

Physical rehabilitation of patients with post-COVID syndrome

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Abstract:

At present, the problem of physical rehabilitation of persons who have had an infection caused by SARS-CoV-2 seems to be relevant and it requires an urgent search for means and methods of physical recovery in the sanatorium. *Purpose:* The main aim is to determine the effectiveness of therapeutic walking in the protocol of the individual physical rehabilitation program at the stage of sanatorium recovery of patients with post-COVID syndrome. *Research materials and methods.* The research work was carried out in a multidisciplinary sanatorium in the Trans-Baikal Territory (Russia). A rehabilitation protocol has been developed, in which 38 men aged 46-55 underwent a 21-day recovery process. A 500-metre daily health-care route with walking rates at the beginning and physical therapy on the 7-th and 21-st days of rehabilitation have been provided as the main treatment and health procedure for post-COVID patients. A milestone assessment of exercise tolerance was carried out based on the results of the 6MWD walking test; degree of respiratory failure on the mMRC scale; muscle strength on the MRC scale; blood oxygen saturation level by pulse oximetry. The quality of life was assessed according to the EQ-5D-3L questionnaire; the health, activity, and mood of the project participants were determined with a help of the WAM questionnaire. Research results. At the end of the project, 89,5% of patients had the positive dynamics in the functional state of the cardiorespiratory system. Respiratory rate decreased by 21,9%, systolic blood pressure decreased by 7.1%, compared to the indicators values at the beginning of the project. The number of patients with low muscle strength on the MRC scale and respiratory failure has been significantly decreased. The indicators of the 6 MWD walking test increased by 19,4% and the walking rate (number of steps) increased in patients with different types of post-COVID syndrome, the indicator of blood oxygen saturation improved compared to the beginning of rehabilitation, $p < 0.05$. The quality of life and WAM indicators have significantly improved. *Conclusions.* The obtained results of our research project showed the effectiveness of using therapeutic walking in the form of the health path (terrain cure route) - a route that was included in the protocol of the individual physical rehabilitation program at the stage of sanatorium recovery after COVID-19.

Keywords: post-COVID syndrome, physical rehabilitation, health path (terrain cure route), testing.

Introduction

Constant waves of COVID-19 pandemics emergence among the population of most countries on the planet, associated with a high ability to mutate the SARS-CoV-2 virus, requires continued scientific search for new effective methods of diagnosis, treatment, control and prevention of this disease (Wu & McGoogan, 2020; Kokhan et al., 2022).

The main nosologic manifestation of SARS-CoV-19 corona virus infection is associated with acute respiratory damage to the upper respiratory tract and the fairly frequent development of bilateral pneumonia, and sometimes the development of respiratory distress syndrome (Suvarna et al., 2019; Yang, 2020). Often, patients who have been ill have severe complications from the cardiorespiratory system (Bader et al., 2021; Baigaliev et al., 2021), reducing the efficiency and quality of human life (Khasanova et al., 2021).

The experience gained by the researchers in post-covid patients' treatment and rehabilitation (Karde, 2021; Kokhan et al., 2021) indicates the importance and consistency of compliance throughout the stages of

complex rehabilitation from inpatient treatment (stage I), rehabilitation treatment (stage II) and rehabilitation of patients who underwent COVID-19 (stage III) in the sanatorium-resort conditions (Derco, 2020).

All over the world, citizens' health restoration in a sanatorium involves the widespread use of not only medical methods (Smith & Wallace, 2020). Only an individual approach, taking into account the existing complications, in the selection of all available methods and means, allow us to hope for a positive rehabilitation dynamics.

The scientific literature presents data (Adamakis, 2021) on the relationship of human physical activity with the severity of COVID-19 disease. Sanatorium complexes are always intended for the implementation of rehabilitation and rehabilitation treatment and prevention of infectious and non-infectious diseases. The possibilities of the sanatorium allow providing for an optimal dosed motor regime creation to increase tolerance to physical exertion (Wang et al., 2020), effective recovery after complex exposure to therapeutic physical factors. Such a complex of rehabilitation measures improves not only the functional characteristics of the body (Mozolev et al., 2020), but also increases immunity (Aksay, 2021) and the level of physical and somatic health (Daia et al., 2021), reduces the severity of chronic human diseases (De la Camara et al., 2021). The main task of sanatorium-resort rehabilitation is the implementation of a range of services aimed at general restorative therapy, symptomatic treatment, prevention of disability and improvement of quality of life (Makarova et al., 2020). The earlier the recovery procedures begin, the greater the effectiveness of the results obtained in improving the health of patients (Kjærgaard et al., 2020).

Despite the form of the disease with COVID-19 corona virus pneumonia, post-infectious asthenia phenomena persist in the body of patients who have been ill for a long time, leading to a disorder of the quality of life and the patients' fitness for work (Ceravolo et al., 2020). According to Huang et al. (2021), more than 70% of patients with confirmed COVID-19 retained symptoms within six months after discharge from the hospital, regardless of whether it was a severe course of the disease, mild or asymptomatic.

Physical rehabilitation, for post-covid patients in conditions of sanatorium health restoration, has several effective methods and various means of therapeutic physical culture. An increase in daily physical activity in combination with rehabilitation procedures has a positive effect on the quality of life and health restoration. Terrain cure (translated from French - terrain treatment) is the use of a therapeutic walking technique with a therapeutic effect and climatic and landscape effects of the terrain. The use of therapeutic walking in complex rehabilitation helps to strengthen the work of skeletal muscles, normalize breathing, eliminate the negative consequences of the disease and psycho-emotional overstrain (Barashkov et al., 2021).

We believe that an important direction of sanatorium-resort rehabilitation of patients who have had a new corona virus infection is to study the issues of improving the functional systems of the body, relieving hypoxic consequences, restoring external respiration, improving physical endurance and quality of life.

Purpose: Determining the therapeutic walking effectiveness in the protocol of patients' with post-COVID syndrome individual program of physical rehabilitation at the stage of sanatorium recovery.

Material & methods

Rehabilitation recovery was carried out in a multidisciplinary sanatorium of the Trans-Baikal Territory (Russia), which since April 2020 has been reoriented to post-covid patients' rehabilitation. The climate in the place where the sanatorium is located is sharply continental and low-mountain. The height of the location above sea level is 740-805 meters. The relative average annual humidity is 73%, the atmospheric pressure is 710-725 mm Hg. 2500 annual hours of sunshine and high air ionization are observed in this area. The sanatorium is located in a picturesque river valley, surrounded by small mountains covered with pine, fir and birch forests.

All these circumstances allowed us to carry out actual experimental work in the therapeutic, physical culture and rehabilitation areas.

The research project involved 38 men aged 46-55 who had been ill with Covid-19. The severity of lung damage was confirmed by computed tomography and was 57.9% with CT-3 (n =22) and 42.1% with CT-4 (n =16).

The high-stakes monitoring of the subjects' functional state was carried out taking into account post covid symptoms, well-being, and the level of the men's tolerance to physical activity. All those who were ill were sent to the sanatorium at the III stage of medical rehabilitation, but not earlier than 30 days after the end of inpatient treatment and the presence of a negative smear result for SARS-CoV-2.

The protocol of the rehabilitation program for patients who underwent Covid consisted of climatotherapy (heliotherapy, arotherapy); hydrotherapy with local therapeutic table mineral water and hydro massage, which helps to improve metabolic processes in the skin-subcutaneous fat layer, in muscle and joint tissues.

A large role in increasing the effectiveness of physical rehabilitation was assigned to therapeutic physical culture - the performance of general restorative and respiratory physical exercises of aerobic orientation. Physical exercises were carried out in dynamic and isometric mode in the gym of the sanatorium or outdoors using outdoor exercise complexes. Patients were assigned a therapeutic swimming pool.

As the main procedure for the rehabilitation of the patients' post-covid condition, a daily 500-meter-long terrain cure route was provided as a method of training therapy for the restoration and development of general endurance. The pace of walking corresponded to the patients' functional capabilities and was recorded by a pedometer at the beginning, on the 7th and 21st days of rehabilitation. At the beginning and at the end of the rehabilitation cycle, exercise tolerance was assessed based on the results of the 6MWD - six-minute walking distance walking test (Casanova et al., 2011), m.

Assessment of respiratory insufficiency degree was carried out on the mMRC scale; assessment of peripheral muscle strength on the MRC scale (Medical Research Council Weakness Scale -MRC) in points; assessment of blood oxygen saturation by pulse oximetry, %. Walking pace and quality of life indicators were monitored in points using a three-level version of the questionnaire EQ-5D-3L (This document should be cited as: EuroQol Research Foundation. EQ-5D-3L User Guide, 2018). This test characterizes the patient's condition according to 5 components: mobility, self-care, and activity in daily life, the presence of pain or anxiety, discomfort. The high quality of life of the patient was assessed at 0 points, low at 10 points.

Patients were tested using the WAM technique (well-being, activity, mood), the differentiated functional state of the body and the presence of complaints were determined (Mikhailova, & Farennikova, 2020). After signing the informed consent to participate, the men were included in a single-center cohort study. Statistical processing of the obtained data was performed using the STATISTICA 10.0 application software package. The differences were statistically significant at $p < 0.05$. This project does not violate the protocol of the Helsinki Declaration (WMA, 2013).

Results

Upon admission to the sanatorium treatment, 21 patients (55.2%) complained of general weakness and fatigue, 18 people (47.3%) complained of shortness of breath of varying intensity when climbing stairs, 9 (23.7%) noted headache and dizziness, 13 (34.2%) had muscle pain, 4 patients (10.5%) had a rare cough with mucus. After the complex sanatorium rehabilitation, 34 people (89.5%) showed positive dynamics of the functional state indicators of the cardiorespiratory system when performing physical loadings. Respiratory rate decreased by 21.9%, systolic blood pressure decreased by 7.1%, compared to the values of indicators at the beginning of the project. There was no tendency to improve the diastolic pressure index. By the end of the follow-up, the number of meters covered in the 6 MWD walking test and blood oxygen saturation significantly increased by 19.4% in patients compared to the beginning of rehabilitation, $p < 0.05$, Table 1.

Table 1. High-stakes indicators values of the patient's body functional state (M±m)

Indicators	Before rehabilitation (n=38)	After rehabilitation (n=38)	p
Respiratory rate at rest/min	21.9±0.9	17.1±1,5	$p < 0.05$
Systolic pressure, mmHg.	128.5±5.4	119.4±2.3	$p < 0.05$
Diastolic pressure, mmHg.	77.2±2.1	73.4±36	$p > 0.05$
6MWD walking test, m	375.5±23,3	448.3±29.7	$p < 0.05$
SpO ₂ , %	96.6±0,2	97.8±0.3	$p < 0.05$

One of the peculiarities and an attractive opportunity to improve the overall endurance of patients in the conditions of the sanatorium-resort stage of rehabilitation is a terrain cure, as an obligatory attribute of recovery. It is a cardio load with a positive effect on the cardiovascular, respiratory and muscular systems activity. Oxygen saturation of the blood occurs, the body's tolerance to physical loading increases and psycho-emotional recovery appears. The carried-out monitoring results indicate that the implementation of the protocol on therapeutic walking allowed increasing the number of steps (walking pace) in patients with different types of post-covid syndrome, $p < 0.05$, Table 2.

Table 2. Monitoring of the rate of passage of the 500 m terrain cure route, (number of steps/min, M±m)

Control day	Disease severity		p
	Patients with CT-4 (n =16)	Patients with CT-3 (n =22)	
First day	69.7±2.1	81.2±3.4	$p < 0.05$
Seventh day	81.2±3.4*	91.2±0.9*	$p < 0.05$
21 st day	91.2±0.9*	94.7±1.8*	$p < 0.05$

Note. * - significant values of indicators in one group of patients, compared with the first day, $p < 0.05$

During rehabilitation in the sanatorium, there has been a significant increase in exercise tolerance, as evidenced by an increase in the pace of walking in patients with different types of post-covid syndrome. The increase in the values of the walking pace indicator on the terrain cure route on the 6th and 21st days of rehabilitation is shown in Figure 1.

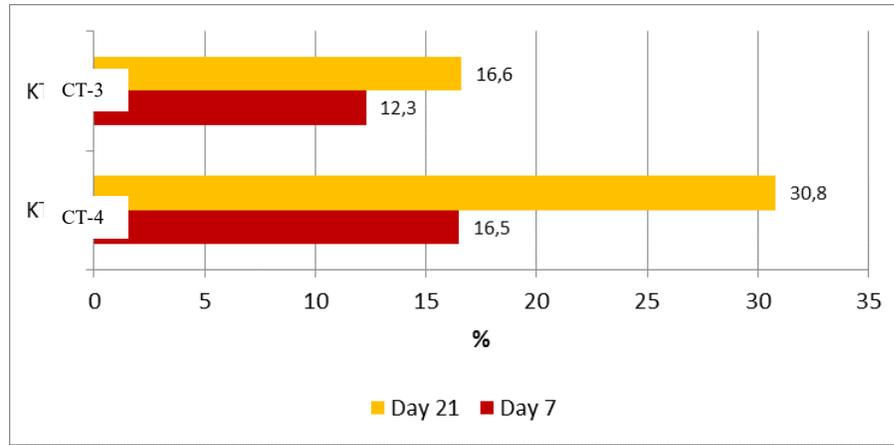


Fig. 1. The increase in the pace of walking on the terrain cure route in different rehabilitation periods

The highest increase in the number of steps (30.8%) was found in CT-4 patients on 21th day of rehabilitation. The smallest increase (12.3%) was registered in CT-3 patients on the 7th day of rehabilitation. At the beginning of rehabilitation in 27 (71.0%) patients, the quantitative measurement of various muscle groups' strength on the MRC scale was estimated at 3 points, which characterizes a significant decrease in the musculature contractility, without the possibility of overcoming additional load. In 5 patients (13.2%), a slight motor deficit was detected with peripheral muscle strength assessment of 4 points and in 6 patients (15.8%), muscle strength was estimated at 5 points, which corresponds to the normal characteristic of strength abilities, Figure 2.

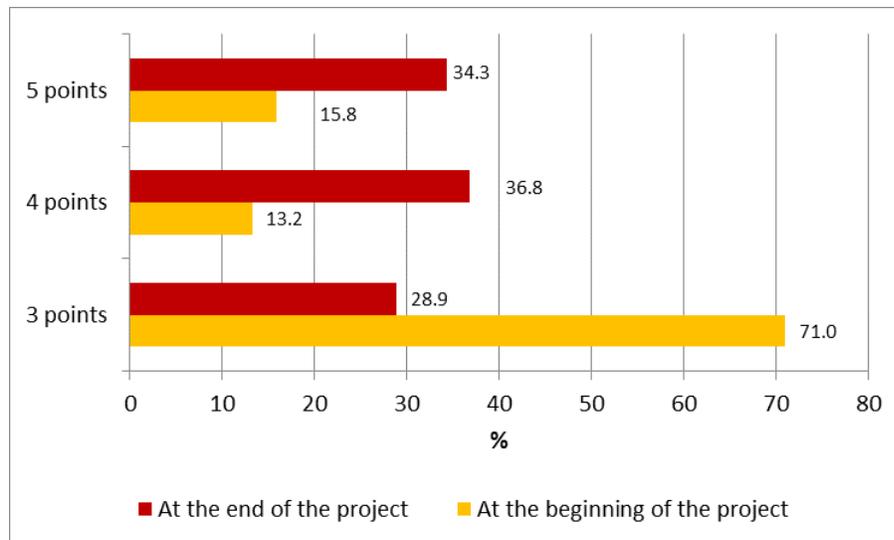


Fig. 2. The number of patients with different muscle strength on the MRC scale at the beginning and at the end of rehabilitation

At the end of rehabilitation, it was found that the number of patients with an assessment of muscle strength of 3 points decreased by 2.4 times, the number of examined patients with normal strength and a slight deficit of motor skills increased by more than 2 times.

Control measurements of respiratory insufficiency degree in the examined men on the mMRC scale showed that no patients with a normal degree of respiratory function were detected at the beginning of monitoring. Subjectively, 33 patients (86.8%) assessed the degree of their respiratory function as severe (0-1 points). 5 people (13.2%) had an average degree of respiratory insufficiency (2 points), which is associated with the presence of chronic bronchopulmonary pathology. At the end of rehabilitation, the number of patients with

moderate respiratory insufficiency increased from 13.2 to 57.8% and patients with normal respiratory function appeared (42.2%). No patients with severe respiratory insufficiency (0-1 score) were identified.

It was found that on the 21st day of the rehabilitation program, the quality of life of the project participants questionnaire improved by 15.7% (from 8.9±0.6 to 7.5±0.5 points), according to the results of testing on the EQ-5D-3L. After the course of sanatorium rehabilitation, the patients' well-being, activity and mood significantly improved compared to the data before the start of rehabilitation, Figure 3.

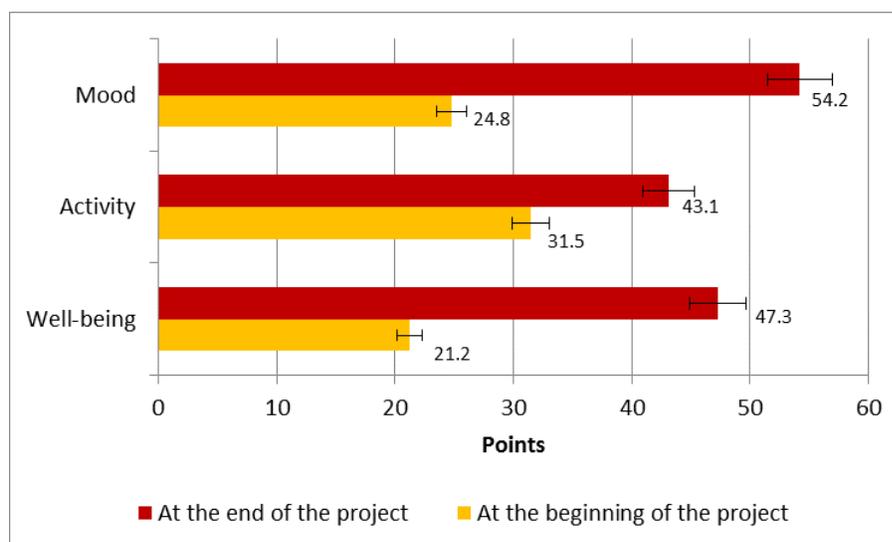


Fig. 3. WAM indicators value in patients before and after rehabilitation

The obtained results of our project showed the effectiveness of using therapeutic walking in the form of a terrain cure route, which was included in individual physical rehabilitation programs at the stage of sanatorium recovery after COVID-19.

Dicussion

Non-drug remedies use for the treatment and prevention of diseases is widely used in world clinical practice (Smith & Wallace, 2020). We have found that the increase in the possibility of the sanatorium-resort stage for the rehabilitation of patients in the post-covid period is influenced by the peculiarities of climatic conditions, natural aerophytotherapy, terrain cure therapy, physical therapy and the entire range of measures in the individual rehabilitation program, which increase the adaptive and compensatory capabilities of the body by non-medicinal means, which is consistent with the materials of other studies (Daia et al., 2021). In the conditions of the sanatorium, physical rehabilitation methods are most preferable because of the proven positive effect of physical exercises, respiratory gymnastics, a wide range of therapeutic and preventive procedures and prescriptions. The results obtained by us of the recovery and endurance development when using terrain cure as a method of training therapy are consistent with the data of Lamberti (2021). We believe that in the rehabilitation program of patients in a sanatorium, the main role should be given to physical activity. This is due to an increase not only in the aerobic capabilities of the body, but also an increase in immunity, which decreases with corona virus infection (Aksay, 2021). An increase in the effectiveness of restorative procedures is noted with the complex use of various therapeutic measures and natural and climatic conditions of the sanatorium in the post-covid period, which is established in our research and does not contradict the data of other authors (Makarova et al., 2020).

Our research shows the importance of terrain cure for the restoration of physical capabilities and the prevention of pulmonary pathologies. The passage of the terrain cure route had a positive effect on the project participants' physical capabilities restoration. Motivation to perform therapeutic walking, not only in the conditions of the sanatorium complex, but also at home, will serve as a pledge to maintain physical activity, prevent physical inactivity and restore quality of life indicators.

At the same time, lack of physical activity is considered to be the cause of 3.2 million deaths worldwide and is the fourth factor in global mortality. Susceptibility and insecurity from GOVID-19 has a multifactorial basis and it is important to understand that health preservation and promotion largely depends on physical activity, which is confirmed by this research work.

Conclusions

It has been established that complex sanatorium-resort rehabilitation in the conditions of natural and therapeutic physical factors contributes to an increase in the adaptive potential and physical activity of patients with post-covid syndrome. At the end of the research project, a statistically significant increase in overall endurance was revealed with regular use of therapeutic walking. The number of meters covered in the 6MWD walking test increased by 19.4%, blood oxygen saturation increased compared to the beginning of rehabilitation. The obtained data demonstrate positive dynamics of physical activity tolerance, recovery of motor activity as well as respiratory cycle structure improvement after inclusion in the protocol of the rehabilitation program of a complex of collective and individual metered training for respiratory and peripheral muscles. On the 21st day of the rehabilitation protocol, the number of patients with a muscle strength score of 3 points decreased by 2.4 times; the number of patients with normal strength increased by more than 2 times. After completion of the rehabilitation program, no patients with severe respiratory insufficiency were identified and the quality of life of the project participants improved by 15.7%. Positive dynamics of well-being, activity, mood of patients who have had COVID-19 was established.

Our research project results have shown the effectiveness of using therapeutic walking in the form of a terrain cure route, which was included in the protocol of an individual physical rehabilitation program at the stage of sanatorium recovery of patients after COVID-19 and allow us to recommend it for wide use.

Conflicts of interest. The authors declare no conflict of interest.

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