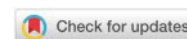


BENEFITS OF BALNEO AND MUD TREATMENT FOR LATE SEQUENCES OF COVID-19

Galina Mratskova^{1*}

¹Department of Medical Rehabilitation and Ergotherapy, Physical Medicine and Sports, Faculty of Medicine, Trakia University, Stara Zagora, Bulgaria, e-mail: doc_mratzkova@abv.bg



Abstract: Balneotherapy is one of the most used therapies, where natural factors are applied for treatment and prevention. It is used in various pathological conditions, with evidence of a good effect in rheumatic and neurological diseases, and in recent years also in patients recovering from COVID-19. The therapeutic factors that are used include: natural mineral or thermal waters, natural peloids (mud) and other environmental therapeutic factors. The pandemic of COVID-19 turned out to be a significant factor that led to changes in lifestyle and habits and, accordingly, the use of balneotherapy procedures for prevention and treatment. Balneotherapy (SPA-therapy) is recommended by the European SPA association after COVID-19, for better recovery of health and limitation of long-term symptoms in patients with post-COVID-19 syndrome (PCS). It is suggested that balneo-climate-treatment can improve lung function, increase the physical activity capacity and the performance of therapeutic exercises as well as the quality of life of patients in the recovery phase after COVID-19. The purpose of the present review is to investigate the benefits and effectiveness of both balneo and mud therapy in patients with long-term post-COVID-19 sequelae. Materials and methods: For the purpose of the present study, a review was made of the known scientific articles published in the world databases (Google Scholar, Pubmed, Science Direct Web of Science, Scopus, and literary sources in Cyrillic). The results were searched for the following keywords: post-COVID-19 condition, long-term effects of COVID-19, post-COVID-19 syndrome (PCS), rehabilitation, balneotherapy, SPA therapy, peloidotherapy, mud treatment, lye therapy, treatment with Rapa (highly concentrated solution of salts (most often NaCl)). Results: The review of the scientific literature published in specific medical journals found evidence for the therapeutic effectiveness and benefits of balneo and mud therapy in patients with long-term consequences of COVID-19. The described application methods are characterized by variety in the application methodology, both for external (baths, bathtubs, showers, therapeutic SPA applications) and for internal application (mainly through inhalations). On the other hand, different recommendations were found regarding the type and chemical characteristics of mineral (thermal) water and therapeutic mud that are preferred for therapy. Overwhelmingly, studies recommend combining balneo (SPA) and mud therapy with resort and climate treatment, moderate physical activity and a dietary regimen tailored to the individual characteristics of patients. Conclusion: Balneo (SPA) treatment, therapies with natural and preformed physical factors could have a preventive role, in order to improve the body's reactivity to the adverse factors of the external environment and pathogenic microorganisms and to increase insusceptibility to infectious diseases.

Keywords: Long-term effects of COVID-19, Post-COVID-19 syndrome (PCS), rehabilitation, balneotherapy, SPA therapy, peloidotherapy, mud treatment.

Field: Medical sciences and Health

1. INTRODUCTION

Balneotherapy is one of the most used therapies, where natural factors are applied for treatment and prevention in many European countries. It is used in a variety of illnesses, with evidence of good effect in rheumatic diseases including: osteoarthritis, fibromyalgia, rheumatoid arthritis, low back pain (Maccarone, M.C. et al. (2021); Marinkev, M. & Angelov, I. (2008); Vladeva, E. et al. (2014)), and in recent years in patients recovering from COVID-19. (Gvozdjaková A. et al. (2022); Kokhan, S. et al. (2022); Petrova, M. et al. (2023) Petrova, M. S. (2022)). The therapeutic factors that are used include: natural mineral or thermal waters, natural peloids (mud) and other environmental therapeutic factors (Maccarone, M.C. et al. (2021); Koleva, I. & Yoshinov B. (2022)).

The pandemic of COVID-19 turned out to be a significant factor that led to changes in lifestyle and habits and, accordingly, the use of balneotherapy procedures for prevention and treatment. The introduction of numerous restrictions in the public sphere and the freedom of movement have substantially limited the possibility of applying mineral water and natural mud treatments in resort settings (Maccarone M.C. et al. (2021)). At the same time, there have been a number of scientific reports that have reported that patients who have refused prophylactic SPA treatments have experienced increased pain complaints, a reduced ability to perform activities of daily living, and increased psycho-emotional distress, which on

*Corresponding author: dmanahilova@abv.bg



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the other hand has been associated with a decreased quality of life. In patients with chronic diseases who did not undergo balneotherapy, increased number of consultations with medical specialists (26.5%) and use of medication treatment (30.1%) was observed (Katsarova, S. (2022)).

Currently, the European SPA Association (European SPA Association) is emphasizing the importance of spa treatment for the prevention and prophylaxis of health and maintenance of an adequate status of the immune system (Katsarova (2022)). Balneotherapy (SPA-therapy) is recommended by the European SPA association after COVID-19, for better recovery of health and limitation of long-term symptoms in patients with post-COVID-19 syndrome (PCS) (Gvozdjaková et al. (2023)). This therapeutic approach could be effective in patients whose main symptoms include: general fatigue, decreased physical activity, muscle and joint pain, shortness of breath, cough, anosmia and anosmia, sleep problems and cognitive and memory disorders, depression, impaired quality of life. Very commonly, researchers report prolonged reduced daily activity in about 35% of patients, limited mobility in about 33%, and very commonly chronic pain in more than a third of patients (Walle-Hansen et al. (2021)). Other investigators report that limitations in daily activity persist in about 50% of patients, even 6 months after hospitalization for COVID-19 (Taboada et al. (2021)). It is suggested that balneo-climate-treatment can improve lung function, increase the physical activity capacity and the performance of therapeutic exercises as well as the quality of life of patients in the recovery phase after COVID-19. (Angelova, T. (2022 (a,b))). Rehabilitation begins in the acute phase, and the rehabilitation programs are prescribed by a specialist in Physical and Rehabilitation Medicine in collaboration with specialists from other medical fields who are involved in the design and implementation of each patient's individual treatment plan (Gerasimova et al. (2021); Milushev, (2021) Takeva, et al. (2021)). The rehabilitation programs are fully tailored to the patients' local and general status. They are dynamic over time, and they follow any change in the patient's condition (Mratskova (2021)). After the acute phase is dealt with, patients are referred to inpatient or transitional rehabilitation units (Milanova & Georgiev (2021)).

Conducting rehabilitation in spa resorts is part of the overall process of recovery and long-term medical care (Petrova M. et al. (2023)). Integrative approach to the application of natural physical factors, therapeutic exercises and physical electro-modalities is essential for the recovery of pre-morbid activity and for the prevention of pre-existing comorbidity (Mollova, K. et al. (2021); Grishechkina, et al. (2023); Krumova & Uzunova (2022)), whilst also potentially having a beneficial impact in reducing the health and economic consequences of COVID-19 (Kashiliska & Petkov (2021)).

The purpose of the present review is to investigate the benefits and effectiveness of both balneo and mud therapy in patients with long-term post-COVID-19 sequelae.

2. MATERIALS AND METHODS

For the purpose of the present study, a review was made of the known scientific articles published in the world databases (Google Scholar, Pubmed, Science Direct Web of Science, Scopus, and literary sources in Cyrillic). The results were searched for the following keywords: post-COVID-19 condition, long-term effects of COVID-19, post-COVID-19 syndrome (PCS), rehabilitation, balneotherapy, SPA therapy, peloidotherapy, mud treatment, lye therapy, treatment with Rapa (highly concentrated solution of salts (most often NaCl)).

3. RESULTS

The review of the scientific literature published in specific medical journals found evidence for the therapeutic effectiveness and benefits of balneo and mud therapy in patients with long-term consequences of COVID-19. The described application methods are characterized by variety in the application methodology, both for external (baths, bathtubs, showers, therapeutic SPA applications) and for internal application (mainly through inhalations). On the other hand, different recommendations were found regarding the type and chemical characteristics of mineral (thermal) water and therapeutic mud that are preferred for therapy. Overwhelmingly, studies recommend combining balneo (SPA) and mud therapy with resort and climate treatment, moderate physical activity and a dietary regimen tailored to the individual characteristics of patients.

4. DISCUSSIONS

Recovery from SARS-COV-2 disease is a process that requires prolonged medical monitoring and post-COVID care especially in patients with prolonged symptoms after COVID-19. A number of studies have described different symptoms and/or symptom clusters that are a consequence of acute infection or that occur immediately after infection. Persistent symptoms can be registered in all organs and systems, but impairment of the respiratory, musculoskeletal, cardiovascular, nervous, digestive, and other systems is most commonly described. Very often, these clinical manifestations are accompanied by increased fatigue, reduced physical capacity, limited daily activity, cognitive and psychosocial impairment, and result in decreased quality of life (Jimeno-Almazán et al. (2021)). Due to the unfavorable health and economic consequences, recently not only medication therapy has been paid attention to, but also models for comprehensive recreation through the incorporation of natural and preformed physical factors and combined rehabilitation programs in the recovery process after SARS-CoV-2 illness are gradually starting to be developed and improved (Szromek, A.R. (2021)), while complying with all safety requirements of the therapy (Antonelli & Donelli (2020); Masiero, et al. (2020)).

Balneotherapy is applied in the form of natural or artificial mineral and gas waters for external (bathtubs, baths, bathing, etc.) or internal application (drinking or inhalation) (Vladimirova, (2022)); Angelova, (2022)). In balneological resorts, rehabilitation interventions are usually performed on patients with musculoskeletal and neurological disabilities either on their own or in combination with other traditional balneotherapeutic procedures (Edreva, (2009); Masiero, et al. (2018); Bernetti, et al. (2020)), including patients with persistent respiratory symptoms after COVID-19. (Maccarone & Masiero (2021); Angelova, (2022(a)); Katsarova, (2022)).

In the medical rehabilitation of patients after suffering COVID-19, in resort settings, the application of hydro- and balneotherapy is recommended. (Petrova, et al. (2023)) Water procedures (rinsing, scrubbing, bathing in a swimming pool) have an active influence on the mechanisms of thermos-adaptation and are the basis of the hardening regime. Due to its mild and gentle action, the wet rub procedure is recommended in the beginning of a SPA course (Lobzin et al. (2020)). The treatment of choice is the conduct of sodium chloride baths, which have a regulatory effect on the functional state of the central nervous system, endocrine and cardiovascular systems, stimulating non-specific immunological reactivity. Carbon baths (with carbonated mineral waters and waters enriched with carbon dioxide and dry carbonated baths), which have a beneficial effect on the work of the respiratory and cardiovascular systems, contribute to reducing hypoxemia and increase tolerance to hypercapnia. A gentler method of SPA treatment is dry carbonic baths (Nikityuk, et al. (2020)). They increase the synthesis of biologically active substances, activate oxidative-repair processes, have pronounced anti-inflammatory effects, lead to favorable changes in immunological parameters, improve gas exchange, resulting in a decrease in compensatory hyperventilation. Natural carbonated mineral water deposits in Bulgaria are located in Mihalkovo. Another variety of gas baths are oxygen baths, which improve gas exchange, eliminate oxygen deficiency and improve the functional state of the central nervous system (Khan & Razumov (2018); Abuseva, et al. (2020)).

Mineral water inhalations, aerosol and nasal douches specifically target the respiratory tract and are recommended in the treatment of respiratory diseases (Corradi, et. al. (2012)). There is evidence that inhalations of sulphur-rich mineral waters administered to COPD patients result in an increase in muco-ciliary clearance, reduce the synthesis of pro-inflammatory cytokines and decrease the levels of elastase produced by neutrophils. Combination with sauna therapy, on the other hand, leads to a reduced risk of developing pneumonia. At the same time, inhalation with salt-iodine-bromine thermal water has a mild anti-inflammatory effect on the respiratory tract in COPD (Khaltaev, et al. (2020)). Inhaled salt-iodine mineral water therapy has a vasodilating effect on the bronchial mucosa, increases secretory IgA production and improves muco-ciliary clearance (Khaltaev, et al. (2020)). Another study, Passalie t al. (2013) found that a 14-day inhalation course of radioactive (radon) waters resulted in improved muco-ciliary clearance and a reduction in the inflammatory response (Passali, et al. (2013)).

Another method of application of mineral waters is the partial or total immersion of the body in water (bathtubs, baths and bathing pools). Although it is difficult to accurately determine the effect of these treatments, due to the fact that they are often combined with reshaped physical factors (electromagnetic fields, light, ultrasound, etc.) and/or underwater gymnastics, it has been found that procedures with immersion lead to significant improvements in terms of dyspnea and spirometric findings after therapy and at least 6 months afterwards (Passali, et al. (2017)). In COPD patients, exercises in mineral water have been shown to be more suitable compared to land-based exercises (Khaltaev, et al. (2020)). In smokers, mineral baths improve biochemical parameters in exhaled air condensate (Carubbi, et al. (2019)).

The balneotherapy for post-COVID-19 patients with persistent pulmonary symptoms is performed in a resort setting by a multidisciplinary team and combines specific balneotherapy procedures, including mineral water inhalation, with respiratory gymnastics, kinesitherapy and pre-formed physical factors. The therapeutic complex is directed towards conducting rehabilitation aiming to improve the function of the respiratory system (Antonelli, & Donelli (2020); Masiero et al. (2020)). From the studies conducted, mineral water inhalation was found to be effective in improving the elastic properties of the pulmonary interstitium, reducing inflammation, and stimulating muco-ciliary function. One of the current hypotheses explaining the mechanism of action of inhalation therapy is that inhalation may act on glutathione (GSH), reducing oxidative stress associated with inflammation in lung damage and reactive oxygen radical (ROS) production (Corradi, et al. (2012)). On the other hand, the thermal factor that acts in aquatic immersion treatments improves the function of the respiratory system and probably modulates both innate and acquired immune defenses (Cohen, (2020); Maccarone, et al. (2020); Angelova, (2022)). Furthermore, SPA treatments improve psycho-emotional tone, lead to relaxation, reduce stress levels and increase quality of life (QoL) (Antonelli & Donelli (2020); Masiero, et al. (2020)). Balneotherapy could also positively affect comorbidities, such as obesity, COPD, fatigue, neurological and musculoskeletal conditions, among others (Masiero, (2008); Masiero, et al. (2018); Masiero, et al. (2020); Maccarone, et al. (2021)).

Peloid therapy in the recovery phase after COVID-19. Peloid therapy is a commonly used physiotherapy procedure that is based on treatment with natural factors. In the recovery period of patients after COVID-19 complicated with pneumonia, mud therapy is applied in order to maximize the resorption of the forming fibrotic changes and adhesions. Mud has bio stimulatory, regenerative and trophic effects. Suitable muds are sulphatic peloses, which are applied in complex resort treatment (Valiullina & Pogonchenkova (2020)).

According to Grozeva, A. (2019), the studies conducted so far show that Bulgaria has mud healing resources of diverse composition and origin (Grozeva, A. (2019)). The main mud deposits are concentrated in coastal lakes (limans). For prophylactic and therapeutic purposes, the mud from Lake Shabla (highly sulphidic); Taukliman in the resort Rusalka (the lake is fresh-water lake, the mud belongs to the class of carbonate sapropels, medium sulphidic); Balchikiska Tuzla (highly mineralized, medium sulphidic mud); Pomorie Lake (in the black layer the mud is medium sulphidic, in the grey layer it is slightly sulphidic); Lake Atanasovskoe (medium sulphidic). The advantage of Bulgarian mud therapy is the possibility to combine peloid therapy with sea climatic factors, thalassotherapy, heliotherapy, warm sea water, psamotherapy (therapy with warm sea sand). This combination facilitates prophylaxis and rehabilitation in patients after COVID-19 and in the presence of PCS. Lime mud is mostly inorganic and is formed in saline coastal lakes. It is black in color, contains hydrogen sulphidic and iron iron hydrosulfide, with an alkaline reaction, creamy consistency, flexible, fine texture, and minor contamination (Grozeva, (2022); Monova, et al. (2022)).

Although mud therapy is a method that has been used since antiquity, it also finds application in modern balneology. The mechanism of the action is still not fully understood. It is mostly based on the complex action of the chemical, physical and biological factors of mud. Another mechanism of action is through radiant energy, due to the radioactive content of the peloids. Mud possesses bacteriostatic and bactericidal action and also good absorption properties (Grozeva, (2022)). The most commonly applied mud treatments include the "Egyptian method" in the open air (Ismailova, et al. (2018)), applicative methodology (complete or partial mud treatments) after the procedure the patient takes a shower with sea or rap water, intracavitary treatments (intracavitary methodology), mud bath (mud is diluted with mineral, sea or lake water-rap); mud iontophoresis. In Pomorie, mud baths 10-20% suspension (mixture of mud with rapa) are applied at a temperature of 36-38°C, a course of 12-14 baths (Grozevaq (2022)). Among the studies conducted there are reports describing the effectiveness of peloid therapy in diseases of the musculoskeletal system, especially the mud from Pomorie Lake, Balchishka Tuzla, Varna Lake (Grozeva, (2022)). Good therapeutic effects have also been reported by a number of other authors in their studies (Fioravanti, et al. (2015(a)); Pascarelli, et al. (2016); Fioravanti, et al. (2015(b)); Koçak, et al. (2020)). The immunostimulatory effect of mud treatments has also been demonstrated (Masiero, (2020); Maccarone et al. (2020); Maccarone et al. (2021)) Other studies, of patients who underwent balneotherapy and mud treatment, have shown an improvement in quality of life, a reduction in hospital admissions and medication intake over a one-year period (Pascarelli, et al. (2016); Fioravanti, et al. 2015(b)); Koçak, et al. (2020)).

The exact mechanism of action of balneo- and mud therapy is not yet fully understood, but at present the positive effects of this therapy on humoral and cellular immunity have been demonstrated, which is essential both for patients with post-COVID syndrome and for prevention. The rich mineral composition of the mineral water and the mud contribute to the improvement of muscle function and to the reduction of muscle pain in post-COVID-19 patients. Limanic mud is a powerful natural physical factor, which, due

to its anti-inflammatory, analgesic, immunoregulatory and blood circulation improving effects, has been successfully applied in the rehabilitation of a number of diseases, including those following a coronavirus infection (Grozeva (2022)).

Therapy with rapa and lye in prolonged symptoms after COVID-19. In rehabilitation programs in balneotherapy, very often mud therapy is applied in parallel with rapa and lye. The rapa is the water above the mud layer in the liman lakes. Its chemical composition is identical to that of the liquid phase of mud and seawater but differs from them in the concentration of salts dissolved in it (highly concentrated solution of salts (most often NaCl). Lye is the by-product of salt extraction in the Burgas and Pomorie salt pans (Koleva & Yoshinov (2022); Grozeva, (2022)). Lye contains all the elements of sea and lake water, in different salt concentration and ionic state, biologically active substances formed during the decomposition of plankton in the lake and from the healing mud because of diffusion processes in the rapa. The most applied methodologies are lye electrophoresis, lye compresses, lye baths, magnetic field through lye, lye massage and lye inhalation (Grozeva, (2022)). After the application of lye therapy, a reduction of pain (VAS) and paresthesia in peripheral nerve damage is found (Grozeva & Angelova-Popova (2017)). Lye applications can be an effective means of reducing musculoskeletal and peripheral nerve symptoms after experiencing COVID-19. Their application in combination with interferential currents and magnetic field can reduce clinical symptomatology (Mratskova & Elkova (2022)).

At this time, there is accumulated clinical experience and scientific evidence of the therapeutic effectiveness of mud and lye therapy, sea treatment and rap therapy in patients with PCS, including those with muscle pain, weakness and fatigue (Grozeva, (2022)). In patients with PCS and concomitant symptoms on the respiratory system, inhalation with 2% lye solution, or stay in a salt room, as well as infrared sauna is indicated. In patients with neuromuscular symptoms after coronavirus infection, it is also necessary to conduct electrical stimulation of hypotonic and hypo trophic muscle groups and magnetic therapy in the presence of joint stiffness. In addition, balneotherapy in the course of complex rehabilitation includes individually dosed kinesitherapy depending on the general condition of the patient.

5. CONCLUSIONS

Balneo (SPA) treatment, therapies with natural and preformed physical factors could have a preventive role, in order to improve the body's reactivity to the adverse factors of the external environment and pathogenic microorganisms and to increase insusceptibility to infectious diseases. It is likely that all of these potential health benefits could play a favorable role in limiting the spread, scope, and consequences of pandemically spread diseases, including COVID-19.

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