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# DYNAMICS OF INDICATORS OF THE BARTHEL'S ACTIVITY INDEX AND RANKIN SCALE AFTER ACUTE CEREBRAL HEMISPHERIC ISCHEMIC STROKE DEPENDING ON TREATMENT METHODS

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The purpose of the study was to evaluate the dynamics of indicators of Barthel's activity index and Rankin Scale after acute cerebral hemispheric ischemic stroke and their correlation at different stages of recovery depending on the treatment methods. The study involved 77 patients diagnosed with acute cerebral hemispheric ischemic stroke. The observation period was six months. The study found that in the group of active physical rehabilitation, the average total indicators of functional recovery after 6 months of observation had significantly ($p<0.05$) faster and better positive dynamics compared to the initial values versus the corresponding indicators in the groups of only baseline therapy and its isolated combination with the neurometabolic drug α-glycerylphosphorylcholine, respectively.

**Key words:** ischemic stroke, physical therapy, functional recovery, neurorehabilitation, Rankin scale, Barthel index.

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# ДИНАМІКА ПОКАЗНИКІВ ІНДЕКСУ АКТИВНОСТІ БАРТЕЛА ТА ШКАЛИ РЕНКІНА ПІСЛЯ ГОСТРОГО ГЕМІСФЕРАЛЬНОГО ІШЕМІЧНОГО ІНСУЛЬТУ ЗАЛЕЖНО ВІД СПОСОБІВ ЛІКУВАННЯ

Метою роботи була оцінка динаміки показників індексу активності Бартела й шкали Ренкіна після гострого мозкового гемісферального ішемічного інсульту та їхньої кореляції на різних етапах відновлення залежно від способів лікування. У дослідженні взяли участь 77 пацієнтів із діагнозом гострого мозкового гемісферального ішемічного інсульту. Період спостереження – півроку. Встановлено, що в групі застосування активної фізичної реабілітації середні сумарні показники відновлення функцій через 6 місяців спостереження мали достовірно ($p<0,05$) швидшу й кращу позитивну динаміку порівняно з початковими значеннями проти відповідних показників груп лише базової терапії та її ізольованої комбінації з нейрометаболічним препаратом α-гліцерилфосфорилхоліну відповідно.

**Ключові слова:** ішемічний інсульт, фізична терапія, функціональне відновлення, нейрореабілітація, шкала Ренкіна, індекс Бартела.

*The study is a fragment of the research project* "*The influence of complex physical (medical) rehabilitation on motor, cognitive and psychoemotional disturbances at acute cerebrovascular pathology: optimization of diagnostics, forecasting and treatment with the substantiation of the differentiated approach*"*, state registration No. 0120U105395.*

Cerebral stroke is an epidemic that is a leading cause of disability among the adult population in most countries of the world, and is of great medical, social and economic importance. Hence, this problem is acutely relevant worldwide, and it is a priority area of scientific research, which is constantly being studied. According to The Global Burden of Diseases 2021, based on data from 204 countries from 1990 to 2019, the absolute number of strokes in the world increased by 60 %, mortality from stroke increased by 43 %, and the age of incidence decreased by 17 %. Based on the analysis of 19 risk factors for the disease, it was also found that in 2019, according to the World Bank, low-income countries demonstrated three times higher mortality than high-income countries. Among people under the age of 70, the prevalence of stroke increased by 22 % [4, 7]. The clinical presentation of cerebral hemispheric ischemic stroke (CHIS) is dominated by focal neurological deficit, the most common of which is the pyramidal syndrome of varying degrees of severity by hemitype, speech and language disorders. In addition, cognitive and anxiety-depressive disorders of varying degrees of severity are also particularly relevant in hemispheric strokes [1, 11, 13].

For assessing the patient's functional status, screening and dynamic diagnosis of motor impairment, it is recommended to use international standardized scales, in particular the Modified Rankin Scale (mRS) and the Barthel Activities of Daily Living Index (ADL BI), which should be applied by clinicians in their practice [3, 7]. By the way, the mRS is positively distinguished not only by a high level of matching grades between individual raters, but also by a clear demonstration of an almost complete range of activity restrictions in patients after stroke [2]. The ADL BI is used to study functional

impairment in stroke patients. The Barthel Self-Care Capacity Index has well-established clinometric properties and provides a realistic measure of residual deficit, and therefore is indicative in the management of post-stroke patients [6].

Treatment of cerebral strokes should be timely and based on the principles of evidence-based medicine, which will help reduce mortality and further disability of patients. Thus, dynamization and rehabilitation of people with stroke should begin as early as possible, from the first days of the patient's stay in the stroke unit, immediately after stabilization of basic vital functions (respiration and hemodynamics) [5, 7, 11].

The key principles of rehabilitation are the earliest possible start, permanence and systematicity, stage-by-stage and integrated approach, and active participation in the rehabilitation of the patient and his/her family members [3, 12, 15].

**The purpose** of the study was to evaluate the dynamics of indicators of Barthel's activity index and Rankin Scale after acute cerebral hemispheric ischemic stroke and their correlation at different stages of recovery depending on the treatment methods.

**Materials and methods.** The study was conducted at the Municipal Enterprise "M.V. Sklifosovskyi Poltava Regional Clinical Hospital of the Poltava Regional Council", Municipal Enterprise "1st City Clinical Hospital of the Poltava City Council", and the Center for Neurology and Rehabilitation "Lytvynenko Clinic".

The criteria for inclusion in the study were the presence of cerebral non-lacunar ischemic hemispheric stroke (confirmed clinically and by neuroimaging) and the presence of a signed informed consent form for voluntary participation in the study.

The criteria for excluding patients from the study were age under 18 and over 80 years; presence of intracranial hemorrhage (confirmed clinically and by neuroimaging), lesions of two or more pools; presence of a previous acute cerebrovascular accident in the case history, total aphasia (confirmed clinically and by neuroimaging); psychopathological syndrome and/or somatic diseases in the stage of decompensation and/or oncological pathology; extension of the affected hand $<10^{o}$ at the screening stage; mRS score of 0 and 5 points at the first examination after CHIS.

The study involved 77 patients diagnosed with acute CHIS. The diagnosis was made based on the current International Classification of Diseases, 10th Revision. Patients were examined and treated in accordance with the Unified Clinical Protocol for the provision of medical care to patients with ischemic stroke (Order of the Ministry of Healthcare of Ukraine No. 602 as of August 03, 2012).

All study subjects underwent general clinical, instrumental and laboratory examinations to verify the diagnosis, and identify complications and comorbidities.

During the study, at the randomization stage, patients with acute cerebral hemispheric ischemic stroke were divided into three clinical and rehabilitation groups:

– group 1 – n=22 (28.6 %), mean age – 59.82±1.73 years, of which men – 63.64 % (14/22), women – 36.36% (8/22), – patients who received only baseline therapy in accordance with the current clinical protocol;

– group 2 – n=26 (33.8 %), mean age – 58.39±1.9 years, of which men – 65.38 % (17/26), women – 34.62 % (9/26) – patients in whom two courses of the neurometabolic drug α-glycerylphosphorylcholine (α-GPC) were added to the baseline therapy after the first and third examinations – 1000 mg daily for 28 days;

– group 3 – n=29 (37.6 %), mean age – 58.69±1.21 years, of which men – 62.07 % (18/29), women – 37.93 % (11/29) – patients in whose treatment, together with baseline therapy, active physical rehabilitation (APR) techniques were used after the first and third examinations (classes with a physical therapist for 2 hours daily for 21 days).

The assessment was carried out using international standardized scales: ADL BI and mRS. The observation period was six months. Testing was performed on the 1st week (days 3–7, V1), 30th day (V2), 90th day (V3), and 180th day (V4) after cerebral hemispheric ischemic stroke.

The statistical processing of the data was carried out using the SPSS and Statistica 10.0 software packages, methods of descriptive statistics and statistical analysis. In particular, descriptive statistics are presented in the form of mean ± standard error of the mean (M±m); the Mann-Whitney U-test was used to assess intergroup differences. To evaluate dynamic changes within groups, the nonparametric Wilcoxon test for paired variables was used. The correlation between quantitative indicators was assessed using Spearman's rank correlation coefficient. Pearson's $\chi 2$ criterion was used to assess the relationships between qualitative indices. Differences were considered statistically significant at $p<0.05$.

During the study, all patients signed the informed consent to participate in the study. The research complied with the Rules for the Humane Treatment of Patients in accordance with the requirements of the Tokyo Declaration of the World Medical Assembly, the requirements of the International Recommendations of the Helsinki Declaration of Human Rights, the Council of Europe Convention on Human Rights and Biomedicine, the Law of Ukraine "Fundamentals of Ukrainian Health Care Legislation" as amended, the Orders of the Ministry of Healthcare of Ukraine, the Ethical Code of Physicians of Ukraine and the Ethical Code of Scientists of Ukraine, current legislation.

**Results of the study and their discussion.** When comparing the study groups by age and gender, no statistically significant differences were found. When analyzing the structure of patients by the degree of disability according to the ADL BI at week 1 after cerebral hemispheric ischemic stroke, it was found that in group 1, 54.55 % (12/22) of patients had a score corresponding to severe disability and dependence on external assistance, 40.9 % (9/22) had scores indicating moderate disability and 4.55 % (1/22) with minimal motor function limitation, while in group 2 these figures were 53.85 % (14/26), 30.77 % (8/26) and 15.38 % (4/26), respectively, and in group 3 they were 62.07 % (18/29), 31.03 % (9/29) and 6.9 % (2/29), respectively. At the six-month follow-up, there were no indices corresponding to severe disability according to the ADL BI in the study groups, while 40.91 % (9/22) of patients in group 1, 26.92 % (7/26) of patients in group 2 and 6.9 % (2/29) of patients in group 3 had a moderate degree of disability, and a mild degree of disability was observed in 59.09 % (13/22) of patients in group 1, 73.08 % (19/26) in group 2 and 93.1 % (27/29) in group 3. The distribution of patients by the degree of disability according to the ADL BI scale is shown in Fig. 1.

When analyzing the structure of functional impairment in patients by mRS on the 1st week after cerebral hemispheric ischemic stroke, it was found that in group 1, 9.09 % (2/22) of patients had a score corresponding to a mild impairment of functional capacity, 59.09 % (13/22) had moderate functional limitation and 31.82 % (7/22) had a moderately severe functional impairment, while in group 2 these figures were 19.23 % (5/26), 53.85 % (14/26) and 26.92 % (7/26), respectively, and in group 3 they were 10.34 % (3/29), 51.73 % (15/29) and 37.93 % (11/29), respectively. At the six-month follow-up in group 1, 31.82 % (7/22) had a mild functional limitation, 54.55 % (12/22) had a moderate functional limitation, and 13.63 % (3/22) had a moderately severe functional limitation, while in group 2, the number of patients with a moderately severe functional limitation was 3, 85 % (1/26) of patients had a slight limitation of functional capacity according to mRS, mild – 46.15 % (12/26), moderate – 50.0 % (13/26) of patients, and in group 3 – 31.03 % (9/29), 44.83 % (13/29) and 24.14 % (7/29) of patients, respectively. There were no scores corresponding to a moderately severe degree of functional limitation in patients of groups 2 and 3 at the six-month examination. The distribution of patients by the degree of functional capacity by mRS is shown in Fig. 2.

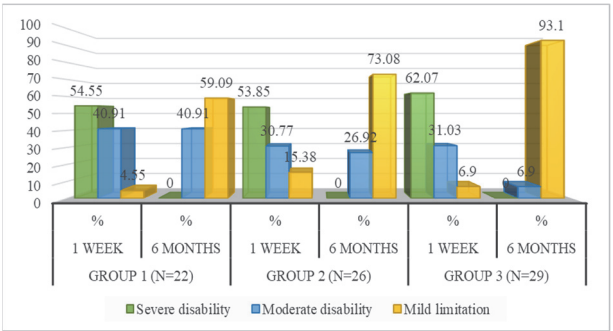


Fig. 1. Distribution of patients by the degree of disability according to ADL BI at the beginning of treatment and 6 months after CHIS, %.

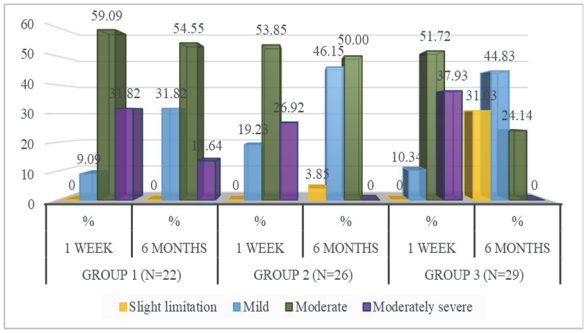


Fig. 2. Distribution of patients by the degree of functional capacity according to mRS at the beginning of treatment and 6 months after CHIS, %.

When analyzing the dynamics of changes in the ADL BI scale, the following was found:

– there was no statistically significant difference between groups 1 and 2 at all stages of observation: 45.91 (95 % CI = 38.57–53.25) points in group 1 vs. 48.65 (95 % CI = 40.82–56.49) points in group 2 (p=0.633) on days 3–7 after CHIS, 63.64 (95 % CI = 60.09–67.18) points vs. 67.12 (95 % CI = 63.3–70.93) points, respectively (p=0.202) on day 30, 68.86 (95 % CI = 66.21–71.52) points vs. 71.92 (95 % CI = 69.88–73.96) points, respectively (p=0.111) on day 90, and 72.5 (95 % CI = 69.36–75.64) points vs. 75.39 (95 % CI = 73.15–77.62) points, respectively (p=0.278) on day 180 after CHIS;

– there was no statistically significant difference between groups 1 and 3 on days 3–7 of follow-up: 45.91 (95 % CI = 38.57–53.25) points in group 1 vs. 46.03 (95 % CI = 39.65–52.42) points in group 3 (p=0.946), while on days 30, 90 and 180, group 3 showed significantly better recovery compared to group 1: 71.21 (95 % CI = 67.61–74.8) points vs. 63.64 (95 % CI = 60.09–67.18) points, respectively (p=0.009)

on day 30, 75.86 (95 % CI = 73.38–78.35) points vs. 68.86 (95 % CI = 66.21–71.52) points respectively (p=0.001) on day 90 and 82.07 (95 % CI = 79.76–84.38) points vs. 72.5 (95 % CI = 69.36–75.64) points respectively (p<0.001) on day 180;

– there was no statistically significant difference between groups 2 and 3 both on days 3–7 and on day 30 of follow-up: 48.65 (95 % CI = 40.82–56.49) points in group 2 vs. 46.03 (95 % CI = 39.65–52.42) points in group 3 (p=0.555) and 67.12 (95 % CI = 63.3–70.93) points in group 2 vs. 71.21 (95 % CI = 67.61–74.8) points in group 3 (p=0.133), respectively, while on days 90 and 180, group 3 showed significantly better recovery compared to group 2: 75.86 (95 % CI = 73.38–78.35) points vs. 71.92 (95 % CI = 69.88–73.96) points (p=0.022) on day 90 and 82.07 (95 % CI = 79.76–84.38) points vs. 75.39 (95 % CI = 73.15–77.62) points (p<0.001) on day 180 after CHIS.

Graphical representations of the dynamics of the mean values of ADL BI scores in patients of the study groups at different periods of observation are shown in Fig. 3.

When analyzing the dynamics of changes in mRS scores, the following was found:

– between groups 1 and 2, a significantly better recovery in group 2 compared to group 1 was observed only on day 90 after CHIS: 2.54 (95 % CI = 2.34–2.73) points vs. 2.96 (95 % CI = 2.68–3.23) points (p=0.026), while at other stages of the study there was no statistically significant difference: 3.23 (95 % CI = 2.97–3.48) points in group 1 vs. 3.08 (95 % CI = 2.81–3.34) points in group 2 (p=0.451) on days 3–7 after CHIS, 3.14 (95 % CI = 2.87–3.4) points in group 1 vs, 73 (95 % CI = 2.43–3.03) points in group 2 (p=0.051) on day 30, and 2.82 (95 % CI = 2.54–3.1) points vs. 2.46 (95 % CI = 2.24–2.69) points, respectively (p=0.082) on day 180 after CHIS;

– there was no statistically significant difference between groups 1 and 3 only on days 3–7 of follow-up: 3.23 (95 % CI = 2.97–3.48) points in group 1 vs. 3.28 (95 % CI = 3.04–3.51) points in group 3 (p=0.748), while on days 30, 90 and 180, group 3 showed significantly better recovery compared to group 1: 2.69 (95 % CI = 2.47–2.91) points vs. 3.14 (95 % CI = 2.87–3.4) points, respectively (p=0.016) on day 30, 2.07 (95 % CI = 1.83–2.31) points vs. 2.96 (95 % CI = 2.68–3.23) points, respectively (p<0.001) on day 90 and 1.93 (95 % CI = 1.66–2.21) points vs. 2.82 (95 % CI = 2.54–3.1) points, respectively (p<0.001) on day 180;

– there was no statistically significant difference between groups 2 and 3 both on days 3–7 and on day 30 of follow-up: 3.08 (95 % CI = 2.81–3.34) points in group 2 vs. 3.28 (95 % CI = 3.04–3.51) points in group 3 (p=0.279) and 2.73 (95 % CI = 2.43–3.03) points in group 2 vs. 2.69 (95 % CI = 2.47–2.91) points in group 3 (p=1), respectively, while on days 90 and 180, group 3 showed significantly better recovery compared to group 2: 2.07 (95 % CI = 1.83–2.31) points vs. 2.54 (95 % CI = 2.34–2.73) points (p=0.007) on day 90 and 1.93 (95 % CI = 1.66–2.21) points vs. 2.46 (95 % CI = 2.24–2.69) points (p=0.008) on day 180 after CHIS.

Graphical representations of the dynamics of the mean values of mRS scores in patients of the study groups at different periods of observation are shown in Fig. 4.

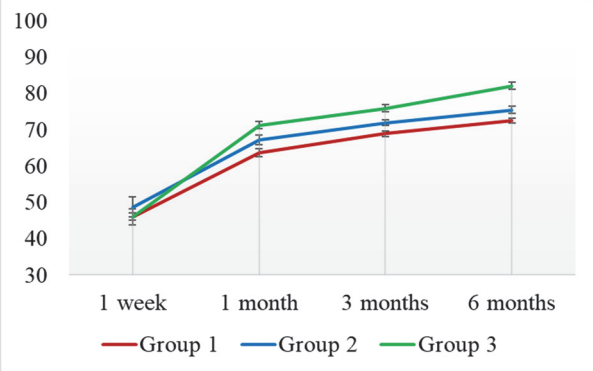


Fig. 3. Dynamics of mean values of ADL BI scores in patients of the study groups during different observation periods.

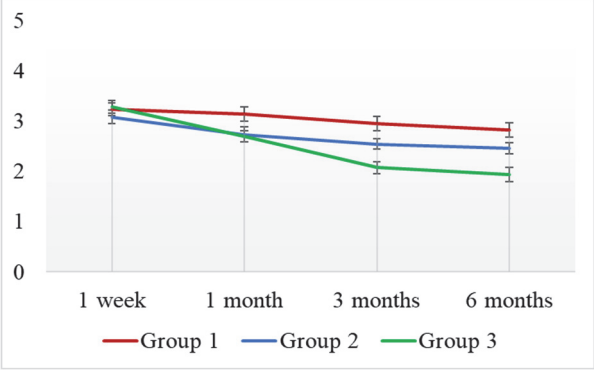


Fig. 4. Dynamics of the mean values of mRS scores in patients of the study groups during different observation periods.

Comparison of the mean total scores of the studied scales within the groups at different observation periods after CHIS is shown in Table 1.

When determining the increase/decrease in the average values of the ADL BI scale on the 30th, 90th and 180th day relative to their initial values after a cerebral accident, it was found that, compared to the initial values, the average scores changed as follows: on day 30, the index increased in group 1 by 38.61 %, in group 2 – by 37.94 %, in group 3 – by 54.68 %, on day 90, in group 1 – by 50.0 %, in group 2 – by 47.83 %, in group 3 – by 64.79 %, on day 180, in group 1 – by 57.92 %, in group 2 – by 54.94 %, in group 3 – by 78.28 %.

Table 1

**Comparison of the mean total scores of the studied scales within groups at different observation periods after CHIS, M±m**

| Index | Group | Observation period | | | | p, Wilcoxon |
|---|---|---|---|---|---|---|
| | | V1 | V2 | V3 | V4 | |
| ADL BI | 1 | 45.91±3.75 | 63.64±1.81 | 68.86±1.35 | 72.5±1.6 | $p_1<0.001$<br>$p_2<0.001$<br>$p_3<0.001$ |
| | 2 | 48.65±3.99 | 67.12±1.95 | 71.92±1.04 | 75.39±1.14 | $p_1<0.001$<br>$p_2<0.001$<br>$p_3<0.001$ |
| | 3 | 46.03±3.25 | 71.21±1.83 | 75.86±1.27 | 82.07±1.18 | $p_1<0.001$<br>$p_2<0.001$<br>$p_3<0.001$ |
| mRS | 1 | 3.23±0.13 | 3.14±0.14 | 2.95±0.14 | 2.82±0.14 | $p_1=0.414$<br>$p_2=0.034$<br>$p_3=0.013$ |
| | 2 | 3.08±0.14 | 2.73±0.15 | 2.54±0.1 | 2.46±0.11 | $p_1=0.014$<br>$p_2=0.002$<br>$p_3<0.001$ |
| | 3 | 3.28±0.12 | 2.69±0.11 | 2.07±0.12 | 1.93±0.14 | $p_1<0.001$<br>$p_2<0.001$<br>$p_3<0.001$ |

Note: p1 is the level of statistical significance of the change in the indicator on day 30 compared to its initial value, p2 is the level of statistical significance of the change in the indicator on day 90 compared to its initial value, p3 is the level of statistical significance of the change in the indicator on day 180 compared to its initial value**.**

When determining the increase/decrease in the average values of mRS indicators on the 30th, 90th and 180th day relative to their initial values after a cerebral accident, it was found that, compared to the initial values, the mean scores changed as follows: on day 30, the index decreased in group 1 by 2.82 %, in group 2 – by 11.25 %, in group 3 – by 17.89 %, on day 90, in group 1 – by 8.45 %, in group 2 – by 17.5 %, in group 3 – by 36.84 %, on day 180, in group 1 – by 12.68 %, in group 2 – by 20.0 %, in group 3 – by 41.05 %.

In order to clarify changes in the motor status of patients with cerebral hemispheric ischemic stroke, a correlation analysis was additionally performed between the relevant diagnostic parameters in the study groups at different observation periods (Table 2).

Table 2

**Correlation between the mean total values of the examined indices within the groups at different stages of recovery after CHIS**

| Index | Group | Correlation coefficient, R | | | |
|---|---|---|---|---|---|
| | | V1 | V2 | V3 | V4 |
| ADL BI – mRS | Group 1 | -0.809** | -0.687** | -0.282 | -0.506* |
| | Group 2 | -0.901** | -0.48* | -0.535** | -0.517** |
| | Group 3 | -0.828** | -0.553** | -0.787** | -0.782** |

Note: * – correlation is significant at the $p<0.05$ level, ** – correlation is significant at the $p<0.01$ level.

It was found that the mean total indices of recovery of impaired functions at the end of the study compared to their initial values in patients of group 2 versus group 1 in terms of ADL BI ($\Delta=2.98$ %, $p=0.9917$) and mRS ($\Delta=7.32$ %, $p=0.2678$) demonstrated a doubtful reliability, although at first glance they had a tendency to positive dynamics [9, 13].

At the same time, when comparing the effect of active physical rehabilitation and metabolic therapy using α-glycerylphosphorylcholine in the treatment regimen of patients in the acute and rehabilitation periods of cerebral hemispheric ischemic stroke on the restoration of impaired functions, it was found that under the influence of APR methods, functional regression of poststroke deficit is significantly more effective compared to the separate use of α-GPC without APR [14]. This was evidenced by the mean total indices of recovery of impaired functions at the end of the study compared to their initial values in patients of group 3 versus group 1, which were significantly ($p<0.05$) better both in terms of mRS ($\Delta=28.37$ %, $p=0.0002$) and ADL BI ($\Delta=20.36$ %, $p=0.0372$) and significantly ($p<0.05$) better than the same indices in patients of group 3 versus group 2 in terms of mRS ($\Delta=21.05$ %, $p=0.0013$). This is significant, because mRS is positively distinguished not only by a high level of matching grades between individual raters, but also by a clear demonstration of an almost complete range of activity restrictions in patients after stroke [2, 8].

Therefore, it can be assumed that the use of α-glycerylphosphorylcholine without methods of active physical rehabilitation against the background of baseline therapy in the treatment regimen of patients in the acute and rehabilitation periods of cerebral hemispheric ischemic stroke is inefficient, and the use of APR methods is justified in the scheme of comprehensive treatment of patients in both in acute and rehabilitation periods of cerebral hemispheric ischemic stroke to accelerate and improve the efficacy of their functional recovery [9, 10, 12].

## Conclusion

The study found that in the group of active physical rehabilitation, the mean total indices of functional recovery after 6 months of observation had significantly ($p<0.05$) faster and better positive dynamics compared to the initial values versus the corresponding indices in the groups of only baseline therapy and its isolated combination with the neurometabolic drug α-glycerylphosphorylcholine, respectively.

Thus, after analyzing the effect of active physical rehabilitation and neurometabolic therapy using α-glycerylphosphorylcholine in the treatment regimen of patients in the acute and rehabilitation periods of cerebral hemispheric ischemic stroke, a significantly better ($p<0.05$) regression of poststroke deficit under the influence of APR methods was proved compared to the isolated use of α-GPC without APR. This confirms the feasibility of using active physical rehabilitation methods in the scheme of comprehensive treatment of patients in both acute and recovery periods of cerebral hemispheric ischemic stroke to accelerate and improve the efficacy of their functional recovery.

*Prospects for further research. In the future, we plan to conduct additional studies on the optimization of therapeutic and rehabilitation measures in patients with cerebral hemispheric ischemic stroke, taking into account the features of functional deficits at different stages of recovery.*

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