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## Polyfactorial approach in the correction of cognitive impairment in patients with post-Covid syndrome

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### Abstract

The article discusses a multi-level polyfactorial approach in the correction of cognitive impairment in patients with post-Covid syndrome based on the combined use of cognitive-motivational correction of the psychological state and physiotherapeutic methods of treatment: multi-level magnetolaser therapy, advanced blood irradiation, transcranial neuroacoustic and light-pulse stimulation.

According to the results of the analysis of the results of testing patients based on the Montreal scale for assessing cognitive functions before the start, after 6 and 12 procedures, as well as 4 weeks after the completion of rehabilitation in the first group, the average indicators of the level of cognitive functions changed from 18.2 to 21.4 points, in the second group from 17 to 26 points.

Psychological testing using the psychometric tables of A. Beck and Spielberger-Hanin showed a decrease in the average level of depression after the procedures in the first group by 5.4±1.4 (from 27.5 to 22.1) points, the anxiety level by 4.9±0.3 (from 35.1 to 30.2), in the second group by 9.9±1.2 (from 27.3 to 17.4) and 8.2±0.4 (from 35.2 to 27.0), respectively. Additionally, it should be noted that the clients of the second group were more interested in conducting a second course.

A multi-level approach in the medical rehabilitation of patients with post-Covid syndrome based on the use of psychological correction, magnetolaser effect on the projection of the liver, supravenuous irradiation of blood and combined transcranial neuroacoustic and light-pulse stimulation in combination with endonasal breathing of a singlet-oxygen mixture in a magnetic field turned out to be the most effective for restoring cognitive functions.

**Key words:** Cognitive impairment, anxiety depression, post-Covid syndrome, psychosomatic correction, cognitive-motivational correction, magnetolaser therapy, advanced blood irradiation, transcranial neuroacoustic stimulation, light-pulse stimulation, singlet-oxygen therapy, endonasal respiration in a magnetic field.

### Introduction

Topicality. Post-COVID-19 syndrome (Long Covid) is a psychosomatic and psychofunctional disorder due to infection with the coronavirus infection SARS-CoV-2, which causes the systemic infectious disease

COVID-19. According to the WHO, as of 05.11.2021, there are already about 250 million diagnosed cases of infection with the SARS-CoV-2 virus in the world, of which about 5 million were fatal. (Scientists ..., 2021).

1. If we take into account the fact that no more than half of the real carriers of this virus are diagnosed with the SARS-CoV-2 virus and in the next 2-3 years at least 40-50% of the world's population will be infected with this virus, humanity may face a pandemic of mental disorders and behavioral disorders caused by the SARS-CoV-2 virus. If now mental disorders occupy a stable 4th place in terms of the level of influence on premature mortality and total costs in the health care system, then in 3-4 years this disease can take a leading place among all diseases. (<https://index.minfin.com.ua/ua/reference/coronavirus/geography>)

In order to improve the quality of life of patients who have been infected with the SARS-CoV-2 virus, the authors conducted pilot work on the development of technology for the use of physiotherapeutic methods of treatment at the stage of post-Covid rehabilitation.

**The purpose of the work.** To investigate the effect of psychosomatic correction by physiotherapeutic methods on the level of anxiety depression and cognitive functions of patients who have been infected with the SARS-CoV-2 virus.

#### **Materials and methods**

When citing research, the hypothesis was accepted that the effect on the human body of the corona of the SARS-CoV-2 viral infection is systemic.

With this in mind, in order to determine the rehabilitation potential of the patient and the formation of an individual rehabilitation protocol before the study, after performing 6 rehabilitation sessions, after the completion of rehabilitation and 4 weeks after the completion of rehabilitation, an assessment of the state of functional systems was carried out using the method of I. Nakatani (Medical ..., 2007). (MIT-1EPD apparatus, NMC Medintekh LLC).

To assess the level of anxiety depression, it is proposed to use psychometric tables of A. Beck and Spielberg-Hanin (Pizova et al., 2021). The Montreal Cognitive Assessment Scale was used to assess the level of cognitive impairment. (Burlaka et al., 2018; Samosyuk et al., 2018; Chukhraiev et al., 2017; Butska & Chukhraev, 2017; Butska et al., 2017; Patent UA No. 102215, 2015).

*Participants.* The anonymous study involved 48 patients aged 41 to 68 years who have confirmed post-Covid syndrome and gave voluntary consent to participate in the study, underwent inpatient treatment in 2021 and were sent to post-Covid rehabilitation. The study involved 18 men and 30 women. All patients who took part in the study underwent (before the start, after 6 procedures, after 12 procedures and 4 weeks after the completion of rehabilitation) an assessment of the state of functional systems by the method of I. Nakatani, determination of the level of depression according to the psychometric tables of A. Beck and the level of anxiety according to the Spielberger-Hanin tables and an assessment of the state of cognitive functions based on the Montreal scale for assessing cognitive functions.

*Procedure / Test protocol / Skill test trial / Measure / Instruments.* Study participants were randomly divided into 2 groups of 24 patients. In the first group, medical rehabilitation of patients was carried out on the basis of applying a cognitive-behavioral approach, taking into account their personal characteristics, the level of anxiety depression and assessment of cognitive functions in combination with a program of detoxification of the body.

*Data collection and analysis / Statistical analysis.* The complex activities included the following cognitive-behavioral techniques and trainings (Butska & Chukhraev, 2017; Butska et al., 2017):

- Cognitive restructuring – a technique that allowed patients to understand that they could control their feelings, thoughts, and therefore behavior;
- training of self-confidence and orientation on the ground – exercises with modeling of situations requiring the skills of independent decision-making, coping with neuro-psychological overloads, the ability to communicate with others and enter into contacts; special attention was paid to the ability to independently navigate the terrain and make decisions;
- memory training and solving logical problems.

Detoxification of the body was performed using endonasal respiration with a singlet-oxygen mixture (Patent UA No. 102215, 2015) in a magnetic field using the MIT-S apparatus (NMC Medintekh LLC) based on a patented method (Patent UA No. 109330, 2016; Chukhraiev, 2018). The singlet-oxygen mixture with endonasal respiration provides saturation of the blood with active oxygen and compensates for the lack of an oxidant during a biochemical reaction, reduces the level of formation of free radicals, reduces the level of intoxication of the body. The use of magnetic field exposure to the sinuses of the nose during endonasal breathing increases blood saturation with active oxygen, increases blood fluidity, enhances the capillary effect and increases the oxygen capacity of the blood.

In the second group, in addition, in comparison with the first group, functional correction of the liver was carried out by the method of magnetic laser stimulation of the liver, supravenuous irradiation of blood in combination with transcranial neuroacoustic and light-pulse stimulation (Apparatus "WIT-MT", LLC "NMC Medinteh"). The optical flux power of the red magnetolaser applicator was  $50 \pm 10$  mW, the induction of the magnetic field was at the level of  $25 \pm 5$  mT. The applicator was installed on the projection zone of the liver (right hypochondrium). The modulation frequency of the optical flux and magnetic field was determined on the basis of the Samosyuk-Chukhraev method (Chukhraeva, 2018). In most patients, it was  $9.4 \pm 1.7$  Hz.

The power of intravenous irradiation of blood flowing through the ulnar vein was 15 mW, the power of the light pulse flow was 270 mW. A variant of the procedure is shown in the figure Fig. 1.



Fig. 1. Variant of the transcranial neuroacoustic and light-pulse stimulation procedure using the TARA apparatus.

The procedures were carried out simultaneously with psychological correction, after singlet-oxygen therapy (Chukhraeva at al., 2018; Samosyuk at al., 2021; Patent of Ukraine for utility model No. 130133, 2018; Patent of Ukraine for utility model No. 131534, 2019). The time of the procedure corresponded to 15 minutes.

## Results

In all patients who took part in the study, after the procedures, there was an improvement in mood, a decrease in the level of depression and the level of anxiety according to the psychometric tables of A. Beck and Spielberger-Hanin, respectively. At the same time, the main changes were observed in a decrease in the frequency of repetition of suicidal thoughts, a decrease in irritability and aggression.

According to the results of testing based on the Montreal Scale for Assessing Cognitive Functions (MoSA), the level of cognitive functions in the first group increased by an average of 3.2 points, and in the second group by 8.96 points. At the same time, the most pronounced were changes in visual-constructive skills (2.6 points), memory (1.9 points) and attention (1.7 points). Most likely, this became possible due to the conduct of neuroacoustic stimulation using relaxing music and a decrease in the level of intoxication after performing endonasal breathing with a singlet-oxygen mixture.

The results of the diagnosis according to the method of I. Nakatani, allowed to conclude that the functional state of the channels of the lung, liver and heart was normalized after the rehabilitation according to the proposed protocol. Normalization of the lung canal was due to compensation for aerobic starvation due to an increase in the oxygen capacity of the blood after its supravenuous irradiation with laser radiation of the red spectrum range ( $0.63 \mu\text{m}$ ) and blood saturation with active (singlet) oxygen when performing endonasal breathing of the singlet-oxygen mixture. This procedure made it possible to significantly increase (up to 9-11 units) the electrical conductivity of the lung channel on the Ryodoraku scale.

Normalization of the liver was performed through magnetolaser therapy, which improved the microcirculation of blood and lymph inside the liver with simultaneous stimulation of biochemical processes in the zone of magnetolaser therapy. In total, this led to a decrease in the electrical conductivity of the liver channel by 12-14 units on the Ryodoraku scale.

The integral criterion for harmonizing the functional state of patients with post-Covid syndrome was the normalization of the electrical conductivity of the heart canal and a decrease in the average value of the deviation

of the electrical conductivity of energy channels from the functional corridor on the Ryodoraku scale map by more than 7 units.

Negative effects in the process of rehabilitation on the basis of the proposed protocol were not recorded. All patients gladly took part in the testing and subsequent discussion of psychological problems.

The most active were patients of the second group. Individual selection of magnetolaser stimulation parameters caused an additional positive reaction in almost all patients of the second group. The results of determining the psychological state of patients are shown in the figures Fig. 2–Fig. 4.

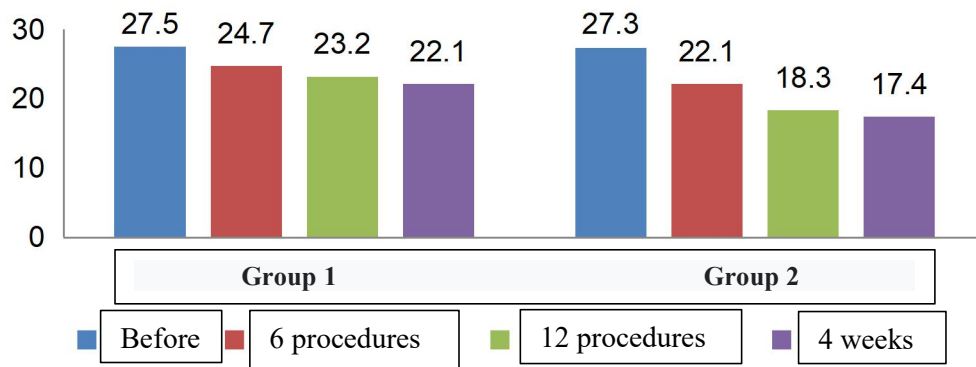


Fig. 2. Changes in the level of depression in patients of groups 1-2 (according to the table of A. Beck).

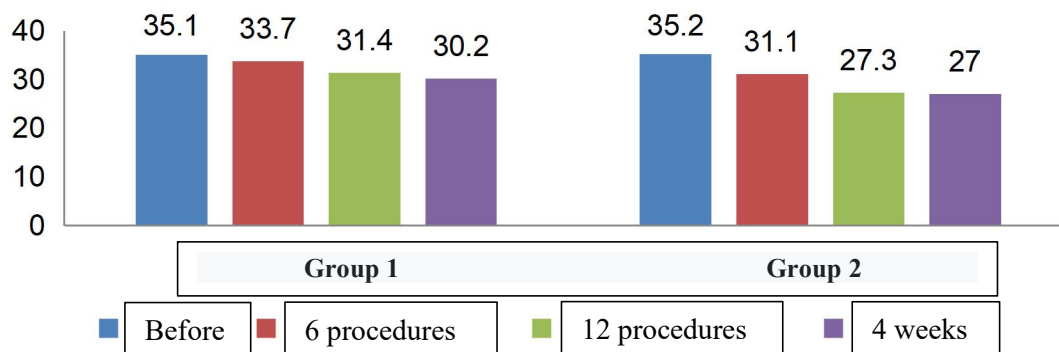


Fig. 3. Change in the level of anxiety in patients of groups 1-2 (according to the Spielberger-Hanin table).

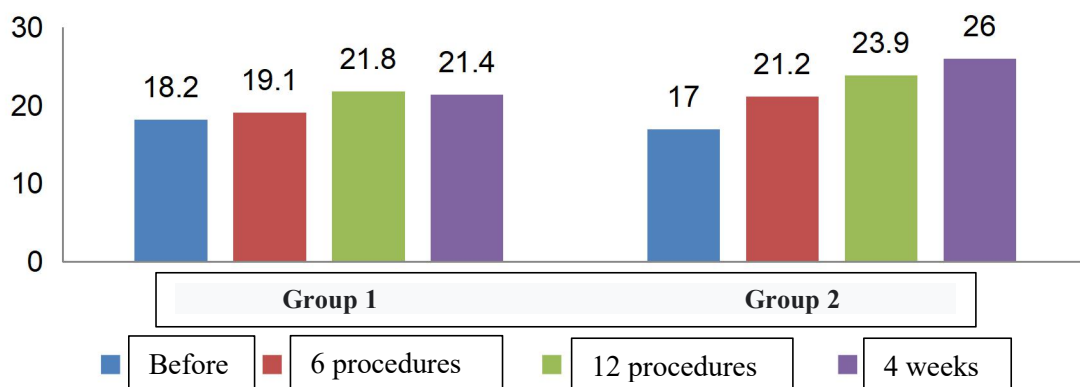


Fig. 4. Distribution of patients into groups before and after rehabilitation depending on the stage of cognitive impairment.

## Discussion

The negative manifestations of infection with the virus include its impact not only on the human respiratory system, but on the possibility of damage to most of the functional systems of the human body and an active mutation in a short time - almost every 1.5-2 years, the world's population is faced with a new variant of the virus, which has a higher degree of aggressiveness and resistance to the developed technologies for the treatment of COVID-19 diseases.

In most patients infected with the SARS-CoV-2 virus, neurological disorders similar to neuroviral infection are diagnosed already at the first stage - loss of smell and / or impaired taste, cognitive disorders. A group of American scientists led by J. Becker (Icahn School of Medicine, October 2021) (<https://index.minfin.com.ua/ua/reference/coronavirus/geography>) as a result of clinical observations, it was possible to find out that almost every fourth (24%) patient out of 740 study participants who had covid-19 and were treated with the Mount Sinai system in New York, experienced cognitive difficulties, including problems with memory, multitasking, speed of information processing and focusing attention. They found that long-term cognitive impairment can be observed even 7 months after the onset of the disease. This is mainly manifested in the preservation of new memories and the reproduction of memories. There were also those participants in the study who slowly processed information, planned events and expressed their opinions in public.

Study author Jacqueline Becker recommends screening for mental disorders after contracting COVID-19 as the standard in determining rehabilitation potential, regardless of the patient's age, as there have been cases in the U.S. where recovered patients have been unable to care for themselves even after being discharged from the clinic.

Similar manifestations of cognitive disorders in patients with post-Covid syndrome noted the director of the clinic of the University of California at Los Angeles, Dr. Helen Lavretsky: "They cannot function, they cannot think, their memory is impaired, they are confused. When they go somewhere, they say they don't know how they got there." (Scientists ..., 2021).

According to Professor of the School of Systems Biology at George Mason University in the United States A. Baranova, after suffering infection with SARS-CoV-2, the condition of patients resembles a post-stroke state. "This is offensive news, but it is not fatal, as humanity we know how to deal with it. We need to borrow the practices of recovering people after stroke and apply them more widely to those people who still cannot get out of the post-Covid state" (2021).

- According to experts in the field of post-Covid rehabilitation [3-8], the main complaints of patients who have undergone viral infection with SARS-CoV-2 include: psychosomatic hypoxia and impaired transport function of the blood oxygen, manifested in the form of shortness of breath, feelings of lack of air, the desire and inability to take a deep breath due to heaviness behind the sternum or discomfort in the chest, apnea, intoxication of the body (indicators of laboratory and paraclinical studies may differ slightly from the physiological norm);
- the emergence and development of varying degrees of severity of mental disorders: chronic fatigue, bad or depressive mood with frequent changes, apathy, tearfulness, impaired sleeping and sleep phases, irritability, aggressive behavior, anxiety and panic attacks, suicidal thoughts, psychological and social maladaptation of varying degrees;
- general weakness, sometimes accompanied by myotonic manifestations, up to the chronic course of neuromuscular diseases;
- the occurrence and development of pain and pain syndromes of various etiologies and localization: toothache and facial pain, severe headaches, myalgic muscle pain, joint pain; quite often in patients of this group, paresthesia is noted - a feeling of "needles", "goosebumps", burning and other unpleasant symptoms,
- inflammatory processes in the oral cavity;
- violation of thermoregulation, weakening of hearing and vision, loss of smell, distorted perception of smell / taste;
- gastrointestinal disorders, diarrhea, appetite disorders;
- increased excretory function of the skin, hair loss and deterioration of the skin (nails), rashes and exacerbation of skin reactions, including neuroendocrine;
- cognitive decline;
- exacerbation of chronic diseases.

All these processes are based on viral and autoimmune mechanisms of damage to various organs and systems (Pizova et al., 2021; Goertz et al., 2020), which are locally manifested in:

1. Violation of aerobic metabolism due to a decrease in lung function, including due to the pathology of the nervous system of the lungs, which develops with corona viral infection. The weakened lungs of the patient are not able to fully perform their function of saturating the blood with oxygen.
2. A decrease in the transport function of the blood and, as a result, hypoxia and intoxication of the body with an increased level of formation of free radicals and microthrombi.
3. Decreased excitability of nervous tissue. Disorders can occur in the central, autonomic nervous system, cardiovascular system and respiratory organs, neuromuscular system.
4. Disruption of the neuroendocrine system due to the neurotoxic effect of corona viral infection.
5. Formation of inadequate autoimmune reactions due to excessive immune response.

Numerous observations of patients with post-Covid syndrome show that over time, the listed symptoms decrease, and many patients note relief and recovery after a few weeks or months from the onset of the disease, but about 20% of patients are forced to undergo long-term post-Covid rehabilitation - for three months or more.

Post-Covid medical rehabilitation should be performed using a systemic (multi-level) polyfactorial approach aimed at:

1. Restoration of the function of the respiratory system, restoration of blood function and circulatory system.
2. Stimulation of the excretion and detoxification system of the body.
3. Restoration and stimulation of the nervous and neuromuscular systems.
4. Correction of the neuroendocrine system.
5. Rehabilitation of organs and functional systems of the affected during the course of the disease.

Subjects who started with early training using proprioceptive exercises in closed kinetic chain and immediate weight-bearing of the operated leg had better static and dynamic postural balance in the quantitative and qualitative way in their sixth postoperative month after isolated anterior cruciate ligament reconstruction. These patients were ready for a safe return to more vigorous activities, while the patients who started to execute these specific proprioceptive exercises a month later had more precautious and uncertain performance in more challenging tasks (Grueva-Pancheva & Stambolieva, 2021).

Participants of the AVG group showed significant differences in executive function and delayed recall. For executive function, the number of errors decreased and increased by the number of movements per second, while the number of movements per second increased in the delayed recall test. After 12 weeks, the participants of the aerobic group showed an increase in the following characteristics: the number of movements per second in the executive function test; execution speed increased in the visual attention and short-term memory test; the number of movements per second increased in a delayed recall test. It also observed an increase in the score of MMSE. There were no significant differences between the groups, except for short-term memory in pre-intervention. Results and the adherence to the program suggest that sports AVG may be used as exercise alternative for older adults because it produces effects on the cognitive performance similar to the aerobic exercise (Guimarães et al., 2018).

Data demonstrate that karate training can have negative effect on cognitive function in young individuals. However, more research is needed to confirm our observations and elucidate the underlying mechanism of the influence of karate training on the level of cognitive functions. In order to confirm the negative influence of karate training on the level of cognitive functions, it seems necessary to determine the level of cognitive functions before starting karate training and after several years of training (Dwojaczny et al., 2021).

## **Conclusion**

According to the results of the analysis of the results of testing patients based on the Montreal scale for assessing cognitive functions before the start of post-Covid rehabilitation based on the protocols developed by the authors, after 6 and 12 procedures, as well as 4 weeks after the completion of rehabilitation in the first group, the average indicators of the level of cognitive functions changed from 18.2 to 21.4 points, in the second group from 17 to 26 points.

Psychological testing using the psychometric tables of A. Beck and Spielberger-Hanin showed a decrease in the average level of depression after procedures in the first group by  $5.4 \pm 1.4$  (from 27.5 to 22.1) points, the anxiety level by  $4.9 \pm 0.3$  (from 35.1 to 30.2), in the second group by  $9.9 \pm 1.2$  (from 27.3 to 17.4) and  $8.2 \pm 0.4$  (from 35.2 to 27.0), respectively. Additionally, it should be noted that the clients of the second group were more interested in conducting a second course.

A multi-level approach in the medical rehabilitation of patients with post-Covid syndrome based on the use of psychological correction, magnetolaser effect on the projection of the liver, supravenuous irradiation of blood and combined transcranial neuroacoustic and light-pulse stimulation in combination with endonasal breathing of a singlet-oxygen mixture in a magnetic field turned out to be the most effective for restoring cognitive functions and correcting anxiety depression.

Treatment of post-Covid syndrome is the work of not only the doctor, but also the patience and daily work of the patient himself. A job that will certainly bear fruit if done correctly and conscientiously.

#### **Compliance with Ethical Standards**

**Conflict of Interest.** The authors declare that there is no conflict of interest that could be perceived as interfering with publication of the article.

**Competing Interests.** The authors declare that they have no competing interests.

**Ethical Approval.** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed Consent.** Informed consent was obtained from all individual participants included in the study. All subjects of the institutional survey gave consent for anonymized data to be used for publication purposes.

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