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RELEVANCE OF BIOFEEDBACK IN REMOTE REHABILITATION AFTER STROKE

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Abstract

Introduction. Over the past several decades, stroke has remained a leading cause of long-term disability, requiring a comprehensive and individualized approach to rehabilitation.
Aim. To study the effectiveness of using biofeedback during remote rehabilitation using the «Osnova» simulator for patients with stroke.
Materials and methods. The study involved men aged 45-60 years with impaired locomotor functions as a result of cerebral and spinal cord accidents. Given the nature of the disease and the age range, only one group of 10 people participated in the study. At the outpatient and remote stages, at the beginning of the program and every 5 sessions, the Berg balance test and the 'Get Up and Walk' test were performed. During the sessions, the following vital signs were obtained: blood pressure (BP), heart rate (HR), and stress level, as measured by an electronic device (Garmin smartwatch) that assesses heart rate variability (HRV).
Results. As part of a four-week rehabilitation program for patients after stroke, the main vital signs were monitored during exercises in a vertical and horizontal position. The data obtained (coefficient of variation) shows that the participants are homogeneous. During the first week, the heart rate ranged from 77±1.09 to 86±3.26 bpm with a tendency to increase, indicating the initial adaptation of the cardiovascular system. In the second week, the heart rate decreased to 73±1.68-76±1.45 bpm at the beginning, but by the fifth session, it increased again to 84 bpm due to an increase in exercise intensity. The third and fourth weeks showed consistently high heart rate values – up to 95±2.00 bpm, which indicates adaptation and increased endurance. Systolic and diastolic blood pressure decreased from the initial values of 128±3.35-137±2.75 mmHg and 86±3.13-93±2.17 mmHg to stable normal values of 121±0.98-129±3.74 and 76±4.29-90±1.67 mmHg, confirming the safety of rehabilitation on the «Osnova» simulator.
Conclusions. The introduction of the latest technologies, such as biofeedback and tele-rehabilitation, significantly improves the effectiveness of patient recovery. The results of the study showed a significant improvement in the functional state of the cardiovascular system and the body's adaptation to physical activity in different body positions using the «Osnova» device.

Keywords: **telerehabilitation, ischemic stroke, physical therapy, rehabilitation, digital technologies, «Osnova» device, quality of life**

INTRODUCTION

Stroke is a leading cause of adult disability, often resulting in motor, speech, memory, and emotional impairments. Its rehabilitation is a complex, long-term process requiring a multidisciplinary team of neurologists, physiotherapists, speech therapists, psychologists, and social workers [1, 2, 3]. The OECD reports a steady rise in the cost of caring for chronically ill and disabled patients, partly due to insufficient rehabilitation services that delay their return to work. Investing in neurorehabilitation helps reduce this burden by restoring patients' ability to work and participate in society, yielding long-term economic benefits. In Ukraine, the demand for rehabilitation has grown sharply because of the war, which has led to numerous cases of traumatic brain injuries, spinal and limb damage, and PTSD, often combined with mental health issues. The high prevalence of cardiovascular diseases and strokes, along with stress and limited prevention, adds further pressure to the healthcare

system [4]. Research shows that neuroplasticity – the brain's ability to form new neural connections – plays a crucial role in recovery after stroke, and techniques like mirror therapy help restore motor functions [5]. The use of constraint-induced movement therapy (CIMT) has proven effective for faster limb recovery. Moreover, European studies emphasize the benefits of robotic systems and biofeedback, including exoskeletons and simulators, which support movement, reduce therapists' workload, and enhance training intensity [6, 7].

Remote rehabilitation is becoming increasingly popular thanks to technological developments, enabling patients – especially those in remote areas – to perform exercises at home under specialist supervision via dedicated apps or video communication. Recent studies emphasize the growing role of tele-rehabilitation platforms using artificial intelligence and biofeedback for personalized remote rehabilitation, where programs automatically adapt exercises based on patient progress [8, 9]. The use of virtual reality (VR) Serious Games enhances both motor and cognitive recovery, increasing patient engagement by up to 40% compared to traditional methods [10, 11]. Wearable devices such as fitness trackers and sensor bracelets enable real-time monitoring, helping doctors adjust rehabilitation programs and reducing the risk of recurrent stroke by 25% [12]. Additionally, virtual support groups and online counseling effectively address emotional challenges, lowering depression rates by 30-40% [13, 14]. These innovations demonstrate that technology significantly enhances the efficiency and emotional support of post-stroke rehabilitation. Recent European studies show that a combined approach (a combination of in-person and remote rehabilitation) is the most effective. Classical rehabilitation allows patients to lay the foundation for recovery when working under the supervision of specialists. Remote rehabilitation helps to maintain the results achieved and ensures the continuity of the process [11, 15]. Analyzing the results of the study, we note that the combined approach allows for a 15% faster recovery of motor functions compared to in-person rehabilitation alone.

Despite significant achievements in the field of classical and distance rehabilitation, the problem remains the limited availability of rehabilitation services and the low awareness among patients and their families about the importance of regular exercise [16, 17]. To improve the effectiveness of rehabilitation, it is necessary to provide patients with modern technologies and promote support programs focused on long-term recovery and social integration. Given all of the above, the question arises whether the use of biofeedback during remote rehabilitation of patients with acute cerebrovascular accident using the «Osnova» [15] simulator will have a positive effect.

AIM

The study aims to investigate the effectiveness of the use of biofeedback during remote rehabilitation using the «Osnova» simulator for patients with an acute cerebrovascular accident.

MATERIALS AND METHODS

Participants. The study involved male patients aged 45-60 years with impaired locomotor functions as a result of cerebral and spinal cord accidents. Given the nature of the disease and the age range, only one group of 10 people participated in the study. Although our study did not include such a large sample, we developed criteria for the inclusion/exclusion of patients in the analyzed group. The inclusion criteria were: patients with impaired locomotor functions as a result of cerebrovascular disease (cerebral, spinal), stable physical and psycho-emotional state of the patient, minimally preserved mobility with aids, ability to self-care, and a willingness to actively participate in physical rehabilitation. The main exclusion criteria were: deterioration of the patient's physical and psycho-emotional state, the patient's refusal to participate in the study, and structural damage to the nervous system that cannot be restored. The main endpoints are indicators that reflect a possible improvement in the patient's functioning (verticalization and movement, balance and coordination, exercise tolerance). Secondary endpoints are indicators that characterize the improvement in the patient's quality of life.

Methods and procedure. The study lasted two months and was divided into two stages – outpatient and remote. At each stage, 20 sessions were conducted at the rate of 5 sessions per week using the «Osnova» device. The outpatient stage involved working with the patient in a medical facility under the supervision of a physical therapist. At this stage, we monitored the patient's vital signs during exercises to assess physical activity tolerance, strength, and coordination, and learning ability. The remote stage – classes were held at home. At this stage, based on the results of the data obtained, an individual rehabilitation program was developed for each patient under the remote supervision of a physical rehabilitation specialist. If necessary, the patient could use the help of unqualified personnel (relatives, friends, etc.). At the ambulatory and distance stages, at the beginning of the program and every 5 sessions, the Berg Balance Test and the Stand and Walk Test were conducted (Timed Up and Go, TUG). Berg balance test (BBS) is a clinical tool designed to quantify balance and fall risk in patients, especially among the elderly and stroke patients. The Berg test is a reliable tool for assessing balance and helps determine the need for rehabilitation measures to reduce the risk of falls in patients. Approximate duration of the test: 15-20 minutes.

The Timed Up and Go test (TUG) is a clinical tool used to assess the mobility and balance of patients,

including those who have had a stroke. It helps to determine the risk of falls and the effectiveness of rehabilitation measures. For patients after a stroke, the TUG test is an important tool for assessing functional status and planning rehabilitation activities. It helps to identify mobility limitations and determine the need for additional support or for modification of the rehabilitation program. It should be noted that the patient may use assistive devices such as a cane or walker if necessary. However, this should be taken into account when interpreting the test results.

During the sessions, the patient's vital signs were obtained: blood pressure (BP), heart rate (HR), and stress level using electronic devices (Garmin smartwatch). A smartwatch (Garmin) measures heart rate variability (HRV), which reflects the balance between the sympathetic and parasympathetic systems of the autonomic nervous system. We developed a diary of stress levels during the implementation of the rehabilitation program, where we recorded the indicators: before the session: the patient sits quietly for 2-3 minutes, and the device measures the level of stress; during the session: the smartwatch measures automatically (or is recorded in the middle of the session); after the session: a new level is recorded 5-10 minutes after the end of the session.

We determined the level of stress by the following parameters (Level of stress-Value-Interpretation): Low stress levels (0-25) – relaxed state, good heart rate variability, parasympathetic activity dominates; Moderate stress levels (26-50) – easy activation of the body, normal reaction to daily stress; High stress levels (51-75) – result in the body being mobilized, monitor recovery; Very high stress levels (76-100) – in a state of prolonged or excessive stress, the body is overloaded. It is recommended to reduce the load and pay attention to how you feel [18]. Study participants were also asked to indicate the presence of anxiety, poor health, which exercises caused the most stress, whether breaks occurred, etc. During the session, the type of load was recorded in the form of the type of exercise, number of repetitions, additional weighting, starting position, and use of additional support.

Statistical analysis of data processing was performed using the SPSS Statistics program.

RESULTS

Monitoring of blood pressure (BP) and heart rate (HR) is critical during rehabilitation sessions in patients after stroke, as it allows timely detection of hemodynamic changes that may indicate cardiovascular overload or the risk of recurrent cerebrovascular events. Given that this category of patients is prone to disorders of cerebral circulation, monitoring blood pressure and heart rate during physical activity allows for individualized exercise, maintaining it within a safe range and preventing complications, including orthostatic hypotension, hypertensive crises or tachycardia. Assessment of stress levels using wearable electronic devices (e.g., Garmin smartwatches) based on heart rate variability (HRV) analysis is an additional important tool in post-stroke rehabilitation. It allows for the assessment of the patient's psycho-emotional stress level, which can significantly affect the effectiveness of the recovery process, as increased stress is associated with a decrease in neuroplasticity, lower motivation to participate in classes, and an increased risk of developing depression. Thus, comprehensive monitoring of physiological and psycho-emotional parameters contributes to a safe and individualized approach to the rehabilitation of patients after stroke. We proceeded to analyze the indicators.

The obtained data (coefficient of variation) show that participants are homogeneous in terms of vital activity indicators when performing standing/ sitting/ lying exercises: HR bpm (V – 8.91%), SBP, mmHg (V – 6.39%), DBP, mmHg (V – 7.34%), stress level (V – 7.02%). (V – 7.34%), stress level (V – 6.02%). According to the indicators of vital activity during sitting/lying exercises: HR, bpm (V – 7.61%), SBP, mmHg (V – 4.58%), DBP, mmHg (V – 7.22%), stress level (V – 5.84%). As part of a four-week rehabilitation program for patients after stroke, the main vital signs were monitored during exercises in an upright position. The dynamics of heart rate (HR), blood pressure (systolic – SBP and diastolic – DBP), as well as stress level, determined using an electronic device (Garmin smartwatch), were assessed. The data made it possible to trace the processes of adaptation of the cardiovascular and autonomic systems against the background of rehabilitation load.

The dynamics of heart rate (HR) in patients undergoing physical rehabilitation after stroke over four weeks. Each data series reflects the average heart rate during five consecutive sessions at each stage of the week.

During the first week, the heart rate ranged from 77±1.09 to 86±3.26 bpm, showing slight fluctuations with a general upward trend in the fifth session. This may indicate an initial adaptive load on the cardiovascular system in the context of the gradual inclusion of patients in physical activity. In the second week, a relative decrease in heart rate was observed in the first sessions (73±1.68-76±1.45 bpm), which can be interpreted as a sign of the onset of cardiovascular adaptation to exercise. However, by the fifth session, the heart rate increased again to 84 bpm, likely in response to an increase in exercise intensity or a change in physical condition. The third week is characterized by consistently higher heart rate values, reaching a maximum of 95±2.00 bpm. This may be due to increased exercise or activation of metabolic processes in response to the

duration of rehabilitation. Such dynamics may also indicate an improvement in neuromuscular activity and a gradual recovery of endurance. The fourth week demonstrates high but stabilized heart rate values in the range of 85±1.78-95±2.35 bpm. This level can be considered a positive sign of the gradual adaptation of the cardiovascular system to regular physical activity, which is an important goal of the rehabilitation process after stroke. Such stabilization confirms the effectiveness of the chosen physical therapy program and gives grounds for its further continuation or gradual modification in order to increase the functional reserves of patients.

Blood pressure had a similar trend: at the beginning of the study, SBP and DBP ranged from 128±3.35-137±2.75 mm Hg and 86±3.13-93±2.17 mm Hg, respectively. During the second week, these values decreased to 121±0.98-129±3.74 mm Hg (SBP) and 76±4.29-90±1.67 mm Hg (DBP), indicating a decrease in vascular resistance and normalization of hemodynamics. In the third and fourth weeks, blood pressure stabilized at the level of physiological normality, which can be regarded as the result of appropriately selected physical activity using the «Osnova» simulator, which did not provoke hypertensive reactions and helped reduce the risk of recurrent vascular events.

The dynamics of stress levels in stroke patients during standing exercises over four weeks of rehabilitation. In the first week, a gradual decrease in stress levels was observed from 69±2.37 to 58±2.16 conventional units. Initial high values of stress levels are probably associated with increased psycho-emotional stress and fear of recurrent stroke, which is typical for the early recovery period. In the second week, the stress level continued to decrease from 52±0.93 to 41±1.87 conventional units, which demonstrates the positive dynamics of the body's adaptation to the vertical body position and physical activity. A decrease of 11 units during the week may indicate the effectiveness of the physical rehabilitation program in reducing psycho-emotional stress. In the third week, a further decrease in stress was recorded from 43±0.42 to 33±1.51 conventional units, with the lowest values in the fourth session (31±4.04). The slight increase to 33±1.51 in the fifth session is probably due to increased physical activity or fatigue at the end of the week. In the fourth week, there was a stable decrease in stress level from 35±2.88 to 25±2.67 units, which indicates the formation of a stable adaptation to physical exercises in the upright position.

In general, the dynamics of stress levels demonstrate a gradual and stable decrease throughout the rehabilitation period, which is a positive sign of psycho-emotional recovery in post-stroke patients. A particularly pronounced decrease in stress levels was observed in the second week, which can be considered a critical stage in overcoming anxiety and fear associated with physical activity.

The dynamics of heart rate (HR) in post-stroke patients during sitting/lying exercises were analyzed. During the first week of rehabilitation, a gradual increase in heart rate from 74±2.09 to 81±0.80 bpm was observed during five sessions. This indicates the initial adaptation of the cardiovascular system to physical activity, which is typical for the early stage of recovery. In the second week, a gradual decrease in heart rate was recorded from 73±1.84 to 69±2.20 bpm, which may be a sign of improvement in the functional state of the cardiovascular system and increased exercise tolerance. Such dynamics are a positive marker of recovery, as it indicates a decrease in the stressful effect of exercise on the body. In the third week, there was a relative stabilization of heart rate with a slight fluctuation from 70±0.47 to 74±1.17 bpm. This may be due to stabilization of adaptation processes or the gradual complication of physical exercises. In the fourth week, there was a slight increase in heart rate to 78±1.02 bpm at the second session, followed by a decrease to 75±1.95 bpm at the end of the week, which indicates a typical training response to restorative exercise. In general, the results obtained demonstrate the characteristic dynamics of recovery in the early rehabilitation period after stroke, where at the initial stage the cardiovascular system is activated, and the subsequent reduction and stabilization of the heart rate indicate the formation of an adaptive response to physical activity.

A similar trend was observed in SBP and DBP. The initial values of SBP were 121-130 mm Hg, and by the fourth week, they stabilized at 119-125 mm Hg. DBP decreased from 84-87 mm Hg in the first week to 75-80 mm Hg at the end of the program. The decrease in blood pressure while maintaining the functional activity of patients indicates an improvement in vascular wall tone and a decrease in peripheral resistance, which is a positive effect of physical rehabilitation.

During the first week, there was a certain fluctuation in the level of stress: from 65±2.26 conventional units at the first lesson to 69±1.22 at the second lesson, after which a gradual decrease in indicators was noted to 59±1.76 at the fifth lesson. Such dynamics indicate the initial psycho-emotional stress at the beginning of rehabilitation, with gradual adaptation of the body to the load even in low-intensity postures. The second week was characterized by a more uniform decrease in stress level: from 50±1.54 to 42±1.37 conventional units. A decrease of 8 units per week on average indicates a stabilization of the emotional state and an increase in exercise tolerance. In the third week, a positive trend was observed with a further decrease in the scores from 40±0.66 to 29±2.42 conventional units. The greatest progress was recorded between the third and fifth sessions, which may be due to a decrease in anxiety and fear of movement. The fourth week of rehabilitation was accompanied by a stable and moderate decrease in stress level from 28±1.33 to

22±0.46 conventional units, which indicates the formation of a stable adaptation to the load and a decrease in psycho-emotional stress during sitting/lying exercises. The overall trend shows a gradual and systematic decrease in stress levels during the rehabilitation period. The transition from values of over 60 units at the beginning to stable 22 units at the end of the fourth week is particularly significant. This indicates the effectiveness of the rehabilitation program in normalizing the psycho-emotional state of patients after stroke, even with minimal physical activity in a low-intensity posture.

In general, the results indicate the effectiveness of using exercises on the «Osnova» device in a sitting or lying position in the early stages of rehabilitation. The reduction in heart rate, blood pressure, and stress levels indicates a decrease in the load on the cardiovascular system and normalization of autonomic regulation. Such changes are important for preventing secondary complications and creating the basis for a gradual transition to more intense forms of physical activity in the subsequent stages of stroke recovery.

DISCUSSION

This study formulated a hypothesis about the positive impact of using biofeedback during remote rehabilitation using the «Osnova» device for patients who have suffered an acute cerebrovascular accident (stroke). It was assumed that the integration of biofeedback technologies would improve patients' motor, cognitive, and emotional performance, as well as increase their adherence to the rehabilitation process. This study also examined the possibility that rehabilitation of patients after an acute cerebrovascular accident (ACVA) involving outpatient and remote stages, using the Berg Balance Test (BBS) and the Stand and Walk Test (TUG), would improve locomotor function, reduce the risk of falls, and improve quality of life. The study assumed that monitoring of vital signs, including blood pressure (BP), heart rate (HR), and stress levels, combined with an individualized approach to physical rehabilitation of post-stroke patients, would ensure safety and increase the effectiveness of restoring locomotor and psycho-emotional functions.

The results demonstrate strong alignment with modern scientific data on the effectiveness of biofeedback technologies in stroke rehabilitation. In particular, published European studies indicate an increase in the effectiveness of motor function recovery by 20-30% when using similar remote therapy techniques, which correlates with the results obtained in this study [8, 9, 19]. The data of our study confirm the increase in adherence to exercise using the «Osnova» exercise machine with biofeedback [15]. In addition, the results are consistent with current findings on the preventive effect of remote monitoring of physical activity: patients demonstrated a consistently higher level of physical activity, which, according to the literature, is associated with a 25% reduction in the risk of recurrent strokes. The results of the study demonstrate a positive trend in improving motor activity and balance, which is consistent with the findings of a number of domestic and foreign studies [13, 14], which emphasize the importance of regular physical activity under the supervision of specialists. The use of BBS and TUG tests allowed us to objectively assess the functional status of patients and the effectiveness of rehabilitation measures. In particular, monitoring of blood pressure and heart rate meets current recommendations for safe and effective rehabilitation [10, 14, 18].

Controlling the psycho-emotional state through heart rate variability (HRV) is a modern approach in post-stroke rehabilitation, as it allows real-time adjustment of exercise intensity and continuous monitoring of patients' psychophysiological state using wearable devices. The observed reduction in stress levels confirms that managing psycho-emotional tension enhances neuroplasticity and motivation, aligning with contemporary rehabilitation practices [12, 18].

Previous research has shown predictors of cognitive decline during the first year after ischemic non-lacunar stroke in patients with atrial fibrillation, highlighting the importance of timely cognitive assessment to maintain independence and prevent complications. These findings were incorporated into our remote physical therapy program using biofeedback and the «Osnova» simulator, which targets both motor recovery and the prevention of post-stroke cognitive deterioration. The analysis of the study results confirms the effectiveness of biofeedback as an important tool for post-stroke rehabilitation. The use of the «Osnova» device significantly improved patients' functional performance and emotional state by allowing real-time visualization of progress. The homogeneity of vital indicators validates the results and supports the practical application of this method. The proposed rehabilitation model can be widely implemented, especially within tele-rehabilitation systems, ensuring treatment continuity and reducing complications. Combined use of BBS and TUG tests with digital monitoring allows for timely adjustment of exercise intensity and focus. This approach increases patient motivation and enhances functional recovery. Regular monitoring of physiological and stress indicators optimizes rehabilitation safety and outcomes. Further research should be directed at studying the long-term effectiveness of remote rehabilitation programs using biofeedback, as well as at optimizing software with the integration of artificial intelligence algorithms.

CONCLUSIONS

Stroke is a leading cause of long-term disability, and effective recovery requires an early, personalized,

multidisciplinary approach supported by modern technologies that enhance neuroplasticity, such as mirror therapy, intensive repetitive training, robotic systems, and biofeedback. Tele-rehabilitation platforms, wearable devices, virtual reality, and gaming applications ensure continuity of rehabilitation at home while significantly boosting patient motivation and treatment effectiveness.

In this regard, it is advisable to further investigate the effectiveness of biofeedback in remote rehabilitation using specialized simulators such as «Osnova» to optimize the recovery process after acute cerebrovascular disorders. The four-week study revealed a significant improvement in the functional state of the cardiovascular system in patients after stroke. Regardless of the position of the body during exercise – standing, sitting or lying down – a decrease in heart rate (HR) was observed against the background of increased tolerance to physical activity. Such dynamics indicate a gradual adaptation of the body to the imposed load, as well as the activation of mechanisms of regulation of the cardiovascular system. Indicators of systolic and diastolic blood pressure demonstrated moderate stabilization, which is clinically significant in the context of prevention of hypertensive crises and secondary lesions. In particular, a more pronounced reduction in SBP and DBP occurred when performing exercises in the sitting/lying position, which confirms the feasibility of using less intense forms of physical activity in rehabilitation. This ensures the safety of the training effect without risk to hemodynamics.

It is worth noting a significant reduction in stress levels through non-invasive monitoring using wearable devices (Garmin smartwatches). The gradual decrease in stress levels from the initial 65-70 conventional units to 22-25 indicates a decrease in psycho-emotional stress, which is likely due to the regularity of sessions, the inclusion of breathing exercises, the structured regime, and social support in the group rehabilitation format.

The study confirms that continuous monitoring of heart rate, blood pressure, and stress levels should be included in post-stroke rehabilitation to track adaptation, prevent overload, and adjust exercise intensity, ensuring greater safety and personalized recovery.

Prospects for further research. Further research should focus on studying the long-term effectiveness of remote rehabilitation programs using biological feedback, as well as on optimizing software with the integration of artificial intelligence algorithms. Research into combined rehabilitation models integrating face-to-face and remote stages, taking into account the individual clinical characteristics of patients, appears to be particularly promising. Further research should also focus on expanding the sample and including patients of different ages and degrees of impairment, which will allow for the refinement of rehabilitation effectiveness criteria. It is also important to investigate the impact of psycho-emotional state on long-term outcomes of functional recovery and quality of life. The implementation of automated data processing systems from wearable devices should also be considered to improve the personalization of rehabilitation measures and increase the effectiveness of clinical decisions.

COMPLIANCE WITH ETHICAL REQUIREMENTS

The publication of data obtained in the course of biomedical research was carried out in accordance with the principles of bioethics and legislative norms and requirements for conducting biomedical research, namely: the Helsinki Declaration (2000), the Constitution (1996) and the Civil Code of Ukraine (2006), the Fundamentals of Ukrainian Legislation on Health Care (1992), the Law of Ukraine ‘On Information’ (1992) (with amendments and additions as of 01.12.2021).

Before the start of the study, all participants received comprehensive information about the purpose, methods, possible risks and benefits of participation. Participation in the study was based on the principle of informed consent, and all respondents signed a consent form before data collection. Participants had the right to withdraw from participation at any time without explanation. In accordance with confidentiality regulations, all data were collected anonymously and processed in compliance with applicable personal data protection legislation, including the General Data Protection Regulation (GDPR), to ensure the protection of personal information. All information was used exclusively within the scope of this study and was summarized for further analysis of the results.

In this work, artificial intelligence was not used to generate text, analyze data or create images. All content was prepared by the authors, who are fully responsible for its accuracy.

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Резюме

АКТУАЛЬНІСТЬ ВИКОРИСТАННЯ БІОЛОГІЧНОГО ЗВОРОТНОГО ЗВ'ЯЗКУ У ДИСТАНЦІЙНІЙ РЕАБІЛІТАЦІЇ ПІСЛЯ ІНСУЛЬТУ

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Вступ. За останні десятиліття інсульт залишається провідною причиною тривалої інвалідності, що вимагає комплексного і індивідуалізованого підходу до реабілітації.
Мета. Дослідити ефективність використання біологічного зворотного зв'язку під час дистанційної реабілітації при використанні тренажеру «Основа» пацієнтів, які перенесли гостре порушення мозкового кровообігу.
Матеріали та методи. В дослідженні брали участь пацієнти чоловічої статі, віком 45-60 років з порушеними локомоторними функціями внаслідок перенесеного ГПМК головного та спинного мозку. Враховуючи особливість захворювання та віковий діапазон, у дослідженні брала участь лише одна група у складі 10 осіб. На амбулаторному та дистанційному етапі, на початку запровадження програми та кожних 5 занять проводилися тест на рівновагу Берге та тест «Встань та йди». Під час проведення занять отримувалися показники життєдіяльності пацієнта: артеріальний тиск (АТ); частота серцевих скорочень (ЧСС); а також рівень стресу, оцінюваний за допомогою електронних пристроїв (смартвоч Garmin) через вимірювання варіабельності серцевого ритму (HRV).
Результати. У межах чотиритижневої програми реабілітації пацієнтів після інсульту проводився моніторинг основних показників життєдіяльності під час виконання вправ у вертикальному та горизонтальному положенні. Отримані дані (коефіцієнт варіації) показують, що учасники є однорідними. Протягом першого тижня ЧСС коливалася від 77±1,09 до 86±3,26 уд/хв з тенденцією до підвищення, що свідчить про початкову адаптацію серцево-судинної системи. На другому тижні ЧСС знизилася до 73±1,68-76±1,45 уд/ хв на початку, але до п'ятого заняття знову зросла до 84 уд/хв через збільшення інтенсивності вправ. Третій і четвертий тижні показали стабільно високі значення ЧСС – до 95±2,00 уд/хв, що свідчить про адаптацію та підвищення витривалості. Систолічний та діастолічний тиск знизилися з початкових 128±3,35-137±2,75 мм рт. ст. та 86±3,13-93±2,17 мм рт.ст. до стабільних нормальних показників 121±0,98-129±3,74 та 76±4,29-90±1,67 мм рт. ст., підтверджуючи безпечність реабілітації на тренажері «Основа». Загальна тенденція демонструє поступове і систематичне зниження рівня стресу протягом реабілітаційного періоду.
Висновки. Результати дослідження показали достовірне покращення функціонального стану серцево-судинної системи та адаптацію організму до фізичних навантажень у різних положеннях тіла при використанні тренажеру «Основа».

Ключові слова: **дистанційна реабілітація, ішемічний інсульт, фізична терапія, реабілітація, цифрові технології, тренажер «Основа», якість життя**

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