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The Effectiveness of Non-Drug Methods in the Rehabilitation of Patients with Severe Covid-19

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Annotation. A prospective controlled trial was conducted involving 100 patients in the Russian Federation who were discharged after severe coronavirus pneumonia. The patients were randomly divided into the main group (50 people), who received an 8-week course of non-drug rehabilitation (respiratory gymnastics, physical therapy, physiotherapy, etc.), and the control group (50 people), who received standard outpatient follow-up without specialized rehabilitation. The assessment included a six–minute walking test (6MWT), lung function indicators (forced lung capacity - LVEF) and quality of life (SF-36) before and after the course. Non-drug rehabilitation measures after severe COVID-19 lead to a significant restoration of exercise tolerance, respiratory function, and quality of life compared to standard treatment. The results confirm the expediency of widespread implementation of medical rehabilitation programs for patients who have suffered severe COVID-19.

Keywords: COVID-19, post-covid syndrome, medical rehabilitation, non-drug methods, respiratory gymnastics, physical therapy, quality of life.

INTRODUCTION.

Patients who have suffered severe COVID-19 often face long-term effects of infection, including decreased lung function, muscle weakness, shortness of breath, fatigue, and decreased quality of life. According to research, about 45% of patients discharged from the hospital after COVID-19 require further medical supervision and support, and 4% require extended rehabilitation in a hospital setting.

One of the key complications of the severe course of COVID-19 is the formation of pulmonary fibrosis, which leads to a decrease in the diffusion capacity and ventilation function of the lungs. Such changes, as well as the consequences of prolonged

immobilization and hypoxia during the illness, necessitate the development and application of rehabilitation programs to restore the functional state of patients[2].

Medical rehabilitation of patients after coronavirus infection is based primarily on non-medicinal methods aimed at restoring impaired functions. A multidisciplinary rehabilitation program usually includes respiratory gymnastics, physical therapy (physical therapy), aerobic training with a metered load, exercises to develop strength and endurance of the respiratory muscles, physiotherapy procedures (massage, hardware methods), as well as psychological support. Such programs can improve bronchial patency, lung ventilation, mucociliary clearance, normalize oxygenation, increase exercise tolerance, and restore the ability to engage in daily activities. At the same time, there is no universal rehabilitation protocol – the program is selected individually, taking into account specific disorders and the severity of the post-cystic syndrome [9].

The effectiveness of non-drug rehabilitation measures after COVID-19 is confirmed by a number of studies. In particular, it has been shown that the inclusion of special methods in rehabilitation, such as interval breathing exercises or hardware physiotherapy procedures, can further enhance the functional recovery of patients. So, Chelombitko et al. It is reported that the use of a course of MDM therapy and interval hypoxic training against the background of standard rehabilitation significantly increased its final effectiveness [8]. Another study showed that after a 10-day course of physical therapy with kinesitherapy, the 6-minute walking distance in post-COVID patients increased in some cases to 60% of the baseline [1]. All this indicates the high potency of non-medicinal methods in recovery from severe coronavirus infection.

The purpose of this study is to provide a real–world analysis of the effectiveness of comprehensive non-drug rehabilitation of patients after severe COVID-19. We analyzed the impact of the developed program on functional parameters (exercise tolerance, respiratory function) and quality of life of patients, comparing the results with the control group without specialized rehabilitation.

MATERIALS AND METHODS OF RESEARCH.

A prospective comparative study conducted on the basis of a multidisciplinary medical rehabilitation center in Russia in 2021-2022. The study included 100 patients (age 55±10 years, 58% men) who had suffered a severe form of COVID-19. The inclusion criteria were: a confirmed diagnosis of COVID-19 with severe course (pneumonia with lung damage >50%, saturation <90% in the acute period), the need for oxygen therapy or ventilation in the hospital, stable condition upon discharge, the presence of postmodern symptoms (shortness of breath, decreased exercise tolerance). Exclusion criteria: decompensation of chronic diseases, neurological deficit that prevents participation in rehabilitation, patient refusal[2].

After signing the informed consent, the patients were randomized into two groups of 50 people each. The main group received a comprehensive 8-week medical rehabilitation program designed for post-COVID-19 patients (corresponding to the recommended duration of 6-12 weeks for COVID-19 rehabilitation). The control group received standard posthospitalization therapy and follow-up (breathing exercises and physical therapy are

recommended only in the form of independent classes without specialist supervision, periodic consultations with a doctor), that is, without targeted professional rehabilitation.

Classes were held 3 times a week on an outpatient basis under the supervision of a multidisciplinary team (physical therapy doctor, physical therapy therapist, physiotherapist, rehabilitation nurse, etc.).

Individual programs included:

- Strelnikova breathing exercises and diaphragmatic breathing exercises, 2 times a day. Inspiratory muscle training techniques (with a Threshold device or an analog) were used to strengthen the respiratory muscles;

- aerobic exercise in the form of dosed walking (10-30 minutes) with a gradual increase in distance, as well as sets of exercises for the main muscle groups. The intensity of the load was selected according to tolerance, with control of heart rate and saturation. The target loads corresponded to 40-60% of the estimated maximum, with a gradual increase.

- Sessions of hardware physiotherapy 3 times a week (magnetic therapy on the chest and respiratory muscles, low–frequency laser on the chest to improve microcirculation - in the absence of contraindications). A course of chest massage (10 sessions) to improve sputum discharge and ventilation;

- Group or individual conversations with a psychologist once a week to reduce anxiety related to the disease and increase motivation for active activities.

All patients were trained in self–monitoring skills, such as measuring peak expiratory velocity, keeping a shortness of breath diary, and using the Borg scale to assess exertion in order to safely continue exercising at home.

Each exercise therapy session was conducted with monitoring of the main indicators (heart rate, blood pressure, SPO_2). When the threshold criteria were exceeded (tachycardia >50% of the initial level, decreased SPO <90%, increased shortness of breath, etc.), the load was reduced or the activity was temporarily stopped. Thus, rehabilitation was carried out in a gentle-training mode with a gradual increase in intensity [2].

All patients in both groups were examined before the start of the program (basic examination) and again after 8 weeks, the data are presented in Table 1.

Table 1 – Indicators and methods for assessing the condition of patients before and after the 8-week program

Indicator	Assessment method / tool	Purpose / characteristic
6-minute walking test (6MWT)	Standard procedure, 30-meter corridor	Assessment of functional ability and exercise tolerance
	Measurement of the distance traveled (in meters)	
Distance 6MWT, m VCCL, % of required FEV1 , % of due mrc (points) SF-36 Physical	The Borg Scale	Assessment of the degree of shortness of breath and fatigue before and after the test

Functioning, points		
Spirometry	Spirograph	Measurement of VVCL and FEV1 in absolute values and in % of the required
Oxygen saturation (SPO_2)	Pulse Oximeter	Determination of blood oxygen saturation at rest and after 6 MWT
Quality of life	SF-36 questionnaire	Analysis of the scale of physical functioning (PF) and the physical component of health (PCS)
Clinical data	Standard clinical examination	The degree of shortness of breath on the mMRC scale, heart rate, blood pressure, BMI, etc.

Количественные показатели внутри групп (до и после) сравнивались с использованием парного критерия Стьюдента, а между группами - с использованием непарного критерия Стьюдента для независимых выборок [6]. Качественные показатели сравнивались с использованием χ2-критерия.Различия считались статистически значимыми при $p<0,05$.

Изначально группы не отличались по основным демографическим и клиническим характеристикам (таблица 2).

Таблица 2 - Исходные характеристики пациентов (M±SD или n (%)).

Parameter	Main group (n=50)	Control group (n=50)
Age, years	55,3 ± 9,8	56,1 ± 9,4
Male, n (%)	28 (56%)	30 (60%)
Invasive ventilation in the acute period, n (%)	10 (20%)	12 (24%)
Time from discharge to start of rehabilitation, days	30 ± 10	29 ± 11
6MWT initial distance	320 ± 50	330 ± 55
Initial FVC, % of the norm	70 ± 12	71 ± 11
of mrc (points) initially	3,1 ± 0,7	3,0 ± 0,8

Средний возраст пациентов составил ~55 лет; доля мужчин составила около 58%. ~22% пациентов в обеих группах нуждались в инвазивной вентиляции легких в острый период COVID-19, в то время как остальные получали неинвазивную кислородную терапию. Средняя продолжительность стационарного лечения составила 21±5 дней, а реабилитация пациентов началась примерно через 4 недели после выписки. Частота сопутствующих заболеваний (артериальная гипертензия ~40%, ожирение ~30%, сахарный диабет ~20% и т.д.) была сопоставима в обеих группах. Исходные значения 6 МВТ и функции легких в группах также статистически не различались.

Представлены результаты исследования и их обоснование.

После 8-недельного курса реабилитации у пациентов основной группы наблюдалось значительное улучшение всех оцениваемых показателей по сравнению с исходным уровнем, в то время как в контрольной группе спонтанное выздоровление было менее выраженным (табл. 2). 6-минутная дистанция ходьбы в основной группе увеличилась в среднем на 120 м (≈38%), с 320±50 м до 440±60 м ($p<0,001$), тогда как в контрольной группе увеличение составило ~50 м (15%), с 330±55 м ($p<0,001$). до 380±50 м и не достиг статистической значимости ($p=0,08$). Улучшение в основной группе было значительно выше, чем в контрольной (рис. 1). Ускоренная жизненная емкость легких (ЖЕЛ) у реабилитированных пациентов увеличилась с 70±12% до 82±10% от требуемой, то есть примерно на 12 процентных пунктов ($p=0,003$), в то время как в контроле она увеличилась с 71±11% до 76±10% (увеличение на +10%).

В дополнение к объективным функциональным тестам значительно улучшились субъективные показатели. Уровень одышки по шкале mMRC снизился в основной группе с медианы 3 (сильная одышка при легкой физической нагрузке) до 1 (легкая одышка при быстрой ходьбе; $p<0,01$), в то время как в контрольной группе он снизился с 3 до 2. Восстановление толерантности к физической нагрузке сопровождалось повышением качества жизни.

Шкала физического функционирования опросника SF-36 в основной группе повысилась с 45±15 до 70±14 баллов, что отражает возвращение способности к самообслуживанию и легкой физической активности. В контрольной группе рост был менее значительным: с 46±16 до 55±15 баллов. Интегральный физический компонент здоровья (SF-36 PCS) увеличился в основной группе с ~30 до ~45 баллов, в то время как в контрольной группе он увеличился только до ~35. Таким образом, реабилитация позволила добиться клинически значимого улучшения качества жизни, тогда как без специальной поддержки улучшения были ограниченными.

Table 3- Dynamics of functional parameters after the rehabilitation course (M±SD)

Indicator	Main group (before → after)	Control group (before → after)
	320 ± 50 → **440 ± 60**	330 ± 55 → 380 ± 50
	70 ± 12 → **82 ± 10**	71 ± 11 → 76 ± 10
	68 ± 15 → 74 ± 14	69 ± 16 → 72 ± 15
	3,1 ± 0,7 → **1,5 ± 0,6**	3,0 ± 0,8 → 2,3 ± 0,7
	45 ± 15 → **70 ± 14**	46 ± 16 → 55 ± 15

Note: changes that significantly differ from the control at $p<0.05$ are highlighted **in bold.**

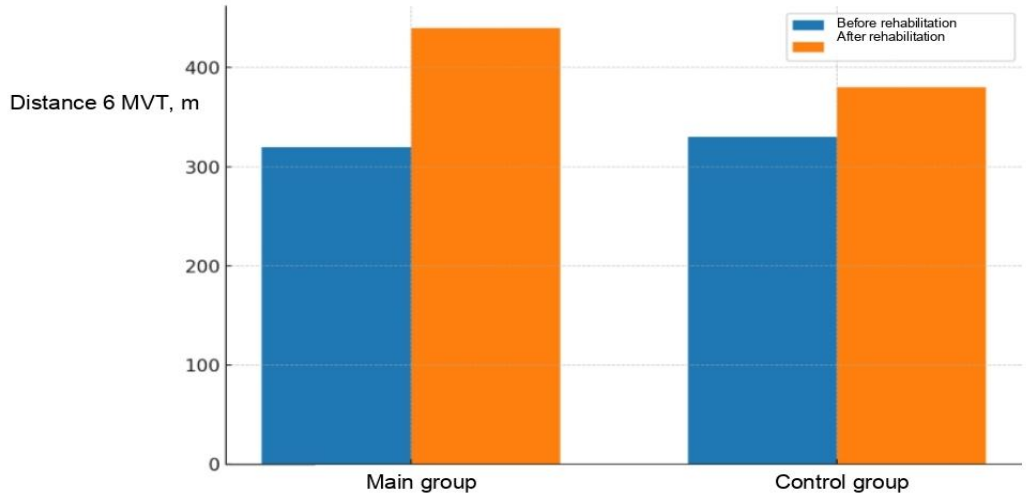

Fig. 1. Dynamics of the distance of the 6-minute walking test (6MWD) in patients of the main and control groups before and after the rehabilitation course

It can be seen that patients who underwent rehabilitation (orange columns) showed a significantly greater increase in the distance of 6MWT compared to patients in the control group without specialized rehabilitation (blue). This indicates the high effectiveness of a set of non-medicinal measures in improving exercise tolerance in those who have suffered severe COVID-19.

The results are consistent with data from previous studies on the benefits of rehabilitation after COVID-19. It is noted in the literature that post-renal rehabilitation can significantly increase the functional reserves of the body and accelerate the return of patients to daily activity. In particular, the improvement of the 6MWT distance after the rehabilitation course was noted in many works: for example, in the study by D. Tache-Codreanu et al. (2024) in 33 patients, the distance increase ranged from 3% to 60% of the initial distance, with an average of about 80 m.[5] In our study, the average gain of ~120 m highlights the effectiveness of the integrated approach. The improvement of VVC by ~12% is comparable with the data of international observations, which report an increase in this indicator of ~10-15% after 2-3 months of training. A decrease in shortness of breath (mMRC by 1-2 points) and an increase in quality of life indicators confirm the clinical significance of the objective improvements obtained.

It is important to note that there was also a certain positive trend in the control group, reflecting a natural recovery over time. However, the degree of this recovery was significantly lower than with targeted rehabilitation. For example, without specialized training, 6MWT increased by only ~15%, while with rehabilitation it increased by almost 40%. Similarly, the increase in VVC without rehabilitation (<5%) was significantly lower than in the main group (~12%). These differences are statistically significant and indicate that the improvements in the main group are due to the rehabilitation measures carried out, and not only to the spontaneous resolution of the consequences of the disease.

An additional confirmation is the absence of significant differences between the groups at the initial stage and the comparability of the therapy received, except for

rehabilitation. At the time of follow-up, none of the patients received active pharmacotherapy that could significantly affect the studied parameters (bronchodilators were used only as indicated in <10% of patients with initial obstruction; there were equally many such patients in both groups). Thus, the contribution of drug interventions to recovery was minimal, which makes it possible to attribute the identified improvements to non-drug rehabilitation with high reliability.

Discussing the mechanisms of the obtained effect, it should be noted that complex physical training promotes both central and peripheral adaptations [3]. Aerobic exercise and respiratory gymnastics improve pulmonary ventilation, promote the opening of previously atelectasis alveoli, improve gas diffusion, and thereby increase blood oxygen saturation during exercise [10]. Training of peripheral muscles (including respiratory muscles) leads to an increase in their strength and endurance, which reduces the relative stress on the cardiovascular system during exercise. Restoring the activity of the diaphragm and respiratory coordination leads to a decrease in the feeling of shortness of breath during exercise, which we observed in the form of a decrease in mMRC and a subjective improvement in well-being. In addition, physiotherapy procedures (magnetic therapy, massage) improve microcirculation and muscle trophism, can promote the resorption of residual inflammatory changes, and psychological support reduces anxiety and improves the patient's commitment to training, maximizing the effect of rehabilitation [4].

Our results emphasize that a multidisciplinary approach in the rehabilitation of post-cystic patients is justified and effective. Even 1-2 months after discharge, when spontaneous recovery is in full swing, additional rehabilitation measures can significantly accelerate and enhance the return of functions. This has not only medical, but also socio-economic significance: faster recovery of working capacity, reducing the risk of repeated hospitalizations and complications. The development of standards for postoperative rehabilitation, their implementation in the healthcare system of the Russian Federation and ensuring continuity (inpatient – day hospital – outpatient unit) is an urgent task.

CONCLUSIONS.

The conducted study demonstrates that the use of complex non-drug rehabilitation has a pronounced positive effect on the functional state of patients who have suffered a severe form of COVID-19. The inclusion of respiratory gymnastics, physical therapy and physiotherapy procedures in the rehabilitation program leads to a significant increase in exercise tolerance, which is confirmed by an increase in the distance covered in the six-minute walking test by almost 38% over two months. At the same time, there is an improvement in the indicators of the function of external respiration, in particular, the accelerated vital capacity of the lungs, which increases by about 12% of the required level, whereas no such changes were recorded in the group without rehabilitation intervention. An additional confirmation of the effectiveness of non-drug correction is changes in the subjective and objective parameters of patients' quality of life. In people who have completed a course of rehabilitation measures, the severity of shortness of breath significantly decreases, which is reflected in the transition from the third to the first degree on the mMRC scale. In addition, there is a noticeable improvement in the physical component of the quality of life,

an increase of about 25 points, which exceeds the level noted in the control group, where recovery occurred spontaneously, without structured rehabilitation. Based on the data obtained, it can be concluded that non-drug rehabilitation methods are an effective tool for restoring patients after the severe course of the new coronavirus infection and deserve to be widely implemented in clinical practice. It is reasonable to include post-kidney rehabilitation programs in the standards of medical care, as this contributes to a faster return of patients to an active life, reduces the risk of developing chronic pathologies and provides an increase in the overall level of somatic well-being. The presented results emphasize the relevance and necessity of developing a medical rehabilitation system, as well as strengthening organizational support for patients at the stages of their recovery.

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