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Application of physical therapy methods for patients after stroke with spasticity in the early period

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Abstract: acute cerebrovascular accident is the leading cause of disability. Stroke ranks 4th among diseases that lead to death or disability. The consequences of stroke include neurological disorders, motor disorders (plegia, hemiparesis, paresis, muscle spasticity), loss of sensation, pelvic dysfunction, loss of coordination and balance, high risk of falls, and impaired ability to move independently and perform daily activities. To achieve optimal independence, stroke patients need qualified rehabilitation care as part of a multidisciplinary team. Evidence-based medicine, treatment, and rehabilitation interventions have improved significantly in the acute and early periods for stroke patients. However, in the late period, today, more than half of patients remain limited in their daily activities and have movement disorders that significantly affect their quality of life and independence. Description of the objective. To substantiate the use of evidence-based medicine methods in physical therapy to restore motor function in patients after stroke in the early period. Materials and methods. From October to December 2021, 20 patients with spasticity, aged 47-85 years, who had suffered an ischemic and hemorrhagic stroke, took part in the examination and rehabilitation activities at Kyiv City Clinical Hospital № 6, Palliative Care Department, for a period of 3 weeks to 1 month. Voluntary consent for examination, treatment, and rehabilitation was obtained from all patients and their caregivers. The diagnostic methods used were computed tomography, magnetic resonance imaging, and, if necessary, laboratory tests. Tests and scales for physical therapy were used to determine functional impairment in stroke patients with muscle spasticity: Rankin Scale, Riverbed Mobility Index, Pain Score, Modified Ashworth Scale, Degree of Arm and Hand Recovery; Degree of Leg and Foot Recovery. Results. After analyzing the methods of evidence-based medicine on the topic of the problem, we have confirmation that in the early period, recovery rates are high. However, in the late period after a stroke, the onset of muscle spasticity significantly limits the motor capabilities of patients and complicates the recovery process. In the late period, the effectiveness of methods to overcome spasticity has not been fully developed, and attention is not focused on the complications that arise and accompany them throughout the recovery period. The appearance of muscle spasticity significantly limits the motor capabilities

of patients, affects the psycho-emotional state of a person, and causes pain, which prevents the full use of the affected limb. Muscle spasticity inhibits and complicates the restoration of motor function in the long term. **Conclusions.** The study confirms the high effectiveness of the proposed methods of evidence-based medicine in reducing pain and increasing the range of motion in the shoulder, elbow, and wrist joints in the early period in patients after stroke. As for the late period, this issue remains incomplete and requires further study. In the palliative care unit of Kyiv City Clinical Hospital № 6, an individual multidisciplinary approach to patients after stroke was used, which contributed to the achievement of the goals. It can be stated that evidence-based medicine methods for the acute and early period have a positive effect on patient independence, and improve cognitive function and motor activity of the affected limbs.

Keywords: [compensation](#), [diagnosis](#), [treatment](#), [physical activity](#), [rehabilitation](#).

Introduction

According to WHO statistics, stroke kills about 5 million people worldwide every year. Approximately 70 – 80% of stroke survivors, of which 20 – 30% are dependent on outside help, have a motor and cognitive disabilities. A stroke is a vascular disease that occurs when a blood vessel in the brain blocks or ruptures, thus stopping normal blood flow to the brain. Part of the brain does not receive enough oxygen due to insufficient blood supply caused by blockage or damage due to bleeding. The consequences of a stroke depend on which part of the brain it occurs in and how large the area of damage is. Patients who survive a stroke often face disability, which affects their independent daily life (Martin-Saez and James 2021).

Risk factors for stroke are:

- hypertensive heart disease;
- ischemic heart disease;
- atrial fibrillation;
- myocardial infarction;
- cardiac circulatory failure;
- diabetes mellitus;
- overweight;
- insufficient physical activity;
- constant stress (Lou, Carstensen, & Nielsen, 2017).

The consequences of an acute cerebrovascular accident affect the cognitive, psycho-emotional, and physical functioning of individuals (Bernhardt et al., 2017).

Patients have the following consequences: paresis, hemiparesis, hemiplegia; spasticity; aphasia; swallowing disorders; apraxia; spatial visual disturbances; gait, balance, and coordination dis-

orders; posture changes; pain in paretic limbs; depression; development of contractures; low level of independence in everyday activities (Kuliński & Pasięka, 2021).

It is proved that the use of physical therapy, and ergotherapy in the acute period after stroke, reduce the risk of complications and helps to restore impaired functions, prepares patients for verticalization and the acquisition of the necessary skills to be independent in everyday activities (Chippala & Sharma, 2016).

Activity and participation of patients after stroke is an important elements of the rehabilitation path. It is used as a means of prevention and rehabilitation and has many benefits that affect the cognitive, psychosocial, and physical conditions of patients (Saunders, 2020).

Studies have shown that stroke survivors have limited functional activity and participation and lead sedentary lifestyles (Fini, Holland, & Bernhardt, 2017).

Current research emphasizes the need to increase physical activity and improve the active lifestyle of patients after stroke (Moore et al., 2018). The planning of rehabilitation interventions, as a result of achievements, can vary and are targeted at factors that the patient chooses. Factors include individual, environmental and social needs, which can positively or negatively influence the participation of patients after a stroke (Stretton, Mudge, & McPherson, 2017).

Aim

To determine the effectiveness of evidence-based physical therapy methods to restore motor function in patients after stroke with spasticity in the early period.

Materials and methods

A course of physical therapy was conducted for patients after a stroke with the consequences of muscle spasticity from October to December 2021, in the Palliative Care Unit at Kyiv City Clinical Hospital № 6. The duration of stay in the institution is from 1 to 3 months. The treatment and rehabilitation activities involved 20 people aged 47-85 years, divided into two groups: the main group – 10 people, and the control group – 10 people. All of them had suffered ischemic and hemorrhagic strokes for a period of 3 weeks to 1 month. All patients had muscle spasticity of paretic limbs. There were no contraindications at the time of treatment and rehabilitation in both group. Patients and caregivers voluntarily consented to examination, treatment, and rehabilitation interventions.

Patients after stroke underwent diagnostic examinations: computerized and magnetic resonance imaging. Ultrasound of the cerebral vessels of the neck, cerebral angiography, echocardiography, and laboratory methods was also performed as needed.

Scales and tests are used to examine and determine the patient's functional status in physical therapy and occupational therapy. During the initial, intermediate, and final examination, the effectiveness of treatment and rehabilitation measures is determined and compared. When patients were admitted to the palliative care unit, the physical therapist used the Rankin Scale from 0-5 points for the main and control groups to understand the severity of the stroke and assess the degree of disability. The Rivermead Mobility Index allowed identifying motor activity in the patient's daily life: 0 points – the inability to perform an arbitrary movement independently, the highest score of 15 – the ability to run 10 meters independently. Measurement of the severity of spastic muscles on the Ashworth scale from 0 – 5 points. Determination of the degree of pain from 1 – 7 points, 1 point – constant severe pain, with shoulder pathology, 7 points – shoulder pain and no prognostic indicators. The degree of recovery of the leg and foot was from 1 to 7 points, and the degree of recovery of the arm and hand was assessed from 1 to 7 points, where the highest score was motor activity and the ability to use the limb in everyday activities.

An occupational therapist for the main and control groups determined the degree of functional independence of patients using the Barthel Activities of Daily Living Index scale, with a total score of 100. The score from 0 to 20 points is complete dependence; from 21 to 60 points – is pronounced dependence; from 61 to 90 points – is moderate dependence; from 91 to 99 points – is slight dependence in the patient's daily activities.

The Montreal Cognitive Scale was used to assess the following cognitive impairments: concentration, executive functions, attention, memory, abstract thinking, counting, orientation in time and space, and constructive visual skills. A score of 26 to 30 points indicates a favorable cognitive status. Shoulder pain was assessed from 1 to 7 points, where the highest score has no pain and prognostic indicators.

Most often, patients after a stroke suffer from shoulder pain, which impairs the range of motion, affects the functional state of paretic limbs, and affects the appearance of muscle contractures. All this worsens balance and coordination, impedes independence in everyday activities, limits motor function, and complicates the rehabilitation process.

For the main group, a physical therapist and an occupational therapist conducted sessions 3 to 4 times a day, from 30 minutes to 1 hour, throughout the treatment and rehabilitation process. Evidence-based medicine methods were also used. During the first month, the sessions were held 2-3 times a day for 30 minutes to 1 hour:

- Positioning every 1.5 hours.
- Mobility in bed and within the ward for 30 minutes a day.
- Verticalization from 10 to 30 minutes, depending on the patient's functional status, and no contraindications.
- Active and passive therapeutic exercises from 30 minutes to 1 hour.
- Restoration of walking skills, focusing on the patient's condition, rapid fatigue from 20 to 30 minutes.

The occupational therapist conducted classes for maximum independence in everyday activities from 30 minutes to 1 hour.

In the second month, the sessions were held 3 to 4 times a day, and the patient used:

- Coordination and balance exercises from 30 to 45 minutes.
- Restoration of walking skills, focusing on the patient's condition, from 20 to 45 minutes.
- Proprioceptive neuromuscular facilitation combined with stretching exercises, from 30 to 45 minutes.

In the third month, 4 times a day, physical therapy and ergotherapy sessions were conducted, from 30 minutes to 1 hour. Stretching exercises were performed for the affected arm and leg, combined with proprioceptive neuromuscular facilitation. Corrected gait, and continued to perform exercises to improve balance and coordination twice a day, from 45 minutes to 1 hour.

A physical therapist and an occupational therapist in the control group worked with patients for the first month, 1-2 times a day, from 30 minutes to 1 hour. The standard program was followed:

- Physiotherapy: stimulating therapy on the affected limbs for 15-20 minutes a day;
- Passive and active exercises for 30 minutes;
- Verticalization and skills to restore walking 20 – 30 minutes;
- Mechanotherapy 15 – 20 minutes;
- Selection of mobility aids.

For the second placement, classes were held 2 times a day from 30 minutes to 1 hour:

- Passive and active exercises for 30 minutes;
- Restoration of walking skills from 30 minutes to 1 hour.
- Mechanotherapy for up to 30 minutes.
- Exercises for balance.

In the third month, classes were conducted similarly, 2 times a day, up to 1 hour. All the previously listed methods of physical therapy.

To achieve the set goals and specific needs of patients, the practicing physical therapist and occupational therapist of the main and control groups of patients with spasticity in the early period used evidence-based medicine methods with a variety of available tools.

The object of the study: patients after stroke with muscle spasticity 20 people, aged 47 – 85 years in Kyiv City Clinical Hospital №6, Palliative Care Department. A multidisciplinary team was created under the supervision of the attending physician: Neurologist, Psychologist, Speech

Therapist, Physical Therapist, Occupational Therapist, Massage Therapist, Ward Nurse, and Junior Nurse. With the voluntary consent of relatives and the patient, upon admission to the department, examinations were carried out, selection of medicines, and methods of evidence-based medicine were also used.

Results

Physical therapist and occupational therapist on admission to the department: assessed the functional status, based on the request and needs of patients, and developed an individual rehabilitation program.

The multidisciplinary team together with the patient discussed short-term and long-term goals built in a Smart format. Each member, within his competence, plans an individual program for the patient for the day. To achieve the goals, they use evidence-based medicine methods and tasks that the patient performs to successfully achieve the result. After all, rehabilitation does not end in the hospital or in the department, recovery continues until the patient is satisfied with his functional state.

For the main group, evidence-based methods were used 2-3 times a day, from 30 minutes to 1 hour:

Positioning is carried out every 1.5 – 2 hours, putting the limbs in the correct position for the body. It helped to reduce any muscle pain, discomfort, and stiffness due to the stroke. Prevention of pressure ulcers and pathological positions.

Mobility in bed and within the ward. Physical therapists conducted training sessions for a safe change of body position.

Functional training – allowed patients to perform tasks in real-time, in a real-life situation (getting up from a chair, walking, and climbing stairs).

Balance and gait training. The physical therapist used various training methods that polished the ability to maintain body balance and improve coordination of movement. Gait training included activities that helped the person to learn and improve the stereotype of walking.

The occupational therapist selected various types of aids: a 4-support stick, walker, and orthosis for the upper or lower limb, for comfortable and safe movement. Training of indepen-

dence skills in everyday activities and conducting classes with the cognitive state of the patient.

CIMT therapy, restricted-induced movement therapy. By limiting the movement of the healthy arm, the patient does not help the affected upper limb. It requires maximal use of the affected arm or hand to perform everyday tasks to regain control of the upper limb.

As the goals are achieved, the needs of the patients change, and the physical and occupational therapist can apply new rehabilitation techniques to help achieve maximum functionality.

With the control group, the physical therapist and occupational therapist worked from 30 minutes to 1 hour, 1 – 2 times a day, using:

Positioning – used to prevent pressure ulcers, pneumonia, and incorrect body position;

Passive mechanotherapy to prevent contractures in the joints of the affected limbs;

Gradual verticalization, transferring patients to a sitting position, then standing;

Selection of auxiliary means for movement;
 Orthotics for the upper limb, during the restoration of walking skills;

Occupational therapist conducted classes to restore self-care skills;

Passive or active exercises for gross and fine motor skills were used.

At the beginning of the study in the control and intervention groups, there were no significant differences in the test examinations and scales. The general characteristics of the control and intervention groups are presented in Table 1. Patients of both groups at admission had a low initial level of functional capacity and independence in everyday activities.

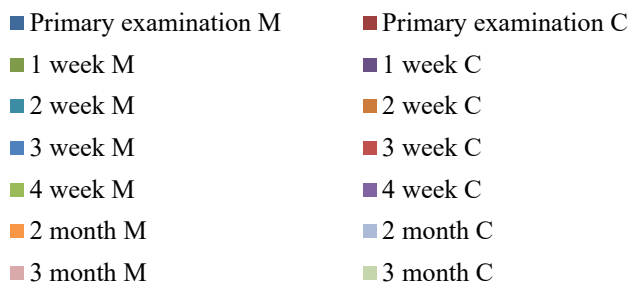
Comparative Pie Chart 1. shows the tests and scales of the treatment and control groups for 3 months of treatment and rehabilitation activities.

At the initial physical therapy examination, the main and control groups had the same rates – 4%. In the first week of intervention, the main group

Table 1. Comparative characteristics of the main and control groups, examination of patients in physical therapy

Tests and scales for Physical Therapy	Primary examination		1 week		2 week		3 week		4 week		2 month		3 month	
	M	C	M	C	M	C	M	C	M	C	M	C	M	C
Barthel index 100 points	20	20	25	20	30	25	40	30	50	35	55	35	60	40
Scale Rankin from 0 - 5 degree	4	4	4	4	4	4	3	4	3	4	3	3	3	3
Degree of pain	2	2	2	2	3	2	4	2	5	2	5	3	5	3
Ashworth scale from 0 – 5 degree	4	4	4	4	3	4	3	4	3	4	2	4	2	4
Index of mobility of Rivermead	3	3	3	3	4	3	5	4	6	4	7	4	8	5
The degree of hand recovery	1	1	1	1	1	1	2	1	2	1	3	2	4	2
The degree of recovery of the hand	1	1	1	1	1	1	2	1	3	2	3	2	4	2
Degree of leg recovery	3	3	3	3	3	3	4	3	4	3	5	3	5	3
The degree of recovery of the foot	2	2	2	2	2	2	3	2	4	3	5	3	5	3

1. Pie chart showing the results of the intervention and control groups for 3 months



has a 1% increase in the results of medical and rehabilitation measures. In the second week, the control group showed a 1% decrease, while the main group showed a 6% decrease. In the third week, the main group – was 8%, and the control group – was 6%, 2% less. In the fourth week, the control group had a result of 7%, and the intervention group had a result of 11%, which is significantly higher. The next month, the functional dynamics of the main group was 12%, while the control group showed no significant changes. Having carried out the final examination, we got a result of 13% in the main group, and 8% in the control group. We assume that the control group did not have a sufficient number of physical therapy sessions and did not follow the recommendations of evidence-based medicine, which has an effective impact on the recovery of patients after stroke with spasticity in the early period.

After the treatment and rehabilitation measures, from 1 to 3 months in the main group, the final examination showed that the Barthel Index, Rankin Scale, Ashworth Scale, Degree of pain, and Degree of recovery of the arm, hand, leg, and foot showed positive dynamics. Patients improved balance, and coordination; discomfort, stiffness of spastic muscles, and pain syndrome

decreased; active movements in the affected limbs appeared, which increases the level and quality of life of people after stroke.

And vice versa, the representatives of the control group on similar tests and scales, the final results are not high.

Discussion

At the beginning of treatment and rehabilitation measures, in the anamnesis and examinations conducted in the groups, there were no significant differences. Patients of the main and control groups had a low level of functional capacity, respectively, and a low level of motor activity.

Control examinations were conducted every week and, if possible, for 2, or 3 months.

At the final examination of physical therapy and occupational therapy, significant changes in the dynamics of the functional state of patients in the main group were determined. In the control group, the results were minor changes.

Statistica 8 software was used to collect statistical data. Table 2 shows the average indicators of patients after the stroke of the control and main groups, after treatment and rehabilitation measures in the Palliative Department.

Table 2. Comparative analysis of the main and control group examinations

Tests and scales for Physical Therapy	The main group	Control group
Barthel index	40 %	29 %
Rankine scale	3,42 %	3,71 %
Degree of pain	3,71 %	2,28 %
Ashworth scale	3 %	4 %
Index of mobility of Rivermead	5,14 %	3,71 %
The degree of hand recovery	2 %	1,28 %
The degree of recovery of the hand	2,14 %	1,42 %
Degree of leg recovery	3,85 %	3 %
The degree of recovery of the foot	3,28 %	2,42 %

According to the Barthel Index, the main group has a score of 40%, compared to a low score of 29% of the control group. The positive dynamics of the Rankin Scale increased in the main group for 3 weeks, and the indicator of the control group changed only for 2 months of treatment and rehabilitation measures, compared to the main group is significantly behind. The degree of pain according to the results of recent studies, the main group has a degree – 5, which significantly improves the functional state of the hand, and the control group – 3 degrees.

According to the Ashworth scale, the final result, in the main group, muscle spasticity decreased to 2 points, which can not be said about the control group, without significant changes – 4 points. According to Rivermead, the main group prevails in the difference by 1.43%.

The degree of hand recovery in the main group is 2% in the control group – 1.28%. The degree of recovery of the hand in the main group is 4 degrees (2.14%), and in the control group, there was no significant difference in degree 2 (1.42%), without significant changes.

The final result in the main group was the degree of recovery of leg 5 (3.85%), and in the control group – degree 3 (3%). Regarding the degree of recovery of the foot, the main group of 3.28% resulted in a degree 5, and the control group has a rate of 2.42% with a degree 3 final result of staying in the department.

Particularly noteworthy is a more pronounced increase in the final results in patients of the main group compared to the control group. Summarizing the above, the reason, in our opinion, lies in the insufficient number of classes and methods of physical therapy used to achieve the goals and maximize the recovery of lost motor functions of patients in the early period after stroke.

The results obtained indicate that the most effective training is carried out from 2 to 4 times a day, from 30 minutes to 1 hour, depending on the patient's condition. We have selected effective and scientifically based methods that contribute to the achievement of the set goals and maximize the recovery of patients after stroke with spasticity in the early period.

Conclusion

The article highlights the data confirming the effectiveness of evidence-based medicine in the

physical therapy of patients after stroke with spasticity in the early period. This is provided that consistent guidelines are followed, physical therapy methods are used appropriately, and the number of sessions performed is measured over time. The use of evidence-based medicine can reduce the disability of patients after early spasticity stroke, gain independence and improve the patient's functional status.

Further work is needed to determine the proposed methods for the restoration of motor functions of patients after a stroke with muscle spasticity in the late period to speed up the rehabilitation process and reduce the negative consequences that occur in the late period. It often turns out that the methods used in the early period are ineffective in the late period. This leads to the adaptation of patients to the consequences and defects after stroke. Worsening the functional state of patients after stroke increases the duration of motor function recovery.

In the future, our goal is to review evidence-based medicine and late-phase examination methods for stroke patients with spasticity.

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Conflict of interest

There is no potential conflict of interest in any form.

Consent to publication

The authors took consent from patients and guardians related to this manuscript, all of whom gave their consent for publication.

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Застосування методів фізичної терапії для пацієнтів після інсульту зі спастичністю у ранньому періоді

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Анотація: гостре порушення мозкового кровообігу головна причина інвалідизації. Інсульт посідає 4 місце серед хвороб, що спричиняють смерть або інвалідність. Наслідками інсульту є неврологічні розлади, рухові (плегія, геміпарез, парез, спастичність м'язів), втрата чутливості; дисфункції тазових органів; втрата координації та рівноваги, високий ризик падінь, перепона до здатності самостійного пересування та здійснення повсякденної діяльності. Для набуття оптимальної незалежності пацієнтам після інсульту потрібна кваліфікована реабілітаційна допомога у складі мультидисциплінарної команди. Доказова медицина, лікування та реабілітацій-

ні заходи, суттєво поліпшені у гострому та ранньому періоді для пацієнтів після інсульту. Але у пізньому періоді, на сьогоднішній день, більша половина пацієнтів, залишаються обмеженими у побутових діях та мають рухові порушення, це значно впливає на якість життя та незалежність. **Опис мети.** Обґрунтувати застосування методів доказової медицини у фізичній терапії для відновлення рухової функції пацієнтів після інсульту у ранньому періоді. **Матеріали та методи.** У Київській міській клінічній лікарні № 6, Відділення паліативної допомоги, з жовтня по грудень 2021 рік, у обстеженні та реабілітаційних заходах взяли участь 20 пацієнтів зі спастичністю, віком від 47 – 85 років, які перенесли ішемічний та геморагічний інсульт, строком від 3 тижнів до 1 місяця. У всіх пацієнтів та опікунів брали добровільну згоду на обстеження, лікування та реабілітаційні заходи. Для діагностичних методів: використовували комп'ютерну томографію, магнітно-резонансну томографію, за потреби здійснювались лабораторні методи обстеження. Для визначення функціональних порушень пацієнтів після інсульту з м'язовою спастичністю були використанні тести та шкали по фізичній терапії: шкала Ренкіна, Індекс мобільності Рівермід, Ступінь болю, Модифікована шкала Ашворд, Ступінь відновлення руки та кисті; Ступінь відновлення ноги та стопи. **Результати.** Проведений аналіз методів доказової медицини за темою проблематики, маємо підтвердження, що в ранньому періоді високі показники відновлення. Але у пізньому періоді після інсульту поява м'язової спастичності значно обмежує рухові можливості пацієнтів та ускладнює процес відновлення. Не до кінця розгорнуте питання на рахунок ефективних методів подолання спастичності у пізньому періоді, не акцентовано увагу на ускладненнях, що виникають у пізньому періоді. Поява м'язової спастичності значно обмежує рухові можливості пацієнтів, впливає на психоемоційний стан людини, з'являються больові відчуття, які заважають належно використовувати уражену кінцівку. М'язова спастичність гальмує та ускладнює відновлення рухової функції в пізньому періоді. **Висновки.** Проведене обстеження підтверджує високу ефективність запропонованих методів доказової медицини у зменшенні больового синдрому та збільшенні амплітуди рухів у плечовому, ліктьовому та променево-зап'ястковому суглобах у ранньому періоді пацієнтів після інсульту. На рахунок пізнього періоду, питання залишається незавершеним, і потребує подальшого розгляду. У Київській міській клінічній лікарні №6, Відділення Паліативної допомоги, використовували індивідуальний мультидисциплінарний підхід для пацієнтів після інсульту, що сприяло досягненню поставлених цілей. Можемо стверджувати, що методи доказової медицини для гострого та раннього періоду мають позитивний вплив на самостійність та незалежність пацієнтів, також покращує когнітивну функцію та рухову активність уражених кінцівок.

Ключові слова: діагностика лікування, компенсація, структурна функція, пошкодження головного мозку, реабілітація, фізична активність



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