acupuncture may stimulate the release of neurotransmitters (Han & Terenius, 1982) and have an effect on the deep structure of the brain (Wu et al. 2002). Lo et al. (2005) established acupuncture, when applied for at least 10 minutes, led to long-lasting changes in cortical excitability and plasticity even after the needle stimulus was removed. With respect to stroke rehabilitation, the benefit of acupuncture has been evaluated most frequently for pain relief and recovery from hemiparesis.

18 RCTs were found evaluating acupuncture for lower extremity motor rehabilitation. 14 RCTs compared acupuncture to sham, no acupuncture, or physiotherapy (Ghannadi et al. 2020; Wang et al. 2020; Wang et al. 2019; Chen et al. 2016; Liu et al. 2016; Salom-Moreno et al. 2014; Bai et al. 2013; Zhuang et al. 2012; Park et al. 2005; Alexander et al. 2004; Fink et al. 2004; Sze et al. 2002; Gosman-Hedstrom et al. 1998; Johansson et al. 1993). One RCT compared yamamoto new scale acupuncture to conventional therapy (Hegyi et al. 2012). Two RCTs compared acupuncture with manipulation to acupuncture (Liu et al. 2009; Zhao et al. 2009). Two RCTs used multifaceted alternative medicine approaches (Wei et al. 2016; Zhang et al. 2013).

The methodological details and results of all 18 RCTs are presented in Table 51.

Table 51. RCTs Evaluating Acupuncture Interventions for Lower Extremity Motor Rehabilitation.

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Acupuncture vs Sham, No Acupuncture, or Physiotherapy		
Ghannadi et al. (2020) RCT (9) N_{start}=24 N_{end}=24 TPS=Chronic	E: Dry needling in gastrocnemius C: Sham needling Duration: 3 sessions/wk, 1wk (48 hrs between sessions)	• Modified Modified Ashworth Scale (+exp) • 10-Meter Walk Test (+exp) • Timed Up-and-Go (+exp) • Single Leg Stance (+exp) • Active Range of Motion (-)

Wang et al. (2020)
RCT (8)
N_{start}=134
N_{end}=67
TPS=Subacute
	E: Acupuncture
	C: Conventional therapy
	Duration: 1session/d, 6d/wk, 4wks (24 sessions) + 45min/d, 6d/wk, 4wks conventional therapy
		• Fugl-Meyer (+exp)
		  • Lower Extremity (+exp)
		  • Upper Extremity (+exp)
		• Barthel Index (-)
		• Spatiotemporal and kinematic gait parameters (+exp)
		  • Velocity (+exp)
		  • Step (+exp)
		  • Cadence (+exp)
		  • Hip Range of Motion (+exp)
		  • Knee Range of Motion (+exp)
		  • Ankle Range of Motion (-)
		  • Peak Circumduction (+exp)
		• Peak Knee Hiking (+exp)

Wang et al. (2019)
RCT (8)
N_{start}=59
N_{end}=59
TPS=Subacute
	E: Acupuncture Baihui (GV20) and Taiyang (EX-HN5)
	C: Conventional therapy
	Duration: 45min/d, 6d/wk, 4wks conventional therapy + 6 consecutive sessions of acupuncture treatments per week, 4wks
		• Modified Ashworth Scale
		  • Knee (+exp)
		  • Ankle(+exp)
		• Short Intracortical Inhibition (+exp)
		• Hmax/Mmax (+exp)
		• Fugl-Meyer Lower Limb (+exp)
		• Barthel Index (-)
		• Motor Evoked Potential (+exp)
		• Integrated Electromyogram Overall (+exp)

Chen et al. (2016) RCT (8) N_{start}=250 N_{end}=233 TPS=Chronic	E: Acupuncture + conventional therapy C: Conventional therapy Duration: 1hr/d, 6d/wk for 3wk	• National Institute of Health Stroke Scale (+exp) • Fugl-Meyer Assessment (+exp)
Liu et al. (2016) RCT (6) N_{start}=38 N_{end}=34 TPS=Acute	E: Acupuncture + conventional therapy C: Conventional therapy Duration: 20min/d, 5d/wk for 4wk	• Fugl-Meyer Assessment (-) • Functional Independence Measure (-) • Modified Rankin Scale (-) • Barthel Index (-) • National Institute of Health Stroke Scale (-)
Salom-Moreno et al. (2014) RCT (8) N_{start}=34 N_{end}=34 TPS=Chronic	E: Acupuncture C: No acupuncture Duration: *Not Specified*	• Support Surface (+exp) • Maximum Pressure (+exp) • Modified Ashworth Scale (-)
Bai et al. (2013) RCT (5) N_{start}=120 N_{end}=111 TPS=Subacute	E1: Acupuncture E2: Physiotherapy E3: Acupuncture + Physiotherapy Duration: 75min/d, 6d/wk for 4wk	E1/E2 vs E3 • Fugl-Meyer Assessment: (-) E2 vs E1 • Fugl-Meyer Assessment: (+exp$_2$)

		• Modified Barthel Index (-)
Zhuang et al. (2012) RCT (7) N_{start}=295 N_{end}=287 TPS=Chronic	E1: Acupuncture E2: Physiotherapy E3: Acupuncture + Physiotherapy Duration: 45min/d, 6d/wk for 4wk	• Fugl-Meyer Assessment (-) • Barthel Index (-)
Park et al. (2005) RCT (9) N_{start}=116 N_{end}=98 TPS=Acute	E: Acupuncture C: Sham acupuncture Duration: Between 9 and 12 sessions for 2wk	• Motricity Index (-) • Barthel Index (-) • National Institute of Health Stroke Scale (-) • Ashworth Scale (-) • 10-Metre Walk Test (-)
Alexander et al. (2004) RCT (6) N_{start}=32 N_{end}=32 TPS=Chronic	E: Acupuncture + conventional therapy C: Conventional therapy Duration: 30min/d, 7d/wk for 2wk	• Fugl-Meyer Assessment (+exp) • Functional Independence Measure (-)
Fink et al. (2004) RCT (6) N_{start}=25 N_{end}=25 TPS=Chronic	E: Acupuncture C: Sham acupuncture Duration: 45min/d, 2d/wk for 10wk	• Walking Speed (-) • Modified Ashworth Scale (-) • 2-Minute Walk Test (-) • Rivermead Motor Assessment (-) • Step length (-) • Cadence (-)
Sze et al. (2002) RCT (7) N_{start}=106 N_{end}=98 TPS=Chronic	E: Acupuncture + conventional therapy C: Conventional therapy Duration: 30min/d, 2-5d/wk for 10wk	• Fugl-Meyer Assessment (-) • Functional Independence Measure (-) • Barthel Index (-) • National Institute of Health Stroke Scale (-)
Gosman-Hedstom et al. (1998) RCT (7) N=104 N_{end}=82 TPS=Acute	E1: Superficial acupuncture E2: Deep acupuncture C: No acupuncture Duration: 1hr/d, 2d/wk for 10wk	• Barthel Index (-) • Sunnaas Index (-)
Johansson et al. (1993) RCT (5) N_{start}=78 N_{end}=57 TPS=Acute	E: Acupuncture C: No acupuncture Duration: 30min/d, 2d/wk for 10wk	• Balance (+exp) • Motor function (+exp) • Mobility (+exp) • Barthel Index (+exp)
Yamamoto New Scalp Acupuncture vs Conventional Therapy		
Hegyi et al. (2012) RCT (5) N_{start}=50 N_{end}=50 TPS=Chronic	E: Yamamoto new scalp acupuncture + conventional therapy C: Conventional therapy Duration: 1hr/d, 3d/wk for 2wk	• Rivermead Mobility Index (+exp) • Barthel Index (+exp)
Acupuncture with Manipulation vs Acupuncture		
Liu et al. (2009) RCT (7) N_{start}=30 N_{end}=30 TPS=Subacute	E: Acupuncture + Needle twisting C: Acupuncture Duration: 20min/d, 5d/wk for 4wk	• Sit-to-Stand (+exp) • Muscle Strength (+exp) • Centre of Gravity Displacement (+exp) • 6-Metre Walk Test (-)
Zhao et al. (2009) RCT (5) N_{start}=131 N_{end}=120 TPS=Chronic	E: Acupuncture + Stimulating surface projection C: Acupuncture Duration: 45min/d, 3d/wk for 4wk	• Fugl-Meyer Assessment (+exp) • Barthel Index (+exp) • Modified Ashworth Scale (+exp)
Multifaceted Alternative Medicine Approaches		

Wei et al. (2016) RCT (6) N_{start}=84 N_{end}=84 TPS=Subacute	E: Moxibustion with Conventional Rehabilitation C: Conventional Rehabilitation Duration: rehab 45min, moxibuston 25-30min, 5d/wk, 4wks	• Brunnstrom Recovery Stages (-) • Modified Ashworth Scale (+exp) • Total Fugl Meyer Assessment (+exp) • Barthel Index (+exp) • Clinical Spasticity Index (+exp)
Zhang et al. (2013) RCT (5) N_{start}=69 N_{end}=61 TPS=Acute	E: Integrated Rehabilitation Techniques of Traditional Chinese Medicine (IRT-TCM) (30 mins of acupuncture 30 mins of massage) C: Neurodevelopment (Bobath) Techniques Duration: 1hr/d, 3wks	• Fugl-Meyer Lower Extremity (+exp) • National Index of Stroke Severity (+exp) • Barthel Index (-) • Modified Rankin Scale (-)

Abbreviations and table notes: ANOVA=analysis of variance; C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Acupuncture Treatment

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **acupuncture** to improve motor function when compared to **conventional therapy or no treatment**.	9	Wang et al. 2020; Wang et al. 2019; Chen et al. 2016; Liu et al. 2016; Bai et al. 2013; Zhuang et al. 2012; Alexander et al. 2004; Sze et al. 2002; Johansson et al. 1993
1b	**Moxibustion** may produce greater improvements in motor function than **conventional therapy**.	1	Wei et al. 2016
2	**Integrated rehabilitation techniques** may produce greater improvements in motor function than **the Bobath method.**	1	Zhang et al. 2013
2	**Acupuncture with needle manipulation** may produce greater improvements in motor function than **acupuncture.**	1	Zhao et al. 2009

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1a	**Acupuncture** may not have a difference in efficacy when compared to **a sham condition** for improving functional ambulation.	3	Ghannadi et al. 2020; Park et al. 2005; Fink et al. 2004
1b	**Acupuncture with needle manipulation** may not have a difference in efficacy when compared to **acupuncture** for improving functional ambulation.	1	Liu et al. 2009

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	There is conflicting evidence about the effect of **acupuncture** to improve functional mobility when compared to **a sham condition or no treatment**.	2	Fink et al. 2004; Johansson et al. 1993
2	**Yamamoto new scalp acupuncture** may produce greater improvements in functional mobility than **conventional therapy.**	1	Hegyi et al. 2012

BALANCE

LoE	Conclusion Statement	RCTs	References
1b	**Acupuncture** may produce greater improvements in balance than **no treatment**.	2	Ghannadi et al. 2020; Johansson et al. 1993
1b	**Acupuncture with needle manipulation** may produce greater improvements in balance than **acupuncture**	1	Liu et al. 2009

GAIT

LoE	Conclusion Statement	RCTs	References
1a	There is conflicting evidence about the effect of **acupuncture** to improve gait when compared to **sham or conventional therapy**.	3	Ghannadi et al. 2020; Wang et al. 2020; Fink et al. 2004

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Acupuncture** may not have a difference in efficacy when compared to **a sham condition, no treatment or conventional therapy** for improving activities of daily living.	10	Ghannadi et al. 2020; Liu et al. 2016; Bai et al. 2013; Hegyi et al. 2012; Zhuang et al. 2012; Park et al. 2005; Alexander et al. 2004; Sze et al. 2002; Gosman-Hedstrom et al. 1998; Johansson et al. 1993
1b	**Moxibustion** may produce greater improvements in activities of daily living than **conventional therapy**.	1	Wei et al. 2016
2	**Integrated rehabilitation techniques** may produce greater improvements in activities of daily living than **the Bobath method.**	1	Zhang et al. 2013
2	**Acupuncture with needle manipulation** may produce greater improvements in activities of daily living than **acupuncture**	1	Zhao et al. 2009
2	**Yamamoto new scalp acupuncture** may produce greater improvements in activities of daily living than **conventional therapy.**	1	Hegyi et al. 2012

RANGE OF MOTION

LoE	Conclusion Statement	RCTs	References

1a	There is conflicting evidence about the effect of **acupuncture** to improve range of motion when compared to **sham or conventional therapy**.	2	Ghannadi et al. 2020; Wang et al. 2020

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Acupuncture** may not have a difference in efficacy when compared to **a sham condition** for improving muscle strength.	1	Park et al. 2005
1b	**Acupuncture with needle manipulation** may produce greater improvements in muscle strength than **acupuncture.**	1	Liu et al. 2009

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1a	**Acupuncture** may not have a difference in efficacy when compared to **a sham condition or no treatment** for improving spasticity.	5	Ghannadi et al. 2020; Wang et al. 2019; Salom-Moreno et al. 2014; Park et al. 2005; Fink et al. 2004
1b	**Moxibustion** may produce greater improvements in spasticity than **conventional therapy**.	1	Wei et al. 2016
2	**Acupuncture with needle manipulation** may produce greater improvements in spasticity than **acupuncture.**	1	Zhao et al. 2009

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1a	**Acupuncture** may not have a difference in efficacy when compared to **sham or conventional therapy** for improving stroke severity.	4	Chen et al. 2016; Liu et al. 2016; Park et al. 2005; Sze et al. 2002
2	**Integrated rehabilitation techniques** may not have a difference in efficacy when compared to **the Bobath method** for improving stroke severity**.**	1	Zhang et al. 2013

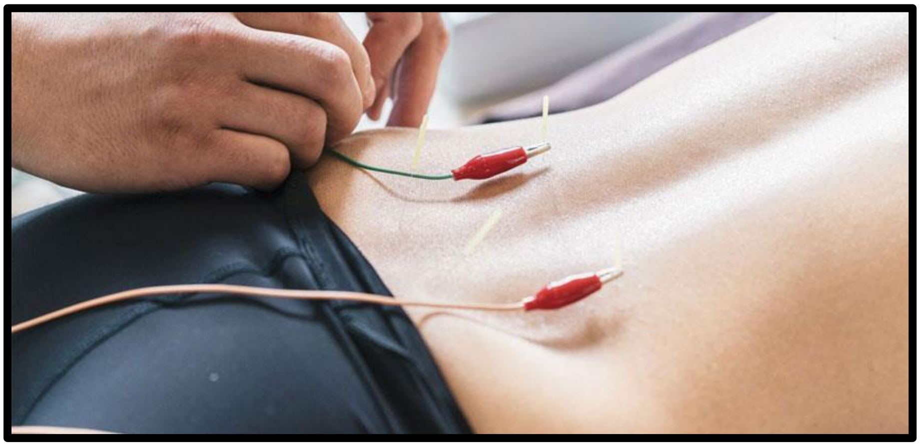
Key Points

Acupuncture may be beneficial for improving balance.

The literature is mixed regarding the use of acupuncture for improving motor function, gait and range of motion

Acupuncture may not be helpful for improving functional ambulation, spasticity, activities of daily living, and stroke severity.

Electroacupuncture and Transcutaneous Electrical Acupoint Stimulation



Adopted from: https://www.promotionhealthcare.com/electroacupuncture-treatment-pain-injuries/

Electroacupuncture is a variant of acupuncture techniques practiced in traditional Chinese medicine, the difference being that a minute electrical current of similar intensity to that of a bioelectric current produced endogenously in the body is applied to the needles used (Wang et al. 2014). The needle is often placed on meridian points throughout the body (Wang et al. 2014). Similarly, transcutaneous electrical acupoint stimulation (TEAS) stimulates meridian points believed to be associated with a medical condition with electrical impulses given through needles (Zhao et al. 2015). The two techniques have very similar mechanisms of action and their influence on afferent stimulation to the body (Zhao et al. 2015).

Six RCTs were found evaluating electroacupuncture and transcutaneous electrical acupoint stimulation for lower extremity motor rehabilitation. Four RCTs compared electroacupuncture to sham electroacupuncture, transcutaneous electrical nerve stimulation, or no acupuncture (Zhao et al. 2015; Hopwood et al. 2008; Hsieh et al 2007; Wong et al. 1997). One RCT comapred high intensity TEAS to low intensity TEAS (Johansson et al. 2001). One RCTs compared electroacupuncture with Heparin to Heparin alone (Si et al. 1998).

The methodological details and results of all six are presented in Table 52.

Table 52. RCTs Evaluating Electroacupuncture and Transcutaneous Electrical Acupoint Stimulation Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Electroacupuncture or TEAS vs Sham, or Conventional Therapy		
Zhao et al. (2015) RCT (9) N_{start}=60 N_{end}=54 TPS=Chronic	E1: High-intensity TEAS (100Hz) E2: Low-intensity TEAS (2Hz) C: Sham TEAS Duration: 30min/d, 5d/wk for 4wk	• Functional Ambulation Classification (-) • Modified Ashworth Scale (-) • Disability Assessment Scale (-) • Global Assessment Scale (-) • Barthel Index (-)
Hopwood et al. (2008) RCT (7) N_{start}=105 N_{end}=92 TPS=Chronic	E: Electroacupuncture C: Sham TENS Duration: 30min/d, 3d/wk for 4wk	• Motricity Index (-) • Barthel Index (-)
Hsieh et al. (2007) RCT (8) N_{start}=63 N_{end}=55 TPS=Acute	E: Electroacupuncture C: Conventional therapy Duration: 20min/d, 2d/wk for 4wk	• Fugl-Meyer Assessment (+exp) • Functional Independence Measure (-)
Wong et al. (1999) RCT (5) N_{start}=118 N_{end}=112 TPS=Acute	E: Electroacupuncture C: Conventional therapy Duration: 2hr/d, 5d/wk for 4wk	• Brunnstrom Recovery Stage (+exp) • Functional Independence Measure (+exp)
TEAS vs High and Low Frequency TENS		
Johansson et al. (2001) RCT (8) N_{start}=150 N_{end}=129 TPS=Acute	E1: Acupuncture + TEAS E2: High-intensity, low-frequency TENS (80Hz) E3: Low-intensity, high-frequency TENS (2Hz) Duration: 30min/d, 2d/wk for 10wk	• Rivermead Mobility Index (-) • 10-Metre Walk Test (-) • Barthel Index (-)
Electroacupuncture with Heparin vs Heparin		
Si et al. (1998) RCT (5) N_{start}=42 N_{end}=39 TPS=Chronic	E: Electroacupuncture + Heparin C: Heparin	• Chinese Stroke Scale (+exp)

Abbreviations and table notes: ANOVA=analysis of variance; C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TEAS=transcutaneous electrical acupoint stimulation; TENS=transcutaneous electrical nerve stimulation; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Electroacupuncture and Transcutaneous Electrical Acupoint Stimulation

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Electroacupuncture** may produce greater improvements in motor function than **conventional therapy**.	1	Hsieh et al. 2007

FUNCTIONAL AMBULATION

LoE	Conclusion Statement	RCTs	References
1b	**TEAS** may not have a difference in efficacy when compared to **sham** for improving functional ambulation.	1	Zhao et al. 2015
1b	**TEAS** may not have a difference in efficacy when compared to **low or high frequency TEAS** for improving functional ambulation.	1	Johansson et al. 2001

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
1b	**Acupuncture with TEAS** may not have a difference in efficacy compared to **high or low frequency TENS** for improving functional mobility.	1	Johansson et al. 2001

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Electroacupuncture or TEAS** may not have a difference in efficacy compared to **sham or conventional therapy** for improving activities of daily living.	4	Zhao et al. 2015; Hopwood et al. 2008; Hsieh et al. 2007; Wong et al. 1999
1b	**TEAS** may not have a difference in efficacy when compared to **low or high frequency TEAS** for improving activities of daily living.	1	Johansson et al. 2001

MUSCLE STRENGTH

LoE	Conclusion Statement	RCTs	References
1b	**Electroacupuncture** may not have a difference in efficacy when compared to **sham** for improving muscle strength.	1	Hopwood et al. 2008

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**TEAS** may not have a difference in efficacy compared to **sham** for improving spasticity.	1	Zhao et al. 2015

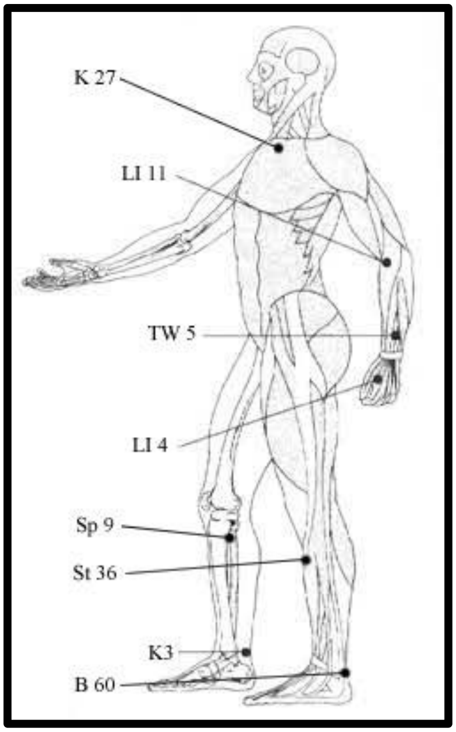
STROKE SEVERITY			
LoE	**Conclusion Statement**	**RCTs**	**References**
2	**Electroacupuncture** may produce greater improvements in stroke severity than **conventional therapy**.	1	Wong et al. 1999
2	**Electroacupuncture with heparin** may produce greater improvements in stroke severity than **heparin** on its own.	1	Si et al. 1998

Key Points

Electroacupuncture may be beneficial for improving motor function and stroke severity.

Electroacupuncture may not be beneficial for improving functional mobility, functional ambulation, spasticity, activities of daily living and muscle strength.

Meridian Acupressure



Adopted from: https://www.acupressure.com/articles/acupuncture_and_acupressure_points.htm

Meridian acupressure is a Chinese medicine treatment that involves placing needles on twelve strategic points of the body. These points are known as meridians and placing needles here helps to alleviate the blockage of energy (otherwise known as qi) (Yue et al. 2013).

One RCT was found that evaluated meridian acupressure techniques for lower extremity motor rehabilitation. This RCT compared meridian acupressure to no acupressure (Yue et al. 2013).

The methodological details and results of this RCT evaluating meridian acupressure interventions for lower extremity motor rehabilitation are presented in Table 53.

Table 53. RCTs Evaluating Meridian Acupressure Interventions for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
Acupressure vs No Acupressure		
Yue et al. (2013) RCT (6) N$_{start}$=78 N$_{end}$=71 TPS=Chronic	E: Acupressure C: No acupressure Duration: *Not Specified*	• Fugl-Meyer Assessment (+exp) • Barthel Index (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Meridian Acupressure

BALANCE			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Meridian acupressure** may produce greater improvements in balance than **no meridian acupressure**.	1	Yue et al. 2013

ACTIVITIES OF DAILY LIVING			
LoE	**Conclusion Statement**	**RCTs**	**References**
1b	**Meridian acupressure** may produce greater improvements in activities of daily living than **no meridian acupressure**.	1	Yue et al. 2013

Key Points

Meridian acupressure may be beneficial for improving balance and activities of daily living.

Traditional Herbal Medicines

Adopted from: https://drmeelainling.com/herbs-diet/

Traditional Chinese, Japanese and Indian herbal medicine are complementary and alternative forms of medicine that have been utilized as a healthcare system in Asian countries for hundreds of years and are widely used for stroke treatment today (Tsai et al. 2017; Han et al. 2017). Different herbal medicines have various beneficial properties such as anti-inflammatory, increasing cerebral blood flow velocity, inhibiting platelet aggregation, increasing tissue tolerance to hypoxia, etc. (Han et al. 2017). Chinese and Japanese herbal medicines commonly used for stroke rehabilitation generally consist of a mixture of different plant and animal extracts with these varying properties (Han et al. 2017).

Eight RCTs were found evaluating Chinese herbal medicine for lower extremity motor rehabilitation. Three RCTs compared NeuroAid to placebo (Venketasubramanian et al. 2015; Chen et al. 2013; Kong et al. 2009). Five RCTs compared other traditional herbal medications (including Dihuang Yinzi, Shaoyao Gancao, Astragalus Membranaceus, and Tokishakuyakusan) to placebo, conventional therapy, or no medication (Ahmed et al. 2015; Yu et al. 2015; Zhu et al. 2014; Chen et al. 2012; Goto et al. 2009).

The methodological details and results of all eight RCTs are presented in Table 54.

Table 54. RCTs Evaluating Chinese Herbal Medicine for Lower Extremity Motor Rehabilitation

Authors (Year) Study Design (PEDro Score) Sample Size$_{start}$ Sample Size$_{end}$ Time post stroke category	Interventions Duration: Session length, frequency per week for total number of weeks	Outcome Measures Result (direction of effect)
NeuroAid vs Placebo		
Venketasubramanian et al. (2015) **Note**: Extension Study based on Chen et al. 2013 (CHIMES) RCT (5) N$_{start}$= 880 N$_{end}$= 701 TPS=Chronic	E: NeuroAid (400mg) C: Placebo (400mg) Duration: 4 capsules/d, (3x/d) of NeuroAid OR Placebo for 12wk	- Modified Rankin Scale (-) - Barthel Index (-)
Chen et al. (2013) (CHIMES Study) RCT (7) N$_{start}$=1100 N$_{end}$=777 TPS=Acute	E: NeuroAid (400mg) C: Placebo (400mg) Duration: 4 capsules/d, (400mg, 3x/d) of NeuroAid OR Placebo for 12wk	- Modified Rankin Scale (-) - Barthel Index (-) - Mini Mental State Examination (-) - NIH Stroke Scale (-)
Kong et al. (2009) RCT (8) N$_{start}$=40 N$_{end}$=40 TPS=Acute	E: NeuroAid (Amount Not Specified) C: Placebo (Amount Not Specified) Duration: 4 capsules/d, (3x/d) of NeuroAid OR Placebo for 8wk	- Fugl-Meyer Assessment (-) - Functional Independence Measure (-) - NIH Stroke Scale (-)
Other Herbal Medications vs Placebo, Conventional Therapy, or No Medication		
Ahmed et al. (2015) RCT (4) N$_{start}$=40 N$_{end}$=40 TPS=Not Reported	E: Unani Medicine (Herbal and Massage) C: Western Medicine (Piracetam 800mg) Duration: Medications 1x/d, 28d - Massage 15min, 1x/d, 2wks)	- Stroke Rehabilitation Assessment of Movement (+exp) - Lower Limb (+exp) - Mobility (+exp)
Yu et al. (2015) RCT (4) N$_{start}$=100 N$_{end}$=86 TPS=Chronic	E: *Dihuang Yinzi* + Physiotherapy (18g) C: Placebo + Physiotherapy (18g) Duration: 18g of *Dihuang Yinzi* OR placebo (2x/d) for 12wk	- Fugl-Meyer Assessment (+exp) - Barthel Index (+exp)
Zhu et al. (2014) RCT (6) N$_{start}$=60 N$_{end}$=55 TPS=Chronic	E: *Shaoyao Gancao* + Physiotherapy (10mL) C: No medication + Physiotherapy Duration: 10mL of *Shaoyoo Gancoo* (3x/d) for 4wk	- Modified Ashworth Scale (+exp) - Composite Spasticity Scale (+exp) - Fugl-Meyer Assessment (+exp) - Barthel Index (+exp)
Chen et al. (2012) RCT (9) N$_{start}$=78 N$_{end}$=66 TPS=Acute	E: *Astragalus Membranaceus* (3g) C: Placebo (3g) Duration: 3g of *Astragalus Membranaceus* OR placebo (3x/d) for 2wk	- Functional Independence Measure (+exp) - Barthel Index (-) - Modified Rankin Scale (-)
Goto et al. (2009) RCT (6) N$_{start}$=31 N$_{end}$=30 TPS=Chronic	E: *Tokishakuyakusan* (2.5g) C: No medication Duration: 2.5g of *Tokishakuyakusan* (3x/d) for 1yr	- Stroke Impairment Assessment Scale (+exp) - Functional Independence Measure (+exp)

Abbreviations and table notes: C=control group; D=days; E=experimental group; H=hours; Min=minutes; RCT=randomized controlled trial; TPS=time post stroke category (Acute: less than 30 days, Subacute: more than 1 month but less than 6 months, Chronic: over 6 months); Wk=weeks.
+exp indicates a statistically significant between groups difference at α=0.05 in favour of the experimental group
+exp$_2$ indicates a statistically significant between groups difference at α=0.05 in favour of the second experimental group
+con indicates a statistically significant between groups difference at α=0.05 in favour of the control group
- indicates no statistically significant between groups differences at α=0.05

Conclusions about Traditional Chinese Herbal Medicine

MOTOR FUNCTION

LoE	Conclusion Statement	RCTs	References
1b	**Other herbal medications** may produce greater improvements in motor function than **conventional therapy.**	3	Ahmed et al. 2015; Yu et al. 2015; Zhu et al. 2014
1b	**NeuroAid** may not have a difference in efficacy when compared to **placebo** for improving motor function.	1	Kong et al. 2009

FUNCTIONAL MOBILITY

LoE	Conclusion Statement	RCTs	References
2	**Unani medicine** may produce greater improvements in functional mobility than **western medicine (piracetam).**	1	Ahmed et al. 2015

ACTIVITIES OF DAILY LIVING

LoE	Conclusion Statement	RCTs	References
1a	**Other herbal medications** may produce greater improvements in activities of daily living than **placebo, conventional therapy, or no medication**	4	Yu et al. 2015; Zhu et al. 2014; Chen et al. 2012; Goto et al. 2009
1a	**NeuroAid** may not have a difference in efficacy when compared to **placebo** for improving activities of daily living.	3	Venketasubramian et al. 2015; Chen et al. 2013; Kong et al. 2009

SPASTICITY

LoE	Conclusion Statement	RCTs	References
1b	**Other herbal medications** may produce greater improvements in spasticity than **conventional therapy.**	1	Zhu et al. 2014

STROKE SEVERITY

LoE	Conclusion Statement	RCTs	References
1b	**Other herbal medications** may not have a difference in efficacy when compared to **placebo** for improving stroke severity.	1	Chen et al. 2012
1a	**NeuroAid** may not have a difference in efficacy when compared to **placebo** for improving stroke severity.	2	Chen et al. 2013; Kong et al. 2009

Key Points

NeuroAid may not be beneficial for improving stroke severity.

Other herbal medications such as Dihuang Yinzi, Shaoyao, Gancao, Astragalus Membranaceus, and Tokishakuyakusan may be beneficial for improving motor function, functional mobility, spasticity and activities of daily living.

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