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SHORT COMMUNICATION

STRATEGIES FOR COMPREHENSIVE STROKE REHABILITATION – EVIDENCE-BASED REVIEW OF THERAPEUTIC METHODS

KOMPLEKSOWA REHABILITACJA PO UDARZE MÓZGU – PRZEGLĄD METOD TERAPEUTYCZNYCH O POTWIERDZONEJ SKUTECZNOŚCI

Dagna Dreczka
Department of Rehabilitation and Physiotherapy, Poznań University of Medical Sciences, Poland

ABSTRACT

Introduction

Stroke is the leading cause of severe disability. The consequences of a stroke depend on the location and size of the brain lesions. The symptoms may include hemiparesis, swallowing disorders, speech disorders, disorders of cognitive functions, hemianopia, gait disturbances, spasticity, depression, reduction of independence in everyday life activities. Due to the multitude of impaired functions after stroke, a comprehensive approach is required in rehabilitation.

Aim

The aim of the study was a concise, evidence-based review of therapeutic methods that may be used in the course of rehabilitation after stroke.

Material and methods

Studies and systematic reviews related to a selected novel or commonly used stroke rehabilitation methods were chosen for evaluation using the PubMed search engine. The research included articles published between 2002 and 2020.

Results

The time to start rehabilitation is important – according to the principle, the sooner, the better. A comprehensive rehabilitation program requires an individual program of rehabilitation exercises, supported by physical modalities therapy as well as occupational therapy, speech-language therapy and neuropsychotherapy. Particular attention must be given to the methods for which there is evidence of effectiveness confirmed by scientific research, such as CIMT therapy, task-oriented training, mirror therapy, electrical stimulation, rTMS, robot-based training, and treadmill training.

Conclusions

The rehabilitation after stroke is effective when certain general conditions are fulfilled, such as cooperation of multidisciplinary rehabilitation teams, early start, and long and intense course. The effect of post-stroke rehabilitation may be even better when certain methods are applied, bringing improvement mostly in motor function.

Keywords: stroke, rehabilitation, neuroplasticity, neurologic rehabilitation

Author responsible for correspondence:
Dagna Dreczka
Department of Rehabilitation and Physiotherapy
Poznań University of Medical Sciences
28 Czerwca 1956 No 135/147
61-545 Poznań, Poland
Email: dagna.dreczka@ump.edu.pl
https://orcid.org/ 0000-0003-1565-0404

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STRESZCZENIE

Wstęp

Udar mózgu jest główną przyczyną ciężkiej niepełnosprawności. Konsekwencje udaru mózgu zależą od lokalizacji i wielkości ogniska udarowego w mózgu. Objawy mogą obejmować: niedowład połowiczy, zaburzenia połykania, zaburzenia mowy, zaburzenia funkcji poznawczych, hemianopię, zaburzenia chodu, spastyczność, depresję, zmniejszenie samodzielności w czynnościach życia codziennego. Ze względu na mnogość upośledzonych funkcji po udarze mózgu, w rehabilitacji wymagane jest kompleksowe podejście.

Cel

Celem niniejszej pracy było dokonanie zwięzłego przeglądu metod terapeutycznych o potwierdzonej skuteczności, które są wykorzystywane w rehabilitacji osób po udarze mózgu.

Materiał i metody

Wybrane i opisane zostały prace oraz przeglądy systematyczne opisujące nowe lub powszechnie stosowane w rehabilitacji poudarowej metody terapeutyczne, przy pomocy wyszukiwarki PubMed. Przeanalizowano prace opublikowane między 2002 a 2020 rokiem.

Wyniki

Ważny jest czas rozpoczęcia rehabilitacji – w myśl zasady im szybciej, tym lepiej. Kompleksowy program rehabilitacji wymaga indywidualnego programu ćwiczeń rehabilitacyjnych, wspartych terapią metodami fizykalnymi oraz terapią zajęciową, terapią logopedyczną i neuropsychoterapią. Szczególną uwagę należy zwrócić na metody, dla których istnieją dowody skuteczności potwierdzone badaniami naukowymi, takie jak: terapia wymuszonej konieczności (CIMT), trening zadaniowy, terapia lustrzana, elektrostymulacja, powtarzalna przezczaszkowa stymulacja magnetyczna (rTMS), przezczaszkowa stymulacja prądem stałym (tDCS), trening z użyciem robotów, trening na bieżni.

Wnioski

Rehabilitacja po udarze mózgu jest skuteczna gdy spełnione są pewne ogólne zasady: współpraca wielodyscyplinarnego zespołu rehabilitacyjnego, wczesny początek oraz intensywny i długi przebieg. Efekt rehabilitacji może być jeszcze lepszy gdy zastosowane zostaną specyficzne metody terapeutyczne, przynosząc poprawę głównie w zakresie funkcji motorycznych.

Słowa kluczowe: udar mózgu, rehabilitacja, neuroplastyczność, rehabilitacja neurologiczna

Introduction

There is no doubt that rehabilitation after stroke is necessary and brings benefits. However, there is still not enough scientific evidence to answer which of the rehabilitative methods used are the most effective, for how long and with what intensity they should be used to achieve the optimal effect. The research on the effectiveness of specific therapeutic methods in post-stroke rehabilitation is difficult in terms of methodology because of a heterogeneous group of patients as well as various ways of application of specific therapies, making it is impossible to take into account all variables. Moreover, there always remains a question whether the functional improvement after stroke was a result of the therapy that was applied or due to spontaneous recovery of stroke lesion in the brain.

Aim

The aim of this paper was to make a concise review of the therapeutic methods of proven effectiveness in terms of Evidence-Based Medicine that may be used in the course of rehabilitation after stroke.

Materials and methods

Studies related to a selected novel or commonly used stroke rehabilitation methods were evaluated using the PubMed search engine. The research included studies published between 2002 and 2020. The stroke rehabilitation strategies of proven effectiveness were selected for further discussion.

Results

Intensity of rehabilitation

The rehabilitation after stroke should be initiated as soon as possible. Furthermore, longer time and intensity of rehabilitation correlate with better functional effects. Kwakkel *et al.* (2004) showed that augmented stroke rehabilitation has clinically relevant treatment effects that may be achieved on instrumental ADL and gait speed.

Occupational therapy

Occupational therapists help patients improve their sensory and motor abilities so that they can relearn valuable skills of everyday life, such as using a computer, preparing meals etc. Occupational therapy has been proven to contribute to greater independence in daily life activities. Legg *et al.* (2007) proved that occupation therapy could improve performance and reduce the risk of deterioration in this ability; therefore, it should be available to everyone who has had a stroke.

Electrical stimulation of shoulder muscles

Shoulder subluxation is a major challenge in the rehabilitation of stroke patients with the hemiplegic shoulder. Due to gravitational forces generated by the weight of the arm, the head of the humerus is pulled downward because the supraspinatus muscle and posterior deltoid are weak or paralyzed. Such subluxation may not only affect the upper limb treatment process but can also lead to additional complications such as pain, which can further delay the recovery of function. Neuromuscular electrical stimulation of supraspinatus and deltoid muscles in the early period post-stroke may be beneficial in terms of reduction or prevention of glenohumeral subluxation and shoulder pain (Ada *et al.* 2002).

Constraint-induced movement therapy (*CIMT*)

Constraint Induced Movement Therapy (CIMT) is a technique that forces the use of the affected hand by restraining the unaffected side. The patient wears a mitt on the less-affected arm for 90% of waking hours and perform repetitive exercises with the more affected arm six to seven hours per day during two to three weeks. For the upper extremity, constraint-induced movement therapy appears to have benefits when started within 2 weeks of stroke. Constraint-induced movement therapy (CIMT) is currently considered the most effective treatment in physical therapy to improve the outcome of the upper paretic limb (Kwakkel *et al.,* 2015).

Non-Invasive Brain Stimulation (*NIBS*)

Non-Invasive Brain Stimulation (NIBS) is a group of emerging modalities for enhancing brain plasticity and rehabilitation outcomes after stroke. These methods modulate the excitability of the brain via transcranial stimulation. Two major modalities of noninvasive brain stimulation are repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS). Repetitive transcranial magnetic stimulation (rTMS) is a feasible and painless neurophysiological modality commonly used for diagnostic and, when applied repetitively, therapeutic purposes. Dionisio *et al.* (2018) proved that rTMS shows potential in improving motor function after stroke. The application of rTMS also seems beneficial in the treatment of post-stroke dysphagia, post-stroke depression and aphasia. Transcranial

Direct Current Stimulation (tDCS) is another emerging approach in stroke rehabilitation. It is based on the application of a weak and constant direct current to the brain. Such use of tDCS has the ability to enhance or suppress cortical excitability, with the effect lasting up to several hours after the stimulation. It has been shown that tDCS application may improve language function, measured by the performance in naming nouns, in people after stroke (Elsner *et al.* 2020).

Mirror therapy (*MT*)
Mirror therapy (MT) is a feasible method for training post-stroke impairments in all phases after stroke. During such therapy, a mirror is placed between the upper or lower limbs so that the image of a moving non-affected limb gives the illusion of normal movement in the affected limb. By this setup, different brain regions for movement, sensation, and pain are stimulated. In contrast to varied therapy approaches, mirror therapy can be used even in completely plegic stroke survivors. MT has been studied to affect motor impairments, but some authors also proved its positive effect on sensation, visuospatial neglect, and pain after stroke (Gandhi *et al.,* 2020).

Robot-assisted gait training
It is believed that the application of robotic gait training leads to early walking recovery among the stroke population. There are various types of robotic devices. These robots have been categorized according to the location of motion they apply – some of them move hips, knees and ankles in coordination with phases of gait; others- only support the motion of ankles. However, the efficacy of robotic gait training seems to be related to a good identification of the patients who could benefit more from robotic training. Patients with more severe motor upper limb impairments are those who benefit the most from robot-assisted therapy in combination with conventional therapy. Most studies claim that robots would increase rehabilitation intensity. Therefore, the positive effects of robotic therapy probably result from the augmented intensity of therapy, as compared to conventional therapy, especially for the most impaired patients (Morone *et al.,* 2017).

Treadmill training
Treadmill training, with or without body weight support, is used in rehabilitation post-stroke. Treadmill training following stroke offers improvement in walking distance. However, it has no significant advantage in improving walking speed and balance over over-ground walking training. Nevertheless, the psychological benefit and cardiovascular advantage of treadmill training may constitute further benefits of treadmill training in post-stroke patients (Gelaw *et al.,* 2019).

Discussion
The goals of rehabilitation after a stroke depend on the stage of the disease. At the earliest period, very often- in an intensive care setting, its main purpose is to avoid the complications of immobilization and secondary consequences of stroke, such as venous thrombosis and pulmonary embolism, pneumonia, bedsores, contractures and pain syndromes. Later, after the stabilization of the patient's medical condition, the rehabilitation is aimed at specific training addressing the lost functions. In the earliest period from the onset of cerebral ischemia, a cascade of plasticity-enhancing mechanisms leads to dendritic growth, axonal sprouting, and the formation of new synapses. Optimal improvement of function after a stroke usually takes place in the first 3–6 months from the onset. Nevertheless, patients in chronic stages after stroke also benefit significantly from participation in a rehabilitation program, provided that it is intense and task-oriented (Grefkes *et al.* 2020). The phenomenon of brain plasticity plays an important role in the course of rehabilitation after stroke. It has been shown that the adult brain's plasticity is triggered in a special way through damage and can be intensified and directed by broadly understood training (Liepert

et al., 2004). Moreover, physical therapy programs are related to a reduction in early and late mortality after stroke (Guerra *et al.,* 2017). The process of rehabilitation after stroke should be conducted by a qualified, multidisciplinary team from the first hours after a stroke. The rehabilitation team should consist of: physician, nurse, physiotherapist, neuropsychologist, speech-language pathologist and occupational therapist. Comprehensive rehabilitation is an important component of therapeutic management after stroke, enabling the patients to achieve functional improvement and independence. There are multiple treatment options for rehabilitation after stroke. There are no optimal management guidelines; the rehabilitation programs after stroke differ depending on physicians' and physiotherapists' experience and available rehabilitation devices. While most of the therapeutic techniques still wait for scientific validation of their effectiveness, the above presented specific methods are of proven efficacy in the course of rehabilitation, addressing specific problems that may occur in post-stroke patients. What should be stressed is the fact that each post-stroke patient has different problems to be addressed with a variety of problem-specific methods that may be applied. The methods presented in the Results section may be effective in one specific post-stroke complication and may not be effective in others. The Results section gives hints in which conditions certain rehabilitation methods should be applied. That knowledge should help stroke rehabilitation practitioners in the best selection of the treatment methods for their patients.

Conclusions

Comprehensive rehabilitation is an important component of therapeutic management after stroke, enabling the patients to achieve functional improvement and independence. Certain conditions should be fulfilled to help achieve such goals:

1. cooperation of multidisciplinary rehabilitation team,
2. early start of rehabilitation,
3. long and intense course of rehabilitation.

Following therapeutic methods are particularly recommended to be part of a rehabilitation program after stroke in certain post-stroke conditions: occupational therapy, neuromuscular electrical stimulation (NMES), constraint-induced movement therapy (CIMT), repetitive transcranial magnetic stimulation (rTMS), transcranial direct current stimulation (tDCS), mirror therapy (MT) , robot-assisted training, treadmill assisted gait training. The selection and use of the mentioned methods as part of rehabilitation programs should be preceded by verification of which specific post-stroke complications seem to be effective. However, what is constantly stressed in relation to stroke rehabilitation, there is a strong need for further research in this field.

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