Methods of Evidence-based medicine for patients after stroke with early Spasticity

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Abstract: acute cerebrovascular accident is the main cause of disability. Stroke has different clinical characteristics and consequences that require individual rehabilitation examination and approach. Adverse neurological disorders are accompanied by motor, cognitive, and psycho-emotional consequences. Over the past 20 years, the treatment of acute cerebrovascular accidents has significantly increased the recovery rates of patients. This is due to the progress of international clinical protocols, randomized evidence-based medicine, adequate medication, step-by-step and individualized physical therapy, and occupational therapy strategies for patients. One of the most important contributions to rehabilitation for stroke patients is made by evidence-based medicine. The literature review highlights current evidence and critical appraisal to confirm the effectiveness of evidence-based medicine in rehabilitation interventions to improve movement control, activity, participation, and functioning. The benefits of rehabilitation interventions on spasticity after stroke in the early period have been proven. However, even after medical and rehabilitation, the restoration of motor function remains insufficient to achieve the patient's request, due to inconsistent application of evidence-based medicine. The purpose of the literature review is to analyze the effectiveness of evidence-based medicine in rehabilitation interventions for people after early stroke with spasticity to improve quality of life and motor function. Materials and methods. In this review, we analyzed rehabilitation interventions and evidence-based medicine in physical therapy. We substantiated the materials of the Canadian Clinician's Guide to Stroke Rehabilitation for 2020. The review includes scientific publications in English. Articles and research by scientists published over the past 15 years. A computer search was conducted through the PubMed database. We considered 63 publications that were evaluated according to the following criteria: reliability, validity, and measurability. The changes that have occurred during the research have been analyzed. Conclusions. Spasticity in the late period after acute cerebrovascular accident has significant negative consequential difficulties that patients are unable to cope with on their own. We have found that rehabilitation measures and physical therapy techniques improve the motor functions of patients with spasticity in the early period, provided that the recommendations of evidence-based medicine are followed. The timely use of methods, tools, and an individualized approach to each patient gives positive results. After all, the purpose of physical therapy is not to convince patients that the consequences of stroke are not subject to rehabilitation, but to help and teach patients to be independent and improve the quality of life of people with spasticity in the early or late period. It was also determined that the topic of recovery of patients with late-onset spasticity after stroke is not sufficiently covered. To date, more than half of people after stroke remain limited in everyday activities and have negative consequences – motor disorders, and activity limitations that
significantly affect the quality of life and independence. Further research is needed to determine whether it is possible to reduce late-onset spasticity and improve the motor function of patients after stroke with the possibility of further use of the affected limb.

**Key words:** Review, Arm, Stroke Rehabilitation, Meta-Analysis, Recovery of Function.

**Introduction**

According to the 2020 press release, the global prevalence of stroke is about 16 million cases per year. The annual number of strokes in Ukraine is more than 110 thousand. The mortality rate is 2-3 times higher than in other countries. After suffering a stroke, 20-40% of the working-age population is disabled. Only 10-20% of people return to work. The incidence of acute cerebrovascular accidents is 1.5 to 2 times higher than the global average. For 2021, the statistics do not differ much from the previous year.

According to the Ministry of Health for 2022, more than 100 thousand Ukrainians become victims of acute cerebrovascular accidents every year. One-third of them are young people under the age of 65.

The Ministry of Health and the National Health Service of Ukraine have jointly substantiated the quantity, quality, and structure of medical services in rehabilitation centers and physical and rehabilitation medicine departments, with which they have signed an agreement to provide quality medical services to patients under the Medical Care for Acute Cerebral Stroke package.

Negative consequences and symptoms of stroke that occur in the acute and early period: aphasia, dysphagia, visual impairment; paralysis, spasticity, loss of sensation in the affected limbs, impaired coordination, ignoring one side of the body, fatigue, paresthesia, pain, and discomfort in the affected limbs, impaired urodynamics and bowel movements. The specific localization of the lesion will be determined by the signs and symptoms that patients manifest after a stroke (Yani et al., 2017).

Upon admission to inpatient rehabilitation, a multidisciplinary team examines the patient on the first day. The team includes a neurologist, a doctor of physical and rehabilitation medicine, a physical therapist, and an occupational therapist. If necessary, it is possible to involve a speech therapist, psychologist, and consultations with other primary and secondary care physicians (Homola et al., 2021).

Depending on the results of the physical therapy and occupational therapy assessment, patients and caregivers are informed of the request and short- and long-term goals are planned. The care provided to stroke patients in the early period can be maximal, intermediate, or minimal in terms of functional performance. The growing dynamics of patients during rehabilitation activities can influence the change of goals, from simple to complex.

In the acute and early period after stroke, physical therapy and occupational therapy are aimed at restoring motor control and motor function of the affected limbs. In the later period, however, the multidisciplinary goals often focus on compensation and independent participation and activities. The rehabilitation team collaborates with the patient and his or her family to achieve the goals. Therefore, there should be consistency in the use of physical therapy and occupational therapy.

In the early period, physical therapy has the following goals: mobilization, verticalization, improvement of coordination and balance, and restoration of walking skills. The use of therapeutic exercises to strengthen the support capacity of the lower extremities and back muscles. Occupational therapy has the following goals: dressing independently, taking care of one's body, hair, and oral cavity, eating, and using therapeutic exercises.

If you do not follow the recommendations in the early period and ignore evidence-based medicine, there are consequences that negatively affect rehabilitation in the later period. Therefore, we must value patients' time and avoid methods that are not effective and not aimed at maximizing patients' recovery after a stroke. After all, spasticity manifests itself in the early period, when it is easier to stop the process and reduce the possibility of its development. Because in a later period, it is more difficult to reduce muscle spasticity, increase the range of motion and return the affected limb to the patient.
Spasticity, pain, stiffness, limited range of motion in the affected limbs, and edema are common problems in patients with late-onset stroke. These consequences affect patients quality of life and require long-term care and rehabilitation interventions (Hotter et al., 2018). There is a small number of studies on the restoration of motor function of the arm in the shoulder, elbow, and wrist joints in people after stroke for the possibility of further use in everyday life and habitual activities.

The choice of individual rehabilitation methods in the acute, early, and late periods is significantly different for patients with muscle spasticity. Therefore, it is important to scientifically separate the recommendations of the periods for patients after stroke, individually aimed at the symptoms of the results of primary and intermediate examinations.

Spasticity is a motor disorder caused by damage to the upper motor neuron. It depends on the rate of enhancement of the tonic muscle stretch reflex, which occurs as a result of excessive excitation of the stretch reflex. It is usually common in patients after a stroke with hemiplegia of unilateral limb involvement (Mclellan, 1981).

In 2005, the scientist Pandyan reported that spasticity is a violation of sensorimotor control, manifested as a result of damage to the upper motor neurons, and appears as a periodic or constant persistent involuntary muscle activation (Pandyan et al., 2005).

Spasticity reduces the range of motion in the joints and muscles, pain, discomfort, stiffness, contractures in the affected limbs, and loss of spatial and temperature sensitivity. Coordination and balance deteriorate, there is a lack of confidence in walking, and there is a high risk of falling. Mood changes, poor sleep. Muscle spasticity causes limitations in daily life activities and reduces the ability to achieve the goal in rehabilitation activities (Esquenazi et al., 2023).

Spasticity provokes the formation of contractures, and contractures can increase the symptoms of spasticity in patients (O'Dwyer et al., 1996). The results of clinical trials indicate that the pain syndrome can appear within 1 week and last up to 16 months (Allison et al., 2016). Analyzing the data, more than half of patients after a stroke complain of shoulder pain and continue to report symptoms of pain 16 months later (Lindgren et al., 2007).

Patients after stroke should undergo treatment and rehabilitation measures to identify functional disorders and maintain the general condition of the body, with the consequences of cardiovascular disease, diabetes, poor nutrition, and rethinking bad habits (Maalouf et al., 2023). Detection of functional dysfunctions at early stages makes it possible to further treat and control the consequences of stroke (Kuo and Hu, 2018).

The pattern of spasticity of the affected lower limb has tension under the knee tendons, which limits the range of motion in the knee joint; plantar flexion, and eversion of the ankle joint, which limits the support capacity and full use of the foot. Patterns of spasticity of the upper affected limb: scapular dysfunction, shoulder adduction, internal rotation, arm bent at the elbow with forearm pronation, and flexion of the wrist joint (Wagner, Davids and Hardin, 2016).

**Aim**

A review of studies and analysis of the effectiveness of evidence-based medicine for the recovery of patients with the consequences of acute cerebrovascular accident in the early period with spasticity was conducted.

**Materials and Methods**

Analysis and synthesis of modern methods of evidence-based medicine and scientific literature studies used for patients after stroke with spasticity.

In the practice of occupational therapists, after the initial examination of patients with spasticity, negative manifestations are detected: limitation of the range of motion in the affected limbs, pain, which provokes difficulties with dressing, and hygiene procedures and affects the quality of self-care (Bethoux, 2015). In the practice of physical therapists, spasticity impedes free movement and affects the speed of walking on different surfaces. It increases the risk of falling, and impairs balance and coordination (Diaz-Arribas et al., 2020).

Diagnostics and examination are aimed at identifying functional consequences, and rehabilitation measures are focused on the patient’s request, not on reducing spasticity (Thompson et al., 2005). Rehabilitation measures after a stroke should take into account the functional limitations and the patient's request to ensure that spastic limbs can be used.
of aids (Feng et al. 2023; Shen et al., 2023; McAndrew et al., 2000).

Adaptation or recommendation of ergotherapy equipment to adapt the environment to the needs of patients: installation of handrails in the bathroom or toilet; specialized utensils for cooking or eating (Simning et al., 2023).

Speech and language therapists help patients restore their ability to communicate effectively. They select alternative means of communication and conduct classes to overcome dysphagia and aphasia with the help of special interventions (Richards and Cramer, 2023).

Speech therapists contribute to the improvement of speech and language skills in patients after a stroke and eliminate possible difficulties in eating or drinking liquids. Provide counseling and training in oral care (de Sire et al., 2020).

The selection of rehabilitation measures is based on the individual needs and capabilities of patients after a stroke. Physical therapy and occupational therapy are integral components that accelerate and facilitate the recovery of affected motor functions, promote independence, and improve the quality of life of stroke patients (Kayola et al., 2023).

**Review and discussion**

The scientific analysis is aimed at early rehabilitation measures applied within seven days of the onset of acute cerebrovascular accident: gradual mobilization, classes with speech and swallowing disorders, and restoration of the affected arm (Bernhardt et al., 2017). A pilot test was also conducted in a public hospital. Early mobilization was used within 24 to 48 hours of the onset of acute cerebrovascular accident (Poletto et al., 2015). The study is important in the early periods of rehabilitation for patients. It emphasizes the potential for recovery of functions in the critical period. However, it is not used if the patient is not in a stable condition. Contraindications: high blood pressure and body temperature, fever, pneumonia, vomiting, diarrhea.

Scientists have conducted an effective randomized control trial, and a possible option for the early period is a modified wheelchair support. It is used to reduce shoulder pain and support the arm in its normal anatomical position (Pan et al. 2018).

Three randomized control trials for stroke patients with shoulder hemiplegia were found. The
effectiveness of the use of orthopedic dressings and bandages for the upper limb in the early period has been proven. It is used to support the affected arm, reducing the risk of shoulder dislocation during walking skills. They have disadvantages if used for a long time: contractures are formed, which encourage the development of synergy of the flexor muscles, and also prevents patients from using the affected arm if there are positive indicators for the restoration of motor function (Ada et al., 2017; Hartwig et al., 2012; van Bladel et al., 2017).

Splinting in a neutral position on the radiocarpal joint of the affected limb for 4 weeks does not improve motor function (Lannin et al., 2007). A systematic review on the use of splints was analyzed and proved to not affect the motor function of the upper limb of patients after acute cerebrovascular accidents (Lannin and Herbert, 2003). The use of splints is not recommended, as it is a passive method that has insufficient evidence and impact on recovery. Prolonged wearing of splints provokes contractures and, in the presence of spastic muscles, increases the level of spasticity. Orthoses should not be used as a substitute for therapeutic exercises. Especially if the examination shows positive results for restoring the motor function of the arm (Management of Stroke Rehabilitation Working Group, 2010).

The analyzed cross-sectional studies of ankle orthoses show that the device has a positive effect on gait speed (Bleyenheuft et al., 2008; Thijssen et al., 2007; Wang et al., 2007; Pohl and Mehrholz 2006). An ankle orthosis is used for patients with a request and rehabilitation goal to improve gait speed. Prolonged wearing of the orthosis has irreversible functional processes: limitation of the range of motion, stiffness, and creation of myogenic contractures. Therefore, repeated assessments and follow-ups by qualified specialists are recommended for patients with ankle orthoses.

The goal of physical therapy and occupational therapy for patients after stroke is to restore movement functions, independence in daily life, and independence in movement. Individualized therapeutic exercises are selected in combination with treadmill gait training and the use of aids. In addition, during and after rehabilitation activities, caregivers and patients are provided with advice and recommendations for continuing the home rehabilitation program, warnings about possible consequences, and contraindications (Zech et al., 2010).

As a result of the study of acute cerebrovascular accidents, patients are faced with over-extension of the affected knee joint when moving and walking. This significantly affects possible knee pain, reduces speed, and worsens gait asymmetry. Over-extension of the knee joint occurs as a result of weakness of the lower leg muscles, and hamstrings, stiffness of the plantar flexors, and impaired sensation in the hip, lower leg, knee, or foot. Rehabilitation tools should not be used routinely to fix and immobilize the knee joint. The best that a physical therapist can offer a patient is the selection of therapeutic methods to stimulate and stabilize the knee during the support phase (Macko et al., 2001).

After analyzing eight randomized control trials in which researchers evaluated inpatient rehabilitation, traditional and standardized exercises in combination with Kinesio taping for inpatient rehabilitation of the arm, and reducing the development of possible shoulder subluxation (Huang et al., 2017; Huang et al., 2016; Chatterjee et al., 2016; Griffin and Bernhardt, 2006; Pandian et al., 2013; Pillastrini et al., 2016; Santos et al., 2017; Hochsprung et al., 2017).

Kinesiotaping is widely used in rehabilitation practice for orthopedic patients. The literature is mixed on the improvement of range of motion and the effect on spastic muscles in patients after stroke. There is little evidence and benefits of the long-term effectiveness of taping on the affected limb. Additional careful study and substantiation of the therapeutic mechanisms of kinesiological taping would be useful in further research with neurological patients.

Application of mirror therapy. The patient is seated at a table, and a specialized mirror is placed in the middle of the person's body to block the view of the affected arm. Mirror therapy is similar to the action of visual feedback, during which the movement of the healthy arm is perceived as the movement of the affected arm. This creates the illusion that the two hands are performing the same task. It is believed that this therapy has an effect on
neuroplastic changes, and may help to increase the excitability of the ipsilateral motor cortex, which is responsible for the affected area (Deconinck et al., 2015).

The scientific article substantiates that the mirror therapy method has been successful in relieving neuropathic pain (Wittkopf and Johnson, 2017). Two randomized control trials were found to reduce regional pain syndrome with mirror therapy (Caccio et al., 2009). One study compared mirror therapy with mindfulness practice (Caccio et al., 2009).

In summary, mirror therapy can be useful for patients after a stroke to improve motor function. However, it does not affect reducing spasticity in muscle activity.

In research on the biofeedback method, electrodes are attached to the surface of the affected muscles of individuals to obtain information and capture the electrical capabilities of the motor unit. The signals with the result are transmitted through audio or visual feedback, which transforms the information received using a computer. Evidence suggests that this method has no effect on the motor function of the hand and does not train accuracy and coordination. However, the literature has mixed data on increasing the range of motion in the joints of the affected arm and the effect on spastic muscles in patients after stroke (Page and Lockwood, 2003).

Patients after stroke with impaired spatial and temperature sensitivity usually have reduced muscle strength, do not control, and do not use the affected limb in everyday activities, which complicates further recovery (Taub, 1980). Therefore, CIMT therapy is designed to maximize the use of the affected limb (Fritz et al., 2005). The peculiarity of the method is the limitation of the healthy arm when efforts are directed to the maximum use of the affected arm in the implementation of the planned tasks (Taub et al., 1999). Instructions for the use of CIMT therapy, the patient should have active movements, bending the hand by about 20 degrees, and extending the fingers by at least 10 degrees. The patient should have minimal sensory and cognitive impairment. The duration of the method is individually selected for each patient. The data were analyzed (Taub and Morris, 2001), with a positive result for patients in the acute period after stroke. The article also presents evidence that CIMT therapy has harmful effects (Dromerice et al., 2009). This method did not yield the expected results, but it can be used in the acute and subacute periods for patients after stroke.

PNF is proprioceptive neuromuscular facilitation. The technique is used to restore lost motor functions, affect the range of motion, improve endurance, and increase muscle strength. It is used after injuries, after surgery, and after disorders or damage to the central nervous system (Hindle et al., 2012). The PNF method focuses on a neurofunctional approach that combines examination, activation of neuromuscular control, stimulation of motor learning, and the proper use of motor control using various movement patterns. This method combines functional mobility patterns using inhibition, facilitation, strengthening, and relaxation of the muscular system (Etnyre and Abraham, 1986; Alaca et al., 2015).

One of the techniques used is rhythm rotation, when the affected limb is slowly taken out of the spasticity pattern, the physical therapist or occupational therapist performs until the joint is felt to be restricted. When the muscles relax, the affected limb is moved to another range, and the technique is continued.

In a systematic review of the use of PNF, it is an effective method of recovery for patients with late-onset stroke. It has an effective effect on balance, coordination, and gait speed. Improves motor function and activity through proprioceptive, skin, and auditory signals. It can be one of the methods of recovery for neurological patients (Nguyen et al., 2022).

The proprioceptive neuromuscular facilitation technique is justified by the effectiveness of improving the elasticity of spastic muscles after stroke, improving balance in dynamics. Studies, it has shown positive results on passive and active range of motion (Farinatti et al., 2011).

**Conclusions**

In this literature review, we highlight effective evidence, the latest recommendations, and research in the field of physical rehabilitation to help restore independence and motor activity after acute cerebrovascular accident in patients with spasticity. At the moment, there are enough evidence-based medicine methods to stabilize the condition and restore motor functions of patients after stroke in the
acute and early period. The use of evidence-based interventions helps to reduce the consequences of disability and significantly improves the ability to restore independence, activity, and participation of patients after a spastic stroke. However, not enough information is available on methods that reduce the outcomes and complications that occur in patients with late-onset spasticity that meet the criteria for the clinical effectiveness of the methods listed in this review, so we need to continue research and promote effective solutions.

The next scientific publication will be devoted to the examination of physical therapy and occupational therapy of patients after acute cerebrovascular accidents.

Acknowledgments

Arm Forces of Ukraine, our support as long as our hearts beat! Military medics, men and women, you are guardian angels! We remember every warrior who laid down his life. We are grateful to everyone who fights for the freedom and independence of our country Ukraine. Forever and ever: Glory to Ukraine! Glory to the heroes!

We are grateful to the Ukrainian Scientific Medical Youth Journal for the support of young and experienced scientists.

Financing

This study did not receive external funding.

Conflict of interests

There is no potential conflict of interest in any form.

Consent to publication

The author has agreed to publish this manuscript.

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A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article

REFERENCES


Методи доказової медицини для пацієнтів після інсульту зі спастичністю раннього періоду

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Анотація: гостре порушення мозкового кровообігу головна причина інвалідизації. Інсульт має різні клінічні характеристики та наслідки, що вимагають індивідуального реабілітаційного обстеження та підходу. Неспривабливи неврологічні розлади супроводжуються руховими, когнітивними та психо-емоційними наслідками. За останні 20-ть років лікування гострого порушення мозкового кровообігу значно зросло у показниках відновлення пацієнтів. Завдяки прогресу міжнародних клінічних протоколів, рандомізованим методам доказової медицини, адекватного медикаментозного лікування, поетапної та індивідуальної стратегії з фізичної терапії, ерготерапії для пацієнтів. Одні з найважливіших внесків у реабілітацію для пацієнтів після інсульту мають методи доказової медицини. У літературному огляді виведені сучасні дані та критична оцінка, щодо підтвердження ефективності методів доказової медицини в реабілітаційних заходах, для покращення контролю рухів, активності, участі та діяльності. Доведено, користь реабілітаційних втручань на спастичність після інсульту у різномірному періоді. Але навіть, після медикаментозної та медичної реабілітації, відновлення рухової функції залишається не достатнім для досягнення запиту пацієнта, за рахунок не послідовності застосування методів доказової медицини. Опис літературі має на меті, відобразити ефективність впливу методів доказової медицини на реабілітаційні втручання осіб після інсульту раннього періоду зі спастичністю, за для підвищення якості життедіяльності та поліпшення рухових функцій в уражених кінцівках. Матеріали та методи. У огляді ми проаналізували реабілітаційні втручання та методи доказової медицини з фізичної терапії. Обзертували матеріали Канадського довідника клініциста з реабілітації пацієнтів після інсульту за 2020 рік. В огляд увійшли наукові публікації англійською мовою. Статті та дослідження науковців опубліковані за останні 15 років. Компьютерний пошук здійснювався через базу даних PubMed. Розглянуто 63 публікації, які оцінювалися за критеріями: надійність, валідність, вимірюваність. Проаналізовані зміни, що відбувались на протязі здійснених наукових досліджень. Висновки. Спастичність у пізному періоді після гострого порушення мозкового кровообігу, має значні негативні наслідки труднощі, з якими пацієнти не мають змоги впоратись самостійно. Ми виявили, що реабілітаційні заходи та методи з фізичної терапії поліпшують рухові функції пацієнтів зі спастичністю у ранньому періоді, за умови дотримання рекомендацій доказової медицини. В часі використання методів, засобів та індивідуальний підхід до кожного пацієнта дають позитивні результати. Адже, мета фізичної терапії не переконати пацієнтів в тому, що наслідки після інсульту не підлягають реабілітації, а допомогти та навчити пацієнтів самостійності та підвищити якість життєдіяльності осіб зі спастичністю у ранньому чи пізному періоді. Також визначили, що не достатньо розкрити тема відновлення пацієнтів після інсульту зі спастичністю у пізному періоді. На сьогоднішній день більша половина осіб після інсульту залишаються обмеженими у побутових діях та мають негативні наслідки – рухові порушення, обмеження активності, що значно впливають на якість життя та незалежність. Необхідне подальше дослідження, щоб виявити, чи можливо зменшити спастичність у пізному періоді та поліпшити рухову функцію пацієнтів після інсульту з можливістю подальшого користування ураженою кінцівкою.

Ключові слова: огляд, рука, реабілітація після інсульту, мета-аналіз, відновлення функції