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Recommendations for Physiotherapy Intervention after Stroke

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Abstract

Stroke is the leading cause of disability and one of the leading causes of death in the world. The number of stroke survivors is projected to increase by 25%, which is a major financial challenge for society given that stroke survivors are living with major and long-lasting consequences including immobility. Physiotherapy plays a significant role in the rehabilitation of patients' functional movement after the stroke occurs. Neurophysiotherapy divides into acute phase, subacute phase and chronic phase according to the time of recovery. The aim of the paper is to review those interventions based on expertly and scientifically proven effects by reviewing available physiotherapy interventions and methods.

The complex field of Neurophysiotherapy needs to be directed towards specific and scientifically effective methods of treating patients affected by a stroke. For the problem reasoning approach of physiotherapy treatment of patients affected by a stroke it is recommended: early mobilization, treatment of shoulder pain and subluxation, mobilization of the feet, treatment of somatosensory functions, balance, muscling from sitting to standing, muscle strengthening and endurance exercises, cyclic bilateral arm and leg training, gait training, mirror therapy, CIMT, application of robotics and virtual reality, hydrotherapy, electrotherapy, and education and social activation of the patient and his or her family.

Conclusion: It is necessary to constantly monitor and research new methods of treatment and evidence of the effectiveness of individual methods. Specific recommendations for physiotherapy treatment of a patient after a stroke can assist the physiotherapist in day-to-day clinical practice and standardize effective treatment methods. Recommendations for physiotherapy treatment for a patient with disabilities after a stroke allow the physiotherapist to develop a creative approach in treating the patient within physiotherapy based on scientifically proven methods.

Keywords: Neurophysiotherapy; Recommendations; Scientifically effective therapy; ASA; AHA

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Introduction

Stroke is defined by The World Health Organization (WHO) as rapidly developed clinical signs of focal or global disturbance of cerebral function, lasting more than 24 h or until death, with no apparent non-vascular cause [1]. Although this definition is still in use, it mostly relays to clinical symptoms so American Heart Association (AHA) and American Stroke Association (ASA) consider it outdated. While the definition is outdated, none of the associations mentioned above, nor any other respected organization has not yet formally adopted a modern version of the definition [2,3]. A stroke is the leading cause of disability and death in the world, and it is defined as neurological deficit which can be caused by narrowing and blocking of the artery which causes ischemic stroke, apropos rupture of the blood vessel which is called hemorrhagic stroke. Both retinal and spinal stroke are pathological subtypes that include ischemic stroke while Intracerebral Hemorrhage (ICH) and Subarachnoid Hemorrhage (SAH) are subtypes of hemorrhagic stroke. Also, as one of the neurological disabilities caused by vascular origin, a temporary interruption of blood flow to the brain may occur, which does not cause permanent neurological damage? [2-5].

A stroke affects more than 600 thousand Europeans every year, and predictions are that by 2035 the number of people affected by a stroke will increase by 34%. Also, the European stroke organization projects that the number of people surviving a stroke will increase by 25% which is a great financial challenge for some of the European countries considering that the ones who survive a stroke end up giving with great and long-term consequences including immobility [6]. Diagnosis of a stroke is made clinically and is confirmed by Computed Tomography (CT) or by a Magnetic Resonance

(MR). Treatment starts as soon as the diagnosis is being set and it is conducted in the unit for treating a stroke. Optimal neurological treatment and medical care procedures are performed in those units according to the status of acute stroke [7,8]. Neurophysiotherapy is divided into an acute, subacute and chronic phase, according with a time course. The acute phase refers to the time spent in a unit for treating a stroke or the time spent in an acute neurological unit which deals with the treatment of stroke. Neurophysiotherapy is, in this phase, limited by restrictions considering acute treating, but it is possible to already conduct early mobilization processes, depending on the general medical condition of a patient. In the subacute phase, the patient is medically stabilized and rehabilitation procedures can be conducted considering functional damages caused by a stroke. Here, Neurophysiotherapy includes wide range of different techniques and methods or facilitation and reeducation of postural control intent to recover mobility of the patient and to enable him to take care of himself and integrate back to society. Consequences of the stroke usually disable patients´ recovery to full mobility as it was before the stroke, so here it is about a targeted recovery of optimal functioning. Since a lot of patients show some functional deficit even after an intensive medical treatment it is needed to chronical rehabilitation has to be conducted. The importance in chronical phase of rehabilitation is secondary prevention of new cardiovascular and cerebrovascular incidents and the maintenance and advancement of the achieved functional motor skills [8-10].

Problem resolving approach in Neurophysiotherapy with patients after a stroke is using a model of clinical concluding according to International classification of functioning, disability and health, ICF which means noticing and treating of patients` problems by participating, activity, body structure and function [11,12].

In the process of clinical concluding, assessment is the first and the most important step process of rehabilitation and it is also the beginning of clinical reasoning on which relies the making of short and long-term goals and the choosing of therapeutic interventions [13]. Lots of neurological damage which is caused by a stroke can affect the functional state of the patient, and the most common disorders are with orientation and perceptions, communication disturbance, damage to the cranial nerves, damage to the musculoskeletal system and damage to the senses of balance, coordination and posture [8]. When it comes to the assessment, first and foremost is the observation of neuromuscular damage, analysis and hypothesis of its interactions, differentiation of problems and definition of the primary and the secondary problems. Regarding the standardization of physiotherapy assessment methods for patients affected by a stroke it is recommended to use tests and measurements of high reliability and validity. Given the diversity of damage caused by a stroke, besides assessing motor control, it is necessary to determine whether there is a deficit of sensory and cognitive functions that also affect motor control. The goals set in the therapy plan must be specific, measurable and achievable (possible), relevant to the patient and time determined. Treatment methods must be aligned with the objectives and efforts should be made to apply those methods that have scientifically proven effects. The process of evaluation and reevaluation enables constant control of the planned goals and methods and their effects in therapy [13-15].

By making physiotherapy interventions, the physiotherapist reduces damage at the level of structures and functions in order to increase the patient's activity and ultimately his participation in society. The physiotherapy intervention is aimed at improving the control of posture and movement of the patient and the regulation and normalization of muscle tone for optimal functioning of the patient. The physiotherapist adjusts interventions to the patient's needs, individualizes and evaluates the outcomes of the treatment. The treatment must be functional, meaning that the effects of the treatment of the individual components of posture and movement must be optimally integrated into the Activity of Daily Living (ALD). Through his or her interventions, the physiotherapist utilizes appropriate, scientifically based techniques and skills aimed at mobilizing joints, neuromuscular and connective tissue, inhibiting abnormal movement patterns and stimulating normal forms of movement, balance and functional activity. Physiotherapy intervention is problem-oriented and the physiotherapist plans and defines short and long-term goals based on the examination and functional assessment of the patient [10,16].

The evaluation and physiotherapy interventions used in the treatment should be related, and it is important to continually evaluate the patient's reactions throughout the treatment. Physiotherapy assessment is mandatory from the acute to the chronic phase of rehabilitation, while interventions performed at each stage of neurological rehabilitation depend on the identified problems and the patient's condition. By reevaluating treatments, concluding is the patient achieving or not achieving treatment goals there may come a need for modification of the goal and/or intervention with explanation [17,18].

Given the wide range of possible functional damage after a stroke and individual bio-psychological sociological differences of each individual, physiotherapy assessment needs to be individual. Besides a need for individual treatment there is also a need for recognizing certain common recommendations and standards for physiotherapy treatment for patients dealing with consequences of stroke.

The goal of reviewing physiotherapy interventions and methods is to recommend the ones which are based on professional and scientifically proven effects.

Recommendations for Physiotherapy Intervention

Physiotherapy treatment in the acute phase of stroke

Patient positioning is performed at all stages of recovery, but most important is at a very early stage of recovery (within 24 h), when the patient does not have the ability of his own automatic postural control to maintain and change position [19,20]. Therapeutic positioning in bed, chair or wheelchair prevents complications of inactivity: decubitus, edema, respiratory complications, feeding problems, pain and subluxation in the shoulder. Positioning enables the maximization of functional recovery potentials, creating a somatosensory input necessary for normalization of consciousness and motor control. Guiding the transition from one position to another enables to maintenance of optimal activity and alignment in different positions [10,21,22]. Positioning needs to modify the patient's environment, and involves supporting unstable, inactive or fixed body segments to allow optimal physiological posture in the bed [22,23]. The time in which the position has to be held depends on the goals and objectives and should not exceed two hours. The activities performed on the patient should be planned so that the patient also receives sensory input through the damaged segments of the body [10,22,23]. Early mobilization depends on the patient's medical condition, can begin as early as 24 h and contains maintenance of soft tissue and joint mobility, transition in bed, sitting and standing upright. Early mobilization enhances the patient's final functional recovery and should be performed several times a day for a duration appropriate for the patient's functional capabilities [24,25].

Supportive techniques and aids for the prevention or treatment of glenohumeral subluxation and shoulder pain

Shoulder subluxation is one of the major complications that occur in approximately 84% of people with CVI. It occurs due to the hypotone of the supporting musculature of the shoulder and may be exacerbated by external forces. Improper treatment leads to a greater risk of traction neuropathy and shoulder injury [26]. Caregivers of patients with CVI should be adequately trained for the treatment of hemiplegic arm, especially in shoulder subluxation [26-29]. Wearing of immobilizer belts, i.e. orthoses, and being supported by pillows or foam helps to keep the arm and shoulder in the correct position. Good positioning will help reduce ligament strain and prevent the appearance of a frozen shoulder [26-28,30]. A study by Nadler et al. [30] reveals that reducing shoulder subluxation with orthosis can reduce pleural shoulder pain [26,30]. Subluxated shoulder can be treated with taping [26,31], Neuromuscular Electrostimulation (NES) [26,32] strength exercises and training oriented to the functional goal of the upper extremities [26,33].

Maintaining foot dorsiflexion

Patients affected by stroke often manifest equinovarus, equinus and equinovalgus deformities, which are caused by spasticity of posterior tibialis and/or triceps surae, and paresis of the dorsiflexion and evertors of the foot [34,35]. For spasticity scores 1-2 on the Ashworth scale, the use of Ancle Foot Orthosis (AFO) may provide sufficient support to correct this position [35]. AFO provides anterior-posterior and medial-lateral stability of the wrist and improves body symmetry in static and dynamic conditions. During gait, it increases the speed and frequency of gait (cadence), the length of steps, reduces the risk of falls and increases stability in paretic foot, which improves gait pattern. The effectiveness of this orthosis is minimal for chronic hemiparesis patients [36,37]. Devices for passive stretching of the foot in the direction of dorsiflexion/plantarflexion, can be an effective alternative to manual passive mobilization as they also improve the range of motion in the ankle and the reduction of deformities [34,38].

Treatment of improvement of somatosensory function of the paretic extremities

Interventions used to improve the somatosensory function of the paretic arm are tactile stimulation of the arm, washing the hands with water at different temperatures, or differentiating the shape, weight, or structure of the item placed by the therapist in the patient's arm [39]. In the treatment of the paretic leg, the patient provides feedback in the detection, localization, differentiation or recognition of different sensory stimuli, pressures or objects, and proprioceptive training of standing and walking on different surfaces [40]. Exercises can be performed in a supine, standing, or sitting position, and it is required that the patient positions the paretic and non-paretic limbs in different positions [39,40]. These interventions improve the somatosensory functions of the paretic arm and legs, and it is recommended that somatosensory functions be integrated into existing exercise programs to improve agility [39-41].

Facilitation of balance reactions

The goal of facilitating balance in sitting is to improve control and dynamic stabilization of the body [42]. The sitting balance allows for many sensory inputs, enhances the performance of upper limb activities, and transitions from one postural position to another [43,44]. Balancing exercises are performed in all body postures where upright and protective reactions are stimulated [45], with the task of maintaining balance in different body postures. Balancing exercises prevent falls during maintenance or change of body position, movement and performing functional activities. Balance training contains body mass transfers with reaching for the subject, balance exercises in standing with gradual reduction of the base of support, transfers of body mass from one leg to the other, standing on one leg with and without adherence, exercises on unstable support surfaces, exercises with and without visual controls, polygons involving balancing platforms, overcoming obstacles, organizing in space and activity against gravity [46,47]. Balance training on the balance platform, with visual feedback relative to standard physiotherapy treatment, improves postural control, reduces postural sway and instability, increases pelvic displacement in the frontal plane, improves body mass transfer and prolongs the standing phase on the paretic leg. This balance training normalizes neuromuscular patterns and increases sensory perception, resulting in improved dynamic balance, gait normalization and progress in functional independence in activities of daily living. Balancing training should be adapted to the functional status of the patient, has to be performed in patients with ataxia, and it is necessary to prevent falls that can cause injury [48,49].

Facilitation of activity from sitting to standing

Facilitation of activity from sitting to standing and standing activity promotes equilibrium reactions and normalization of automatic postural control of the lower extremities, trunk and head. The development of consciousness, body schema and relationships with the environment is encouraged, and the activity is integrated into meaningful functional activities. Tactile and proprioceptive optimal components of the movement from sitting to standing and standing activity are stimulated. In the standing position, transfers of the center of mass of the body are facilitated in all planes and the establishment of stable body references is stimulated in relation to the mobile segments of the body [10,50-52]. Facilitation of activity from sitting to standing and standing treatment is performed daily or occasionally according to the functional condition of the patient, and orthoses is used as needed. The duration of standing gradually increases and depends on the ability of the patient [10]. Selective activity from sitting to standing facilitates the adoption of necessary components and gait patterns [50,52].

Dexterity treatment during mobilization phase

Recovery of the paretic arm shows a tendency in which the grip function returns first, followed by the extension and rough grip, the last function to be recovered is the tweezers grip [53]. Concepts using the hands-on approach show the best results for improving skills. Some of the concepts that apply are: Bobath concept, PNF concept (Proprioceptive Neuromuscular Facilitation), Vojta concept, MRP treatment (Motor Relearning Program), and techniques such as CIMT (Constraint-Induced Movement Therapy), Mirror therapy and the like [54].

Exercises of muscular strength and endurance

The goal of strength exercises is to increase muscle mass, muscle strength and metabolism, to improve body schema and the overall functioning of the neuromuscular system. Exercises are performed for appropriate muscles and muscle groups, with specific emphasis on the paretic musculature and the patient's functional condition [46,55-59]. External loads (weights, straps, and springs) are used in the performance of strength exercises or the proper use of body mass and gravity is used to achieve the effects of strength training. The load may be minimal to maximal depending on the patient's functional condition, and the exercises are performed in 10 to 12 repetitions in three to five series. Strength exercises should be performed according to the program for individual muscles or muscle groups, and excessive loads and irregular exercise patterns should be avoided [46,55,58-60]. Endurance exercises are activities of lower intensity but of longer duration. Endurance exercises include walking, running, cycling, or various aerobic exercises according to the patient's functional condition [57-60]. Endurance exercises increase general endurance, cardiovascular and neuromuscular capacity, and prevent fatigue. This training should be performed two to three times a week in a period of 0 min to 40 min, with an intensity of 60% to 80% of the maximum heart rate [58,59]. In patients with stroke, endurance and strength training should be included in the treatment, but at the same time excessive loads of the cardiovascular and locomotor systems should be avoided [46,55,57-60].

Cyclic bilateral arm and leg training

Bilateral training consists of repetitive extremity movements in a symmetrical or asymmetrical pattern. Research indicates the effectiveness of specific exercises for hemiparetic gait if there is a large number of a repetitive movement [61]. Bilateral leg training increases length of the steps, which is probably the result of improved muscle coordination around the knee and hip joints in such exercises, but this motor parameter was not maintained after three months of patient monitoring [62]. Bilateral upper limb training after CVI is based on the assumption that the movement of the non-paretic upper extremity supports the movement of the paretic upper extremity when performed simultaneously. It has a beneficial effect on muscle strength, range of motion and dexterity of the paretic arm. No negative effects were found on muscle tone in these arm exercises. Repeating active goal-directed repetition of 60 min a day for 2 weeks resulted in improved grip function in patients with chronic hemiparesis [63,64].

Facilitation and walking training

In order to facilitate the reeducation of gait, the components of the normal gait phases are stimulated. Reeducation involves stimulation of the stability phase and the mobility phase of the lower extremities, with adequate postural adaptation of the trunk, head and upper extremities. Walk training provides independent and safe movement indoors and outdoors and optimum mobility for performing the activities of the patient's daily life. The re-education of the gait pattern involves the integration of the learned components of the gait phase into the functional walking activity and is carried out on different surfaces of the support, outdoors and indoors and on the steps [50,65-67]. If necessary, walking aids such as: walking stick, roller, stabilization orthoses, peroneal orthoses, foot up orthoses and foot bandages are used. In addition to straight-line walking, one learns to move sideways and backwards [10,68,69]. Facilitation of treadmill training with full or partial load increases walking speed and stride length [70-73], while walking training with an external auditory rhythm encourages rhythmic walking in gait activity [74]. Training on a non-weight-bearing treadmill should be carried out at least 3 times a week in a period of 3 to 4 weeks, and it is recommended to train at low speed (0.2 m/s) and increase speed and travelled distance every week [41]. Walking training on a treadmill at a load of 10% to 45% of body weight can lead to improved gait and increases walking speed [75]. Relieving body weight from 45% to 50% of the patient on the treadmill has a negative impact on the walking ability of the stroke patient. The positive effects of training on the treadmill are better balance, increased physical endurance, [76] increased ability [76,77] and speed walk [77,78]. The treadmill is recommended as a suspension for patients who are unable to walk independently or who are physically weak, with an initial load of 30% to 40% body weight, with a low walking speed of 0.1 to 0.3 m/s at the start of training. Initially, a 20-min workout is recommended, including 3 short walking sessions (about 5 min each), with breaks between each session. The goal is to increase walking speed, travelled distance and duration and reduce body support to 0% over a 3 to 6 week period [41]. Circuit gait training and activities related to functional mobility improve the length and speed of walking, sitting and standing balance, and reduce patient inactivity [79-81].

Robot assisted gait training (RAGT)

Robots in rehabilitation are electromechanical devices that give external force to the patient's limbs and create normal kinematics for walking performance [82,83]. Robotics provides new opportunities in CVI rehabilitation. Multiple studies have compared the outcomes of a CVI rehabilitation program that includes RAGT with or without conventional therapy with a conventional non-robotics therapy program. Gait function was assessed before and after treatment with various gait tests and balance assessment. All groups showed significant improvement in all outcome measures after treatment, but there was no difference between the groups. It was concluded that RAGT can provide improvement in balance and gait comparable to conventional physical therapy [84-86]. Robotic devices can be classified as exoskeletons that move joints (hips, knees, and ankles), control them during walking phases, and end-effector robots that move only a foot, simulate a stance and swing phase during walking. Another possible classification is by site of action and we can define them as static or dynamic [87]. Clinical research suggests that manual therapy is still more effective than robotic walking training in the subacute and chronic stages [88-90]. The reason may be a decrease in postural control during robot training, often due to the limitations of this passive assist in the swing provided by the robot [89].

Robotics in hand rehabilitation

The results of the studies show that after 15 sessions of intensive robot-assisted rehabilitation therapy, patients with severe and moderate upper extremity damage after stroke show better recovery than those receiving intensive traditional therapy. This finding was confirmed after 30 sessions, although FM (Fugl-Meyer Assessment Scale) and MI (Motricity Index) improved significantly in both groups at the end of treatment. Robotic rehabilitation is more often performed in chronic patients with CVI, where efficacy is more related to the intensity rather than the specificity of the robotic approach. The results of robotic-assisted treatment in subacute phase effectively improve motor performance over a shorter period of time than usual intensive physiotherapy, thus accelerating motor recovery. The results show an effect on reducing spasticity and reject the hypothesis that robotics may be responsible for the increased risk of spasticity [91-95].

Mirror therapy

In mirror therapy, the patient performs movement with the non-paretic extremity while observing his mirror reflection, thereby creating a visual illusion of the paretic limb's ability to move. The patient is instructed to move both arms and legs toward a point or object on the table while constantly looking in the mirror and moving the non-paraical limb [96-100]. Studies show that chronic stroke patients that undergo mirror therapy for 25 min for 6 days a week achieve significant results in the increase of the active range of motion, speed, precision and dexterity in the movement of the hands after 4 weeks. On the lower extremity, mirror therapy has achieved significant results in increasing dorsal flexion of the paretic foot and increasing walking speed [96,101].

(Modified) Constraint induced movement therapy (CIMT)

The method is aimed at establishing the function of the affected limb among persons that suffered a stroke, where the nonparetic arm is limited by temporary immobilization or functional restriction with a glove for a certain period of time while the paretic arm is free and has the opportunity to participate in activities and tasks [102]. The therapy is performed in a period of 2 weeks, about 6 h a day, and the patient must have at least 10° of active extensions in the metacarpophalangeal joint, at least 20° of active extensions in the wrist, high motivation and psychic stability [103]. By limiting the non-parietal arm, CIMT forces the use of the paretic arm and brings it to the level of functional activity [104]. The disadvantage of this therapy is that the physiotherapist or occupational therapist must spend 6 or more hours with the patient for at least 2 weeks and guide him through various therapies and activities that focus on the injured hand. Therapy consists of stretching, strength and coordination exercises, and the application of the simplest to complex activities-hand and finger functions. A modified version of forced-motion therapy is also in use [105].

Virtual reality training

Virtual reality is a way for people to visualize, manipulate and interact with computers and extremely complex data. Computerized virtual reality simulations when coupled to robots, motion monitoring systems, and adaptive sensor gloves utilize participants' instantaneous efficiency and effectiveness. The arm and fist can undergo the therapy at the same time or in isolation. Unilateral and bilateral arm and fist activities are ensured in three-dimensional space. This technique can be used to train rough motor functions of the arm as well as to grasp and manipulate objects. The patient is provided with visual and sometimes auditory feedback on the correctness of their movements. Exercises can be performed with or without supervision. This physiotherapeutic intervention involves repetition, motivation and it presents a challenge for the patient. The training should be performed 30 min per session, preferably 5 days a week for several weeks. As this form of training can lead to increased muscle tone, this aspect should also be monitored [106-108].

Electrotherapy

In the treatment of hemiparetic patients, Neuromuscular Electrostimulation (NMS) is used for the integration into functional walking activities where it stimulates body segments at a particular walking stage, called Functional Electrostimulation (FES), and Transcutaneous Electrical Nerve Stimulation (TENS), which have the effect of reducing pain. The goal of electrostimulation is to increase the range and selectivity of movement and muscle strength in patients with hemiparesis [109-111]. Electromyographic Biofeedback (EMG-BF) is a form of therapy in which muscle activity is converted into visual and/or auditory information for the patient and the therapist. The patient is asked to increase or decrease the activity of the relevant muscles while performing the intended movement. On the lower extremities, walking speed, symmetrical distribution of body weight while standing and range of motion of the ankle or knee are improved [112]. Electromyographic Biofeedback effectively increases range of motion, reduces spasticity, improves coordination and precision on the upper extremity. Functional use of hands in activities of daily living also improves with this form of therapy [112,113]. It is applied to the pelvic floor muscles in the treatment of incontinence [114]. Therapeutic ultrasound acts on musculoskeletal disorders such as pain, muscle spasm, joint contracture and tissue injury [115-118].

Hydrotherapy

In physiotherapy for stroke patients, mechanical and thermal properties of water are used as therapeutic exercises to improve balance, muscle strength, endurance and agility. Therapy exercises in water can be individual or group, and include aerobic training, functional gait training or specific exercises and swimming based on the Halliwick concept. Hydrotherapy is effective in increased muscle strength, levels of satisfaction and improvement in quality of life [119-121].

Facilitation of daily life activities, education and social activities

The Activities of Daily Living (ADL) are the basic activities that enable functioning, relating to personal hygiene, feeding and drinking, going to the toilet [60,122,123]. Their effectiveness depends on the person's ability to perform the transfer and requires the use of at least one hand. Difficulties in ADL can be caused by physical and/or cognitive impairment, and a specific problem-oriented approach needs to be included in treatment. It is important to encourage self-care, to involve and educate the family in the conduct of ADL and to ensure that the patient carries out the activity safely [122,123]. The education of the patient's family and the caregiver must include information about the treatment options they can perform as recommended by the physiotherapist [60]. For the fullest recovery of day-to-day functioning, the patient should be more actively involved in family roles or in the social environment, which includes actively spending leisure time [124] and, where possible, encouraging the person to return to a previous job or a new, adapted job [125].

Conclusion

The consequences of stroke on a person's functioning are complex and occur in various combinations of cognitively perceptual, emotional, sensory and motor problems. Functioning represents a wide area that represents the bio-psycho-social model and includes normal body structures and body functions, normal ability to perform activities, and involvement in the social environment. Physiotherapy deals with the evaluation and treatment of problems related to the recovery of motor function. Motor functioning is determined by genetic inheritance and acquired motor habits, skills and behaviors through life. In a problem-solving approach, physiotherapy must be based on theories of motor control and motor learning, and must be individually tailored to the patient's impairment and past habits and abilities. Due to the complexity of the impairment and the consequences of impaired motor function, there is a need for a quantitative and qualitative approach in the physiotherapy of patients after stroke. At the same time, in order to direct a very complex field of neurological physiotherapy towards concrete and scientifically effective methods of treating stroke patients, it is necessary to constantly monitor the emergence of new treatment methods and evidence of the effectiveness of individual methods. Specific recommendations for physiotherapy treatment of a patient after a stroke can assist the physiotherapist in day-to-day clinical practice and standardize effective treatment methods. The goal of the recommendation for physiotherapy treatment of a patient with a stroke is for the physiotherapist to develop a creative approach to treating the patient within physiotherapy based on scientifically proven methods.

References

1. The World Health Organization MONICA Project (monitoring trends and determinants in cardiovascular disease): a major international collaboration. WHO MONICA Project Principal Investigators. J Clin Epidemiol. 1988;41(2):105-14.
2. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, et al. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013;44(7):2064-89.
3. Coupland AP, Thapar A, Qureshi MI, Jenkins H, Davies AH. The definition of stroke. J R Soc Med. 2017;110(1)9-12.
4. Easton JD, Saver JL, Albers GW, Alberts MJ, Chaturvedi S, Feldmann E, et al. Definition and evaluation of transient ischemic attack: a scientific statement for healthcare professionals from the American Heart Association/American Stroke Association Stroke Council; Council on Cardiovascular Surgery and Anesthesia; Council on Cardiovascular Radiology and Intervention; Council on Cardiovascular Nursing; and the Interdisciplinary Council on Peripheral Vascular Disease: the American Academy of Neurology affirms the value of this statement as an educational tool for neurologists. Stroke. 2009;40(6):2276-93.
5. Xie X, Atkins E, Lv J, Bennett A, Neal B, Ninomiya T, et al. Effects of intensive blood pressure lowering on cardiovascular and renal outcomes: updated systematic review and meta-analysis. Lancet. 2016;387(10017):435-43.
6. James SL, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1789-858.
7. Peisker T, Koznar B, Stetkarova I, Widimsky P. Acute stroke therapy: a review. Trends Cardiovasc Med. 2017;27(1):59-66.
8. Schnurrer-Luke-Vrbanić T, Avancini-Dobrović V, Bakran Ž, Kadojić M. Smjernice za rehabilitaciju osoba nakon moždanog udara. Fizikalna i rehabilitacijska medicina. 2015;27(3-4):237-69.
9. Mills V, Cassidy JW, Katz DI. Neurologic rehabilitation: a guide to diagnosis, prognosis, and treatment planning. Hoboken: Blackwell Science, New Jersey, United States; 1997.
10. Grozdek Čovčić G, Maček Z. Neurofacilitacijska fizioterapija. Zagreb: Zdravstveno veleučilište; 2011.
11. World Health Organization. Geneva: International classification of functioning, disability and health (ICF): 22 May 2001. World Health Organization [Internet].
12. Rosenbaum P, Stewart D. The World Health Organization International Classification of Functioning, Disability, and Health: a model to guide clinical thinking, practice and research in the field of cerebral palsy. Semin Pediatr Neurol. 2004;11(1):5-10.
13. Mario M, Ivan B, Zdravko M, Marin T, Mario K. Metode fizioterapijske procjene nakon moždanog udara . Physiotherapia Croatica. Supplement. 2019;16:35-42.
14. Party IS. National clinical guideline for stroke. London: Royal College of Physicians, UK; 2012.
15. Edwards S. Neurological Physiotherapy: A problem-solving approach. London: Churchill Livingstone, London, UK; 2002.
16. Coling MC. Developing integrated programs: A transdisciplinary approach for early intervention. Therapy Skill Builder; 1991.
17. Jones K. Neurological Assessment: A Clinician's Guide. Edinburgh: Elsevier Health Sciences, UK; 2011.
18. Belagaje SR. Stroke rehabilitation. Continuum. 2017;23(1, Cerebrovascular Disease):238-53.
19. Olavarría VV, Arima H, Anderson CS, Brunser AM, Muñoz-Venturelli P. Head position and cerebral blood flow velocity in acute ischemic stroke: a systematic review and meta-analysis. Cerebrovasc Dis. 2014;37(6):401-8.
20. Bernhardt J, Indredavik B, Dewey H, Langhorne P, Lindley R, Donnan G, et al. Mobilisation'in bed'is not mobilisation. Cerebrovas Dis. 2007;24(1):157-8.
21. Pickenbrock H, Ludwig VU, Zapf A, Dressler D. Conventional versus neutral positioning in central neurological disease: a multicenter randomized controlled trial. Dtsch Arztebl Int. 2015;112(3):35-42.
22. Maček Z, Mandić M. Pozicioniranje nepokretnog neurološkog bolesnika. Acta medica Croatica. 2016;70(Suplement 1):59-63.
23. Kader E, Bitensky NK, Sitcoff E, Goulamhoussen L, Laroui R, Liu S, et al. Positioning. Strok Engine. 2015;1-6.
24. Bernhardt J, Churilov L, Ellery F, Collier J, Chamberlain J, Langhorne P, et al. Prespecified dose-response analysis for a very early rehabilitation trial (Avert). Neurology. 2016;86(23):2138-45.
25. Bernhardt J, Langhorne P, Lindley RI, Thrift AG, Ellery F, Collier J, et al. Efficacy and safety of very early mobilisation within 24 h of stroke onset (Avert): a randomised controlled trial. Lancet. 2015;386(9988):46-55.
26. Physiopedia. Physiopedia contributors; 2019.
27. Seneviratne C, Then KL, Reimer M. Post-stroke shoulder subluxation: a concern for neuroscience nurses. Axone. 2005;27(1):26-31.
28. Stroke-rehab.com. Shoulder subluxation; 2012.
29. Duncan PW, Zorowitz R, Bates B, Choi JY, Glasberg JJ, Graham GD, et al. Management of adult stroke rehabilitation care: a clinical practice guideline. Stroke. 2005;36(9):e100-43.
30. Nadler M, Pauls MM. Shoulder orthoses for the prevention and reduction of hemiplegic shoulder pain and subluxation: systematic review. Clin Rehabili. 2017;31(4):444-53.
31. Chatterjee S, Hayner KA, Arumugam N, Goyal M, Midha D, Arora A, et al. The California tri-pull taping method in the treatment of shoulder subluxation after stroke: a randomized clinical trial. N Am J Med Sci. 2016;8(4):175-82.
32. Nussbaum EL, Houghton P, Anthony J, Rennie S, Shay BL, Hoens AM. Neuromuscular electrical stimulation for treatment of muscle impairment: critical review and recommendations for clinical practice. Physiother Can. 2017;69(5):1-76.
33. Teasell R, Hussein N. Motor Rehabilitation. Stroke Rehabilitation Clinician Handbook. 2016.
34. Vér C, Hofgárt G, Menyhárt L, Kardos L, Csiba L. Ankle-foot continuous passive motion device for mobilization of acute stroke patients. Open J Ther Rehabil. 2015;3(2):23.
35. Padilla MG, Rueda FM, Diego IA. Effect of ankle-foot orthosis on postural control after stroke: A systematic review. Neurología. 2014;29(7):423-32.
36. Wang RY, Yen LL, Lee CC, Lin PY, Wang MF, Yang YR. Effects of an ankle-foot orthosis on balance performance in patients with hemiparesis of different durations. Clin Rehabil. 2005;19(1):37-44.
37. Erel S, Uygur F, Engin Şimşek İ, Yakut Y. The effects of dynamic ankle-foot orthoses in chronic stroke patients at three-month follow-up: a randomized controlled trial. Clin Rehabil. 2011;25(6):515-23.

38. Gao F. American Society of Biomechanics. Dallas, TX, USA; 2010.

39. Bolognini N, Russo C, Edwards DJ. The sensory side of post-stroke motor rehabilitation. Restorative Neurol Neurosc. 2016;34(4):571-86.

40. Chia FS, Kuys S, Low Choy N. Sensory retraining of the leg after stroke: systematic review and meta-analysis. Clin Rehabil. 2019;33(6):964-79.

41. Van der Wees PJ, Hendriks EJ, Custers JW, Burgers JS, Dekker J, de Bie RA. Comparison of international guideline programs to evaluate and update the Dutch program for clinical guideline development in physical therapy. BMC Health Serv Res. 2007;7:191.

42. Cabanas-Valdés R, Cuchi GU, Bagur-Calafat C. Trunk training exercises approaches for improving trunk performance and functional sitting balance in patients with stroke: A systematic review. Neuro Rehabil. 2013;33(4):575-92.

43. Ibrahimi N, Tufel S, Singh H, Maurya M. Effect of sitting balance training under varied sensory input on balance and quality of life in stroke patients. Indian J Physiother Occup Ther. 2010;4(2):40-5.

44. Dean CM, Channon EF, Hall JM. Sitting training early after stroke improves sitting ability and quality and carries over to standing up but not to walking: a randomised controlled trial. Aust J Physiother. 2007;53(2):97-102.

45. Martin ST, Kessler M, editors. Neurologic interventions for physical therapy. 3rd ed. Amsterdam: Elsevier Health Sciences; 2015.

46. Billinger SA, Arena R, Bernhardt J, Eng JJ, Franklin BA, Johnson CM, et al. Physical activity and exercise recommendations for stroke survivors: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2014;45(8):2532-53.

47. de Sèze M, Wiart L, Bon-Saint-Côme A, Debelleix X, de Sèze M, Joseph PA, et al. Rehabilitation of postural disturbances of hemiplegic patients by using trunk control retraining during exploratory exercises. Arch Phys Med Rehabil. 2001;82(6):793-800.

48. de Haart M, Geurts AC, Huidekoper SC, Fasotti L, van Limbeek J. Recovery of standing balance in postacute stroke patients: A rehabilitation cohort study. Arch Phys Med Rehabil. 2004;85(6):886-95.

49. Bayouk JF, Boucher JP, Leroux A. Balance training following stroke: effects of task-oriented exercises with and without altered sensory input. Int J Rehabil Res. 2006;29(1):51-9.

50. Raine S, Meadows L, Lynch-Ellerington M, editors. Bobath concept: theory and clinical practice in neurological rehabilitation. John Wiley & Sons; 2013.

51. Britton E, Harris N, Turton A. An exploratory randomized controlled trial of assisted practice for improving sit-to-stand in stroke patients in the hospital setting. Clin Rehabil. 2008;22(5):458-68.

52. Tung FL, Yang YR, Lee CC, Wang RY. Balance outcomes after additional sit-to-stand training in subjects with stroke: a randomized controlled trial. Clin Rehabil. 2010;24(6):533-42.

53. Pollock A, Farmer SE, Brady MC, Langhorne P, Mead GE, Mehrholz J, et al. Interventions for improving upper limb function after stroke. Cochrane Database Syst Rev. 2014(11):CD010820.

54. Hömberg V. Neurorehabilitation approaches to facilitate motor recovery. Handb Clin Neurol. 2013;110:161-73.

55. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 2011;43(7):1334-59.

56. Patten C, Lexell J, Brown HE. Weakness and strength training in persons with poststroke hemiplegia: rationale, method, and efficacy. J Rehabil Res Dev. 2004;41(3A):293-312.

57. Saunders DH, Sanderson M, Hayes S, Kilrane M, Greig CA, Brazzelli M, et al. Physical fitness training for stroke patients. Cochrane Database Syst Rev. 2016;3:CD003316.

58. Party IS. National clinical guideline for stroke. London: Royal College of Physicians; 2012.

59. Brogårdh C, Lexell J. Effects of cardiorespiratory fitness and muscle-resistance training after stroke. PM R. 2012;4(11):901-7.

60. Maček Z, Kolar M, Stubičar K, Mandić M, Toplice K. Fizioterapijski protokol kod odraslih bolesnika nakon traumatske ozljede mozga. Časopis za primijenjene zdravstvene znanosti. 2018;4(2):273-84.

61. French B, Thomas L, Leathley M, Sutton C, McAdam J, Forster A, et al. Does repetitive task training improve functional activity after stroke? A Cochrane systematic review and meta-analysis. J Rehabili Med. 2010;42(1):9-14.

62. Johannsen L, Wing AM, Pelton T, Kitaka K, Zietz D, Brittle N, et al. Seated bilateral leg exercise effects on hemiparetic lower extremity function in chronic stroke. Neurorehabil Neural Repair. 2010;24(3):243-53.

63. Whitall J, Waller SM, Silver KH, Macko RF. Repetitive bilateral arm training with rhythmic auditory cueing improves motor function in chronic hemiparetic stroke. Stroke. 2000;31(10):2390-5.

64. Luft AR, Waller SM, Whitall J, Smith GV, Forrester L, Macko RF, et al. Repetitive bilateral arm training in long-term stroke survivors induces cortical reorganisation. Stroke. 2002;33(1):416-7.

65. Eng JJ, Tang PF. Gait training strategies to optimize walking ability in people with stroke: a synthesis of the evidence. Expert Rev Neurother. 2007;7(10):1417-36.

66. Peurala SH, Airaksinen O, Jäkälä P, Tarkka IM, Sivenius J. Effects of intensive gait-oriented physiotherapy during early acute phase of stroke. J Rehabil Res Dev. 2007;44(5):637-48.

67. Salbach NM, Mayo NE, Wood-Dauphinee S, Hanley JA, Richards CL, Cote R. A task-orientated intervention enhances walking distance and speed in the first year post stroke: a randomized controlled trial. Clin Rehabil. 2004;18(5):509-19.

68. Yang YR, Yen JG, Wang RY, Yen LL, Lieu FK. Gait outcomes after additional backward walking training in patients with stroke: a randomized controlled trial. Clin Rehabil. 2005;19(3):264-73.

69. Yang YR, Wang RY, Chen YC, Kao MJ. Dual-task exercise improves walking ability in chronic stroke: a randomized controlled trial. Arch Phys Med Rehabil. 2007;88(10):1236-40.

70. Langhammer B, Stanghelle JK. Exercise on a treadmill or walking outdoors? A randomized controlled trial comparing effectiveness of two walking exercise programmes late after stroke. Clin Rehabili. 2010;24(1):46-54.

71. Lau KW, Mak MK. Speed-dependent treadmill training is effective to improve gait and balance performance in patients with sub-acute stroke. J Rehabil Med. 2011;43(8):709-13.

72. Luft AR, Macko RF, Forrester LW, Villagra F, Ivey F, Sorkin JD, et al. Treadmill exercise activates subcortical neural networks and improves walking after stroke: A randomized controlled trial. Stroke. 2008;39(12):3341-50.

73. Dean CM, Ada L, Bampton J, Morris ME, Katrak PH, Potts S. Treadmill walking with body weight support in subacute non-ambulatory stroke improves walking capacity more than overground walking: a randomised trial. J Physiother. 2010;56(2):97-103.

74. Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. Lancet. 2011;377(9778):1693-702.

75. Dobkin BH. An overview of treadmill locomotor training with partial

body weight support: a neurophysiologically sound approach whose time has come for randomized clinical trials. Neurorehabil Neural Repair. 1999;13(3):157-65.

76. Danielsson A, Sunnerhagen KS. Oxygen consumption during treadmill walking with and without body weight support in patients with hemiparesis after stroke and in healthy subjects. Arch Phys Med Rehabil. 2000;81(7):953-7.

77. da Cunha IT, Lim PA, Qureshy H, Henson H, Monga T, Protas EJ. Gait outcomes after acute stroke rehabilitation with supported treadmill ambulation training: a randomized controlled pilot study. Arch Phys Med Rehabili. 2002;83(9):1258-65.

78. Nilsson L, Carlsson J, Danielsson A, Fugl-Meyer A, Hellström K, Kristensen L, et al. Walking training of patients with hemiparesis at an early stage after stroke: a comparison of walking training on a treadmill with body weight support and walking training on the ground. Clin Rehabil. 2001;15(5):515-27.

79. Wevers L, Van De Port I, Vermue M, Mead G, Kwakkel G. Effects of task-oriented circuit class training on walking competency after stroke: A systematic review. Stroke. 2009;40(7):2450-9.

80. Mudge S, Barber PA, Stott NS. Circuit-based rehabilitation improves gait endurance but not usual walking activity in chronic stroke: a randomized controlled trial. Arch Phys Med Rehabil. 2009;90(12):1989-96.

81. English C, Hillier SL, Lynch EA. Circuit class therapy for improving mobility after stroke. Cochrane Database Syst Rev. 2010(7):CD007513.

82. Hesse S, Schmidt H, Werner C, Bardeleben A. Upper and lower extremity robotic devices for rehabilitation and for studying motor control. Curr Opin Neurol. 2003;16(6):705-10.

83. Banala SK, Kim SH, Agrawal SK, Scholz JP. Robot assisted gait training with active leg exoskeleton (ALEX). IEEE Trans Neural Syst Rehabil Eng. 2009;17(1):2-8.

84. Fisher S, Lucas L, Adam Thrasher T. Robot-assisted gait training for patients with hemiparesis due to stroke. Top Stroke R. 2011;18(3):269-76.

85. Swinnen E, Beckwée D, Meeusen R, Baeyens JP, Kerckhofs E. Does robot-assisted gait rehabilitation improve balance in stroke patients? A systematic review. Top Stroke Rehabil. 2014;21(2):87-100.

86. Zheng QX, Ge L, Wang CC, Ma QS, Liao YT, Huang PP, et al. Robot-assisted therapy for balance function rehabilitation after stroke: A systematic review and meta-analysis. Int J Nurs Stud. 2019;95:7-18.

87. Semprini M, Laffranchi M, Sanguineti V, Avanzino L, De Icco R, De Michieli L, et al. Technological approaches for neurorehabilitation: from robotic devices to brain stimulation and beyond. Frontiers Neurol. 2018;9:212.

88. Morone G, Paolucci S, Cherubini A, De Angelis D, Venturiero V, Coiro P, et al. Robot-assisted gait training for stroke patients: current state of the art and perspectives of robotics. Neuropsychiatric Dis Treat. 2017;13:1303-11.

89. Hornby TG, Campbell DD, Kahn JH, Demott T, Moore JL, Roth HR. Enhanced gait-related improvements after therapist-versus robotic-assisted locomotor training in subjects with chronic stroke: a randomized controlled study. Stroke. 2008;39(6):1786-92.

90. Hidler J, Nichols D, Pelliccio M, Brady K, Campbell DD, Kahn JH, et al. Multicenter randomized clinical trial evaluating the effectiveness of the Lokomat in subacute stroke. Neurorehabil Neural Repair. 2009;23(1):5-13.

91. Sale P, Franceschini M, Mazzoleni S, Palma E, Agosti M, Posteraro F. Effects of upper limb robot-assisted therapy on motor recovery in subacute stroke patients. J Neuroeng Rehabil. 2014;11:104.

92. Kwakkel G, Kollen BJ, Krebs HI. Effects of robot-assisted therapy on upper limb recovery after stroke: a systematic review. Neurorehabili Neural Repair. 2008;22(2):111-21.

93. Mazzoleni S, Sale P, Franceschini M, Bigazzi S, Carrozza MC, Dario P, et al. Effects of proximal and distal robot-assisted upper limb rehabilitation on chronic stroke recovery. Neuro Rehabili. 2013;33(1):33-9.

94. Lo AC, Guarino PD, Richards LG, Haselkorn JK, Wittenberg GF, Federman DG, et al. Robot-assisted therapy for long-term upper-limb impairment after stroke. N Engl J Med. 2010;362(19):1772-83.

95. Lum PS, Burgar CG, Van der Loos M, Shor PC, Majmundar M, Yap R. MIME robotic device for upper-limb neurorehabilitation in subacute stroke subjects: A follow-up study. J Rehabil Res Dev. 2006;43(5):631-42.

96. Sütbeyaz S, Yavuzer G, Sezer N, Koseoglu BF. Mirror therapy enhances lower-extremity motor recovery and motor functioning after stroke: A randomized controlled trial. Arch Phys Med Rehabil. 2007;88(5):555-9.

97. Altschuler EL, Wisdom SB, Stone L, Foster C, Galasko D, Llewellyn DM, et al. Rehabilitation of hemiparesis after stroke with a mirror. Lancet. 1999;353(9169):2035-6.

98. Stevens JA, Stoykov ME. Using motor imagery in the rehabilitation of hemiparesis. Arch Phys Med Rehabil. 2003;84(7):1090-2.

99. Stevens JA, Stoykov ME. Simulation of bilateral movement training through mirror reflection: A case report demonstrating an occupational therapy technique for hemiparesis. Top Stroke Rehabil. 2004;11(1):59-66.

100. Thieme H, Morkisch N, Mehrholz J, Pohl M, Behrens J, Borgetto B, et al. Mirror therapy for improving motor function after stroke. Cochrane Database Syst Rev. 2018;7:CD008449.

101. Wada Y, Kondo I, Sonoda S, Yamada K, Narukawa A, Kawakami K, et al. Mirror therapy for severely affected ankle joints of stroke patients. Japanese J Comprehensive Rehabil Sci. 2011;2:71-6.

102. Carr JH, Sheperd RB. Stroke Rehabilitafion: Guidelines for Exercise and Training to Optimize Motor Skill. 2003.

103. Viana R, Teasell R. Barriers to the implementation of constraint-induced movement therapy into practice. Top Stroke Rehabili. 2012;19(2):104-14.

104. Kagawa S, Koyama T, Hosomi M, Takebayashi T, Hanada K, Hashimoto F, et al. Effects of constraint-induced movement therapy on spasticity in patients with hemiparesis after stroke. J Stroke Cerebrovasc Dis. 2013;22(4):364-70.

105. Fuzaro AC, Guerreiro CT, Galetti FC, Jucá RB, Araujo JE. Modified constraint-induced movement therapy and modified forced-use therapy for stroke patients are both effective to promote balance and gait improvements. Rev Bras Fisioter. 2012;16(2):157-65.

106. Merians AS, Tunik E, Adamovich SV. Virtual reality to maximize function for hand and arm rehabilitation: exploration of neural mechanisms. Stud Health Technol Inform. 2009;145:109-25.

107. Shin JH, Kim MY, Lee JY, Jeon YJ, Kim S, Lee S, et al. Effects of virtual reality-based rehabilitation on distal upper extremity function and health-related quality of life: a single-blinded, randomized controlled trial. J Neuroeng Rehabil. 2016;13:17.

108. Thielbar KO, Lord TJ, Fischer HC, Lazzaro EC, Barth KC, Stoykov ME, et al. Training finger individuation with a mechatronic-virtual reality system leads to improved fine motor control post-stroke. J Neuroeng Rehabil. 2014;11:171.

109. Doucet BM, Lam A, Griffin L. Neuromuscular electrical stimulation for skeletal muscle function. Yale J Biol Med. 2012;85(2):201-15.

110. Burridge JH, Ladouceur M. Clinical and therapeutic applications of neuromuscular stimulation: a review of current use and speculation into future developments. Neuromodulation. 2001;4(4):147-54.

111. Knight K, Knight KL, Draper DO. Therapeutic modalities: the art and science. Philadelphia: Lippincott Williams & Wilkins, Pennsylvania, United States; 2012.

112. Woodford HJ, Price CI. EMG biofeedback for the recovery of motor function after stroke Cochrane Database Syst Rev. 2007(2):CD004585.

113. Doğan-Aslan M, Nakipoğlu-Yüzer GF, Doğan A, Karabay İ, Özgirgin N. The effect of electromyographic biofeedback treatment in improving upper extremity functioning of patients with hemiplegic stroke. J Stroke Cerebrovasc Dis. 2012;21(3):187-92.

114. Herderschee R, Hay-Smith EJ, Herbison GP, Roovers JP, Heineman MJ. Feedback or biofeedback to augment pelvic floor muscle training for urinary incontinence in women. Cochrane Database Syst Rev. 2011(7):CD009252.

115. van der Windt DA, van der Heijden GJ, van den Berg SG, ter Riet G, de Winter AF, Bouter LM. Ultrasound therapy for musculoskeletal disorders: a systematic review. Pain. 1999;81(3):257-71.

116. Robertson VJ, Baker KG. A review of therapeutic ultrasound: effectiveness studies. Phys Ther. 2001;81(7):1339-50.

117. Speed CA. Therapeutic ultrasound in soft tissue lesions. Rheumatology. 2001;40(12):1331-6.

118. Wong RA, Schumann B, Townsend R, Phelps CA. A survey of therapeutic ultrasound use by physical therapists who are orthopaedic certified specialists. Phys Ther. 2007;87(8):986-94.

119. Mehrholz J, Kugler J, Pohl M.Water-based exercises for improving activities of daily living after stroke. Cochrane Database Syst Rev. 2011(1) CD008186.

120. Noh DK, Lim JY, Shin HI, Paik NJ. The effect of aquatic therapy on postural balance and muscle strength in stroke survivors-a randomized controlled pilot trial. Clin Rehabil. 2008;22(10-11):966-76.

121. Chu KS, Eng JJ, Dawson AS, Harris JE, Ozkaplan A, Gylfadóttir S. Water-based exercise for cardiovascular fitness in people with chronic stroke: a randomized controlled trial. Arch Phys Med Rehabil. 2004;85(6):870-4.

122. Walker MF, Sunderland A, Fletcher-Smith J, Drummond A, Logan P, Edmans JA, et al. The DRESS trial: a feasibility randomized controlled trial of a neuropsychological approach to dressing therapy for stroke inpatients. Clin Rehabil. 2012;26(8):675-85.

123. Legg L, Drummond A, Leonardi-Bee J, Gladman JR, Corr S, Donkervoort M, et al. Occupational therapy for patients with problems in personal activities of daily living after stroke: systematic review of randomised trials. BMJ. 2007;335(7626):922.

124. Desrosiers J, Noreau L, Rochette A, Carbonneau H, Fontaine L, Viscogliosi C, et al. Effect of a home leisure education program after stroke: A randomized controlled trial. Arch Phys Med Rehabil. 2007;88(9):1095-100.

125. Ntsiea MV, Van Aswegen H, Lord S, Olorunju SS. The effect of a workplace intervention programme on return to work after stroke: A randomised controlled trial. Clin Rehabil. 2015;29(7):663-73.