

DOI [10.35630/2023/13/2.220](https://doi.org/10.35630/2023/13/2.220)

Received 27 March 2023;
Accepted 24 April 2023,
Published 27 April 2023

MEDICAL AND ORGANIZATIONAL ASPECTS OF ACTIVITIES AND EQUIPMENT FOR A POST-COVID REHABILITATION CENTER

Aleksey Breusov^{1,2}  , **Ali Nasibov¹**,
Dmitrii Breusov³ 

¹Peoples' Friendship University of Russia named after Patrice Lumumba, Moscow;

²Kursk State Medical University, Kursk;

³N. N. Burdenko Main Military Clinical Hospital, Moscow, Russia



[download article \(pdf\)](#)

 ab69@yandex.ru

ABSTRACT

The aim of the work is to identify the most common complications after COVID-19 and to develop a system of step-by-step rehabilitation of patients using modern medical equipment. The research program is based on the analysis of data from a sociological survey of 792 respondents aged 18 to 76 years, whose average age was 29 ± 1.8 years, while the proportion of women was 70.8%. The following methods are used in the work: bibliographic, analytical, mathematical-statistical, sociological (questionnaire). Relative extensive indicators are used in data processing and presentation. In the course of the study, complications that were most pronounced in patients after a coronavirus infection were studied; an analysis of effective methods for their prevention was carried out; the most effective methods of rehabilitation based on the stages of patient recovery were developed and proposed. As a result of the work carried out, a comprehensive method of restorative therapy of patients is proposed, depending on their functional capabilities and the medical rehabilitation equipment available at the disposal of postcovid centers. It has been established that effectively staged post COVID-19 rehabilitation carried out in a specialized rehabilitation center enables to improve the patients' quality of life, restore physical activity and mental health, reduce the risk of comorbidities, and mortality associated with post-COVID complications.

Keywords: coronavirus infection, COVID-19, postcovid complications, medical rehabilitation, rehabilitation equipment.

INTRODUCTION

In 2019, the whole world faced a pandemic of the new coronavirus infection COVID-19 (SARS-CoV-2). In March 2020, the World Health Organization (WHO), based on an increase in the number of reported cases of the disease, declared a global health emergency [8, 10]. The spread of coronavirus infection continues. The virus acquires new forms resistant to survival and causes negative complications in the body, which significantly reduce the quality of life of people and can lead to death. Against the background of the coronavirus pandemic in 2020 – 2022, there were significant changes in state policy, public life and social well-being of the population, which a number of authors have already described as unprecedented [7].

With this in mind, the development of a project of a post-ovoid rehabilitation center specializing in the recovery of patients with various complications after a coronavirus infection is of particular relevance. A significant number of complications affecting various organs and systems of the body, reducing social activity and the quality of human life, require the creation of an extensive system of rehabilitation centers. The practical significance of the problem under consideration was determined by the purpose of the study -

to identify the most common complications after COVID-19 and to develop a system of step-by-step rehabilitation of patients using modern medical equipment.

MATERIALS AND RESEARCH METHODS

The research program is based on an automated analysis of data from a sociological survey of 792 respondents aged 18 to 76 years. The studied sample population in 2022 was formed by random sampling. To solve the tasks, a survey was conducted of residents of two regions of the Central Federal District of Russia who had suffered COVID-19, which allowed identifying points of view and trends taking place in groups of respondents.

The survey was conducted according to the developed author's questionnaire containing 36 questions, both in person and remotely, in the form of an online questionnaire. Participation in the survey was anonymous, did not contain any requirements for entering any personal data, respectively, consent to the processing of personal data from respondents was not required.

Of the total number of respondents who took part in the study, 52.4% were people aged 18 to 24 years, 18.7% were people aged 25 to 35 years, 11.7% were people aged 36 to 45 years, 9.8% were people aged 46 to 55 years, 7.4% - persons over 56 years of age. The average age of the respondents was 29 ± 1.8 years. The largest number of those who took part in the study were women - 70.8% of the total number of respondents.

The following methods were used in the work: bibliographic, analytical, mathematical-statistical, sociological (questionnaire). The collection, systematization and processing of the initial information was carried out in the Microsoft Excel 2016 application. Statistical analysis was carried out using PASW (Predictive Analytics SoftWare) Statistics 22 and controlling tools [3]. Relative extensive indicators are used in data processing and presentation.

RESULTS AND DISCUSSION

During the analysis of the survey results, it was found that the largest number of respondents noted chronic fatigue - 54.2 (per 100 respondents). The second most common complication – distortion of smell and taste - was noted by 48.5 (per 100 respondents). The third complication in frequency – hair loss, was observed in 38.4 (per 100 respondents). Shortness of breath, even with minimal physical activity, was noted by 37.2 (per 100 respondents). The next complication in terms of prevalence is joint and muscle pain, it was noted by 36.3 (per 100 respondents). The disease had a significant impact on the psychological state of the respondents. Thus, 35.2 out of every 100 respondents noted depression, anxiety and mood changes. Muscle weakness was noted by 30.4 per 100 respondents (Figure 1).

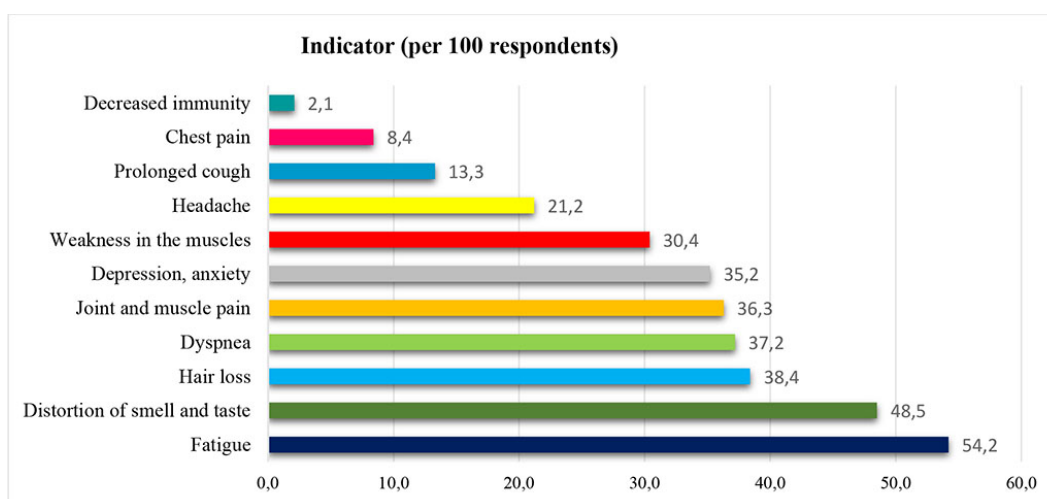


Figure 1. The prevalence of complications in patients after coronavirus infection

Shortness of breath even with minimal physical activity was noted by 37.2 (per 100 respondents). The next complication in terms of prevalence is joint and muscle pain, 36.3 (per 100 respondents) noted it. The disease had a significant impact on the psychological state of the respondents. Thus, 35.2 out of every 100 respondents reported depression, anxiety and mood changes. Muscle weakness was noted by 30.4 per 100 respondents. To a lesser extent, respondents noted a prolonged cough (more than 3 months) - 13.3 per 100 respondents, headache - 21.2 per 100 respondents, chest pain - 8.4, decreased immunity - 2.1 (per 100 respondents). And only a small number of respondents (2.0 per 100) did not note the consequences of the coronavirus infection. Some respondents also noted memory impairment, decreased concentration, a significant increase in body weight after therapy in a hospital, and a periodic increase in blood pressure.

Persons suffering from diseases of the cardiovascular system, to a greater extent, noted chronic fatigue, decreased performance, shortness of breath, pain in muscles and joints, and headaches. Persons with obesity and other metabolic disorders most often indicated the presence of complications such as chronic fatigue, shortness of breath with minimal activity, increased fatigue, and distorted sense of smell and taste. Persons with chronic diseases of the bronchopulmonary tract were significantly more likely to report weakness in the muscles, shortness of breath, as well as pain in the muscles and joints. Individuals with autoimmune diseases reported chronic fatigue, headaches, impaired sense of smell and taste, depressed mood, and anxiety. All respondents believe that after suffering a coronavirus infection, they need a set of rehabilitation measures. Respondents over the age of 56 noted such manifestations of post-COVID syndrome as weakness and pain in muscles and joints, prolonged cough, shortness of breath, chest pain, distorted sense of smell and taste. Persons with liver and kidney pathology are more likely to suffer from chronic fatigue, muscle weakness, and headache. Cancer patients noted symptoms such as distorted sense of smell and taste, chronic fatigue, depression.

The analysis of rehabilitation centers functioning today in the studied regions in Russia showed that at the moment there are 38 rehabilitation centers in these territories, of which 15 carry out general rehabilitation, 7 - children's rehabilitation, 5 - rehabilitation of the spine and joints, 11 - rehabilitation after drug addiction, alcohol, gambling and tobacco addiction. But none of the functioning rehabilitation centers specializes in post-COVID rehabilitation.

The creation of rehabilitation centers specializing in post Covid recovery is very important for each locality, taking into account the characteristics of the course of the disease, the high rate of complications, and the trends of the ongoing COVID-19 pandemic.

A specialized rehabilitation center should meet the main tasks of medical rehabilitation after COVID-19:

- restoration of respiratory functions, improvement of gas exchange and reduction of shortness of breath,
- restoration of the functions of the cardiovascular system,
- restoration of muscle mass and its strength,
- restoration of household and motor activity.

Since the course of the disease in all patients is different, accordingly, the recovery groups should be distributed according to the well-being of patients. Rehabilitation should be built in stages, in accordance with the methodological recommendations, so that the patient undergoes recovery to the best of his ability, without creating an additional negative burden on the body [5].

Rehabilitation can be divided into 3 main stages depending on the patient's well-being.

The first stage is for patients with extremely severe, severe and moderate course of the coronavirus infection. The second stage of rehabilitation is suitable for patients who have minor breathing difficulties, but at the same time oxygen saturation indicators are stable, but motor activity disorders persist, the patient cannot fully move, take care of himself, the level of quality of life is significantly reduced. The third stage of medical rehabilitation is required for patients who do not have difficulty in breathing, can move independently, keep balance, fully serve themselves in everyday life, but still notice muscle weakness, increased fatigue and decreased performance.

Based on the above stages of rehabilitation, we have formulated recommendations for the rehabilitation of patients after a coronavirus infection.

The first stage includes respiratory rehabilitation. For patients with typical lung disease, it is recommended to start recovery from the respiratory system with specialized breathing exercises. Therapeutic physical training and breathing exercises are aimed at increasing the reserves of the respiratory muscles, draining the bronchi, activating gas exchange in the lungs, and reducing the subjective feeling of lack of air [2, 6]. Also, the first stage of rehabilitation should include motor exercises in the prone position with the use of active-passive mechanotherapy, verticalization of the patient, as well as physiotherapy aimed at restoring lung tissues.

At the second stage, specialized breathing simulators can be connected to breathing exercises, which include inspiratory muscles, which include the diaphragm, external intercostal muscles. The action of simulators with a threshold load on the inspiratory muscles is aimed at increasing the strength and endurance of the inspiratory muscles, improving the breathing process and restoring the ventilation capacity of the lungs, and increasing exercise tolerance [4].

Also at the second stage, we recommend connecting physical rehabilitation, which includes active exercises for various muscle groups, training to restore balance, joint exercises using robotic mechanotherapy or specialized simulators with motion activity tracking. It is recommended to conduct training to restore

walking skills, this can be walking in place, climbing stairs, walking in specialized treadmills, in all exercises related to walking on stairs, but this should take into account the condition of the knee and hip joints, as well as body weight patient [1]. The second stage also involves the restoration of household activity, this can be facilitated by special simulators that mimic everyday household activities.

At the third stage of rehabilitation, it is recommended to connect aerobic loads lasting 20-30 minutes. The intensity and type of aerobic exercise should be selected based on the patient's well-being and his physical capabilities. You should also connect strength training of the upper and lower extremities with a gradual increase in the number of repetitions. Resistance should be increased gradually, after the patient has adapted to power loads. Strength training with resistance and weights contributes to the restoration of muscle strength, muscle endurance, and leads to a decrease in muscle fatigue.

Patients who are unable or unwilling for any reason to undergo active rehabilitation may be offered neuromuscular electrical stimulation. Also, at the third stage of rehabilitation, SMT therapy (treatment with sinusoidal modulated currents), ultrasound therapy, low-frequency magnetotherapy and other methods are recommended. Recommended rehabilitation methods depending on the stages are given in Tab. 1.

Tab. 1. Methods of rehabilitation after coronavirus infection depending on the stage

Methods rehabilitation after Covid-19	Stages rehabilitation		
	I stage of rehabilitation	II stage of rehabilitation	III stage of rehabilitation
1	2	3	4
IGGT training		V*	V
Inhalation		V	V
MLS therapy	V	V	V
ELF magnetic therapy		V	V
Electrical stimulation	V	V	V
Verticalization	V		
Early mobilization	V		
Restoring balance and balance		V	
Restoration of household activity		V	
Development of joints and restoration of muscle strength in the limbs	V	V	
Recovery of walking skills		V	V
Cardio workout			V
Strength training			V

V* - recommended methods of rehabilitation

The selection of medical rehabilitation equipment is very important, which must have a registration certificate from Roszdravnadzor, confirming that the medical device has been registered in the Russian Federation and information about it has been entered in the State Register of Medical Devices and Medical Equipment.

As a hypo-hyperoxic equipment for rehabilitation after COVID-19, we recommend considering the device for interval hypo-hyperoxic training (IHHT) HYPO-OXY-1 (trademark OXYTERRA) [9], as well as among the inhalation equipment - the P6 inhaler manufactured by MED 2000 S.R.L. A distinctive feature of these

inhalers is the control of the dispersed flow by regulating the particle size of drugs, which allows them to penetrate into all parts of the respiratory tract, depending on the needs of therapy.

Among the physiotherapy equipment for rehabilitation after COVID-19, the MLS laser therapy device manufactured by ASA S.r.l, Italy is recommended. MLS is a laser therapy based on the patented MLS laser pulse, which results from the superposition and synchronization of 808 nm and 905 nm wavelengths. The inclusion of laser therapy in the rehabilitation program is advisable not only for the restoration of lung tissue, but also for the treatment of joint pain, muscle contractures, inflammation and muscle weakness.

Low-frequency magnetic therapy with Easy Qs and PMT Qs devices, manufactured by ASA S.r.l, Italy, which generate low-frequency magnetic fields ELF (Extremely Low Frequency - extremely low frequency), affecting any tissue: from muscles to bone structures, from nerves to epithelium, spreading therapeutic effect on the whole body. The EASY Qs version is distinguished by its portability, as well as the presence of Flexa applicators with a vibration effect, which improves blood microcirculation and also has a positive effect on sputum discharge from the lungs.

At the first stage of rehabilitation, verticalization of the patient is necessary. The verticalization table VARIO-Line Tilt table manufactured by Beka Hospitec, Germany, allows for effective mobilization of patients, combining smooth verticalization and stabilization of the cardiovascular system. Also recommended for use in rehabilitation after coronavirus infection is a vertical table with built-in robotic mechanotherapy and electrical stimulation Erigo manufactured by Hocoma AG, Switzerland. To restore the skills of vertical standing and balancing at the second stage of rehabilitation, the Thera-trainer Balo manufactured by Medica Medizintechnik GmbH, Germany is recommended. The simulator is designed for verticalization, improving balance (with prevention of falls); prevention of muscle atrophy; muscle strengthening; improving the stability of the upper body; improve blood circulation.

As equipment for early mobilization, it is recommended to carry out mechanotherapy on bedside simulators. One such machine is the RT300-Supine made by Restorative Therapies, Inc. The RT300 can be used from a chair, wheelchair, or bed, and there are two versions that can be used for both upper and lower extremities.

The equipment for restoring balance and balance includes the stabiloplatform with biofeedback Tymo Therapy Plate manufactured by Tyromotion GmbH, Austria.

To restore everyday activity, the Pablo simulator is recommended, which allows you to restore fine, gross motor skills and coordination of the upper limbs with an assessment of functionality using biofeedback (Tyromotion GmbH, Austria) - this is a modern device for the treatment and rehabilitation of patients suffering from motor dysfunctions.

Luna EMG manufactured by EGZO Tech., Poland is recommended as equipment for developing joints and restoring muscle strength in the limbs. It is a rehabilitation robot specially designed for physiotherapy of neurological patients with muscle weakness. For these purposes, you can also consider simulators for the passive development of the joints of the upper and lower extremities Kinetec, France.

Among the simulators for cardiorehabilitation, it is worth highlighting the AlterG Anti-Gravity Treadmill rehabilitation anti-gravity treadmill in the version: AlterG Anti-Gravity Treadmill M320 manufactured by AlterG, Inc. USA, which in addition to the usual functions of the treadmill provides weight loss for the user, as well as a series of cardio equipment Kardiomed 700 manufactured by Proxomed Medizintechnik GmbH Germany, which includes the Mill tour treadmill, Stair stepper, vertical Basic cycle and horizontal Comfort cycle bicycle ergometers, ergometer for upper limbs Upper body and el-lips Cross walk.

It is recommended to use Compass 600 simulators (manufactured by Proxomed Medizintechnik GmbH, Germany) as strength training simulators - a set of strength training simulators with biofeedback. The complex is designed to develop the neck muscles, muscles of the trunk, lower and upper limbs. The main advantage of the Compass series simulators is the innovative biofeedback system (BFB). For systematic successful training, you need not only weight, but also a quality control system for performing exercises during the training process. In the BFB system, you can specify individual or predefined sequences of movements, as well as the speed of performing concentric / eccentric movements and their amplitude.

Walking on level ground, up and down slopes and stairs are basic everyday skills. The sooner patients can achieve independence in walking and going up/down stairs, the sooner they can return to a normal life. The DST Triple Pro by D.P.E MEDICAL LTD (Israel) combines three devices in one, including a ladder with adjustable step height for walking up and down, a flat surface with a variable angle and an exercise track with parallel bars. The simulator is equipped with biofeedback (BFB). It displays information about the patient's previous treatment sessions in the form of a graph before each training session; shows the current progress of the patient. The simulator allows you to estimate how long it takes a patient to go up and down stairs with different step heights, how long a patient can go up / down a slope with a certain angle of inclination, and how long a patient walks a distance of 3 meters on a flat, even surface.

To restore walking skills, the Omega simulator manufactured by Tyromotion GmbH, Austria is

recommended. It consists of a main unit, which includes a motorized movable mechanism, a pedal unit, foot braces, pedals and a control unit for setting therapy parameters. Omega combines unilateral or bilateral leg training with symmetry detection, leg press, stepper, ergometry/cycling, vibration therapy, sensory therapy or foot sag correction.

CONCLUSION

Thus, the most common consequences of COVID-19, according to the study, include: shortness of breath even with minimal physical activity, chronic fatigue, hair loss, depression, anxiety disorders, sleep disturbance, muscle weakness, muscle and joint pain, chest pain, prolonged cough, distortion of smell and taste, headache.

Due to the fact that complications after a coronavirus infection continue in patients for a long time (up to 2-3 years) after the disease, a post-COVID rehabilitation center will speed up the recovery process and restore the patient's ability to an active life.

Based on the well-being of patients and the stages of the rehabilitation process, it is possible to plan the main methods of rehabilitation therapy for patients, depending on their functionality and the medical rehabilitation equipment available to the centers, which has proven clinical effectiveness at each stage of rehabilitation.

It should be noted that the proposed complex of medical equipment is a multidisciplinary and post-COVID rehabilitation center after the end of the COVID-19 pandemic can be redesigned for other areas of medical rehabilitation.

The authors declare that there is no conflict interests and any third-party financing.

REFERENCES

1. Betschart M., Rezek S., Unger I., Beyer S., Gisi D., Shannon H., et al. Feasibility of an outpatient training program after COVID-19. *International Journal of Environmental Research and Public Health*. 2021. Vol. 18. – P. 1-12. DOI: [10.3390/ijerph18083978](https://doi.org/10.3390/ijerph18083978)
2. Bralyuk M.A., Akinina E.G., Voronova O.A. Analysis of the results of using normobaric interval hypoxic-hyperoxic training in patients with post-covid syndrome, Glavvrach of the South of Russia. 2022. No 1(82). – P.37-40.
3. Breusov A.V., Otstavnov S.S., Breusov D.A. Problematic issues of information support for management decision-making in healthcare. *Archiv Euromedica*. 2021. Vol.11. No 6. – P. 6-9. <http://dx.doi.org/10.35630/2199-885X/2021/11/6.1>
4. Edwards A.M., Wells C., Butterly R. Concurrent inspiratory muscle, and cardiovascular training differentially improves both perceptions of effort and 5000 m running performance compared with cardiovascular training alone, *British journal of sports medicine «Sports Med»*. 2008. Vol. 42. – P. 823-827. DOI: [10.1136/bjism.2007.045377](https://doi.org/10.1136/bjism.2007.045377)
5. Kamkin E.G. Interim Guidelines - Medical Rehabilitation for Novel Coronavirus Infection (COVID-19), Version 2 (31.07.2020). 2020. – P. 1-150. <https://normativ.kontur.ru/document?moduleId=1&documentId=367585> (date of the application 14.03.2023).
6. Konchugova T.V., Orekhova E.M., Kulchitskaya D.B. The main achievements and directions of development of apparatus physiotherapy. *Issues of balneology, physiotherapy and therapeutic physical culture*. 2013.No 90. – P. 26-31. <https://www.secret-dolgolet.ru/wp-content/uploads/2013/01/voprosy-kurortologii-fizioterapii-i-lechebnoy-fizicheskoy-kultury>.
7. Lai, C.C., Ko, W.C., Lee, P.I., Jean, S.S., Hsueh, P.R. Extra-respiratory manifestations of COVID-19. *International Journal of Antimicrobial Agents*. 2020. Vol. 56. – P. 1-6. DOI: [10.1016/j.ijantimicag.2020.106024](https://doi.org/10.1016/j.ijantimicag.2020.106024)
8. Micah, A.E., Cogswell, I.E., Cunningham, B., ...Murray, C.J.L., Dieleman, J.L. Tracking development assistance for health and for COVID-19: a review of development assistance, government, out-of-pocket, and other private spending on health for 204 countries and territories, 1990–2050 // *The Lancet*. 2021. Vol. 398. No 10308. – P.1317-1343. DOI: [10.1016/S0140-6736\(21\)01258-7](https://doi.org/10.1016/S0140-6736(21)01258-7)
9. Vasilenko I.A., Grigoriev G.I. Effective rehabilitation after COVID-19: Interval hypo-hyperoxic training, Chief Physician of the South of Russia. 2021. No 2(77). – P. 27.
10. World Health Organization/COVID-19 Weekly Epidemiological Update – 16 November 2022. URL: <https://www.who.int> (date of the application 09.04.2023).

[back](#)