*REVIEW ARTICLE*

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# The use of mineral waters in rehabilitating patients with coronavirus disease – a review

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## Abstract

**Introduction and Objective.** The review aimed to consider evidence of the effectiveness of using mineral waters in the rehabilitation of patients who have had a coronavirus disease.

**Review Methods.** The study was registered on PROSPERO (CRD42023438740). Relevant studies were systematically reviewed, based on randomized controlled trials with meta-analysis that included at least one group receiving mineral waters (MW). General scientific papers and regulatory documents on health care in Ukraine, including rehabilitation and resort resources, and rehabilitation protocols after the coronavirus disease, were also used for the analysis. Search for articles and other scientific works published in English and Ukrainian from 1994 to 5 February 2023, was conducted in the following databases: Pubmed, Web of Science, and Scopus. Dual data abstraction, quality assessment, and strength of evidence was also performeds. The results were evaluated of using various mineral waters in the rehabilitation of patients with complications of COVID-19 disease.

**Brief description of the state of knowledge.** Most of the studies (28%) are devoted to the use of mineral waters for complications of the respiratory system. 12% of papers were devoted to the pathology of the musculoskeletal system, 10% to chronic fatigue (asthenia), anxiety-depressive, and other neuropsychiatric disorders, 9% to epy cardiovascular system, and 8% to dermatological problems.

**Summary.** Differentiated use of balneotherapy, considering the composition of MW, temperature, and the frequency of their application, allows for increasing the effectiveness of rehabilitation of post-Covid-19 complications of various organs and systems of the body.

## Key words

rehabilitation, mineral water, coronavirus disease, post-COVID-19 complications

## INTRODUCTION

The scale of the COVID-19 pandemic and the damage it caused to humanity are unparalleled in society, and its consequences could be equally profound, increasing the financial burden on healthcare in many countries. Currently, the focus is on treating the acute course of the COVID-19 disease; however, it is already necessary to pay attention to the short- and long-term consequences of this disease and the means of their prevention, treatment and rehabilitation.

The consequences of a Coronavirus infection are divided into two main groups – caused directly by the SARS-CoV-2 virus and exacerbation (manifestation) of concomitant diseases. As a result, complications from various body systems are observed [1, 2]. Convalescents develop and manifest a series of pronounced syndromes/diseases, the leading ones being: respiratory disorders with the development of chronic obstructive pulmonary disease [3], chronic fatigue syndrome, mental disorders [4, 5], musculoskeletal and skin disorders [6, 7], cardiovascular disorders, neurological disorders [8, 9, 10, 11], gastrointestinal pathology and metabolic disorders, as well as immunosuppressive syndrome [12, 13].

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In addition to the World Health Organization (WHO) guidelines for self-care after Coronavirus disease, general [14] and national rehabilitation protocols for patients who suffered from the disease [15] have already been developed. However, it is clear that further accumulation of new knowledge about the consequences of Coronavirus disease is ongoing and requires a dynamic expansion of evidence-based research on rehabilitation competencies. This is why it was considered appropriate to study the hypothetical and theoretical aspects of the use of natural healing resources (NHR) in the rehabilitation of certain conditions following COVID-19.

Natural healing resources include mineral and thermal waters, therapeutic mud (peloids), brine of estuaries and lakes, ozokerite, sea water, and climatic conditions [16]. NHR have a sanogenetic and preventive effect, and can simultaneously affect several pathogenetic links in the formation and progression of the pathological process, increasing the rehabilitation potential, eliminating the risk of side-effects, allergic development, and polypharmacy that may develop in the case of further long-term drug therapy at the outpatient stage of treatment.

Mineral waters are the most important and numerous components of NHR. The multi-component, diverse, naturally balanced composition of MW allows them to be widely used to treat and prevent many pathological conditions

[17, 18]. Therefore, from the point of view of treating the consequences and complications of the Coronavirus disease, it is worth considering the various effects of MW on the state of organs and body systems, which should be preferred in rehabilitation activities, compared to long-term and expensive drug therapy.

The presented review aims to consider evidence of the effectiveness of using mineral waters in rehabilitating patients who have had the Coronavirus disease.

## MATERIALS AND METHOD

The study was registered on PROSPERO (CRD42023438740). There was no requirement for an ethical examination. Inclusion criteria were all primary studies, including randomized controlled trials (RCTs), non-RCTs, qualitative studies, and mixed-methods studies, descriptions of COVID-19 disease complications and/or investigated mineral water treatment. Relevant studies were systematic reviews based on randomized controlled trials with meta-analysis that included at least one group receiving MW. General scientific papers and regulatory documents on health care in Ukraine, including rehabilitation and resort resources, and rehabilitation protocols after the Coronavirus disease, were also used for the analysis. Exclusion criteria: conference abstracts, commentaries, correspondence, case reports, expert opinions, and editorials.

The search for articles and other scientific works published in English and Ukrainian between 1994 and 5 February 2023, was conducted in the following databases: Pubmed, Web of Science, and Scopus. The screening was carried out in two stages. The first reviewer carried out an initial selection based on the titles and abstracts of identified studies that met the eligibility criteria. The second reviewer reviewed the results of the initial screening. Disagreements at this stage were resolved by discussion between the two reviewers and obtaining the full texts of such studies. The first reviewer then read the full text of the selected studies for further selection using the acceptance criteria, and rechecked by the second reviewer. Disagreements at this stage were resolved through discussions between the research team and the project leader. Finally, 86 publications were selected for further analysis.

## RESULTS

Mineral water treatment is one of the main therapeutic measures of spa therapy [19]. The mechanism of the therapeutic effect of MW is a complex multi-level process consisting of a combination of local and general mechanisms subject to certain regularities. The therapeutic effects of MW are due to local and general regulatory effects on physiological and pathological processes in the human body, determined by general mineralization, ionic composition, organic matter content, gas composition, and temperature [20]. The effectiveness of the therapeutic effect of MW is determined, first of all, by the correct choice of the type of water and the characteristics of the course of each specific disease. According to the application principle, MWs are divided into external (baths, showers) and internal (drinking MW) applications. This review considers the possibilities for the external use of MW. The main methods of external use of MW in rehabilitating post-COVID-19 disease patients are inhalations and baths.

**Inhalation.** It is now recognized that COVID-19 is a multi-system disease; however, in the acute period, the most common lesions are those of the bronchopulmonary system, with the development of pneumonia and the risk of respiratory distress syndrome, and spontaneous pneumomediastinum [21]. Furthermore, it has been established that this type of pneumonia has morphofunctional features in the form of destruction of alveolar-capillary membranes, with significant impairment of gas transport function of the respiratory system and increasing haemic hypoxia, resulting in persistent disorders of respiratory function of the lungs and the threat of pulmonary fibrosis with respiratory failure, which is why a respiratory rehabilitation programme is essential.

Inhalation of MW, penetrating into the cavity of the upper respiratory tract and lungs in the form of a finely dispersed hydro-aerosol, directly affects the mucous membrane of the respiratory system. As a result of the dispersion of MW, its contact with mucous membranes increases, absorption of chemical components accelerates, and the condition of the external respiration improves. In the zone of aerosol deposition in the trachea and bronchi, the motor activity of ciliated epithelium also increases, while the viscosity of bronchial secretions decreases, thereby increasing mucociliary clearance and the respiratory tract cleansing in patients with chronic obstructive pulmonary disease, in particular, caused by coronavirus infection [22].

It is worth noting that inhaling vapors of thermal MW (hot springs) during bathing and swimming should also be regarded as MW inhalation.

The particularities of the effect of different types of MW are related to the presence of ions of various elements and gas composition, which determines their differentiated use. The particular features of the effect of different types of MW are related to the availability of ions of various elements and gas composition, which determines their differentiated use.

One of the most common manifestations of respiratory tract diseases is allergic reactions, namely: runny nose, itching, cough, shortness of breath, and swelling of the mucous membranes [22]. Respiratory tract infections, particularly those caused by the COVID-19 disease, are further complicated by immune sensitization involving the lung immune response. Thermal water inhalation can modulate the systemic immune response in patients with respiratory diseases [23].

There is evidence of a link between the above-mentioned allergic reactions and manifestations, increased IgE levels and decreased levels of allergen-specific secretory IgA in the mucose membranes of the respiratory tract in asthma. After thermal MW inhalation, there is an increase in the level of protective IgA [22]. Pagani D, et al. report a decrease of mucosal eosinophilia in rhinitis and chronic rhinosinusitis after a series of inhalations with sodium carbonate chloride-sulfate MW [24]. The results of studies of a mouse model of non-atopic asthma prove that, in addition to appropriate climatic conditions, sea air improves overall lung ventilation, and sodium iodide chloride MW inhalation reduces airway hyperreactivity [25].

The studies prove the anti-inflammatory effect of MW inhalation, particularly sulfide MW [26, 27, 28]. Hydrogen sulfide ($H_2S$) is a recognized gaseous mediator involved in

a wide range of cellular functions and physiological and pathological processes in various diseases, including those of respiratory origin. $H_2S$ is a critical therapeutic in obstructive airway diseases, pulmonary fibrosis, emphysema, pneumonia, bronchial asthma, and bronchiectasis [27]. $H_2S$-related enzymes (cystathionine-β-synthase and cystathionine-γ-lyase) are expressed in the human lungs having mucolytic, antioxidant, anti-inflammatory and antibacterial effects, increasing mucus fluidity by breaking S-S bonds in surface proteins and glycoproteins [26], thus maintaining airway epithelial homeostasis. In addition to the antioxidant and anti-inflammatory effects of $H_2S$, the authors [28] also note that it has anti-viral activity. The inhalation effect of $H_2S$ natural sources on respiratory epithelial cells may prevent the penetration of SARS-CoV-2 into respiratory epithelial cells and, therefore, potentially prevent the spread of the virus to the lower respiratory tract and lungs [28].

Also, in addition to mucolytic and anti-oxidant activity, the anti-elastase activity of sulfide MW has been proven, which may help control inflammatory processes in upper and lower respiratory tract diseases. The anti-inflammatory effect of inhalation with sodium sulfate and chloride MW in children with chronic rhinosinusitis has been determined [29]. The results of studies showed that MW inhalation positively affects markers of mucosal inflammation, modulating the expression of pro-inflammatory cytokines and immunoregulatory peptides of nasal secretion in children with chronic rhinosinusitis. The anti-inflammatory effect is confirmed by studies that have demonstrated a decrease in the level of nasal mucus neutrophils in patients after sodium sulfide MW inhalation in recurrent respiratory infections.

The use of iodine-bromine brines – highly mineralized MW [30] – for inhalation in the treatment of respiratory diseases has been proven to be effective, with systemic effects in the form of decreased IgE and increased IgA in the blood serum having been noted. Studies [19, 22, 26] have confirmed the systemic effects of inhalation treatment when modulation of the systemic immune response by balancing the ratio of pro- and anti-inflammatory cytokines in young and elderly patients with upper respiratory tract infections, and a sharp decrease in their frequency being traced.

The effect of inhalation of MW of different chemical compositions on human lung fibroblasts has been studied [31], and in which a significant increase in cell proliferation was observed, along with an increased anti-oxidant capacity (reactive oxygen and nitrogen species, glutathione levels, and superoxide dismutase activity) in fibroblasts after exposure to MW, compared to control fibroblasts. Moreover, cytokine profiling revealed an increase in the release of MIF, IL-6, CL-1, CCL-5, and ICAM-1, which are described as mediators of proliferation, wound healing, and cell migration, proving the effectiveness of MW in protecting against oxidative damage.

Various authors have also noted the anti-bacterial effect of MW inhalation [22], where the MW was of varying degrees of mineralization – from low (sulfide, sulfuric-arsenic) to highly mineralized (sodium chloride, iodine-bromine brines). There are different hypotheses about the mechanisms of the anti-bacterial action of MW inhalation. The local toxicity of MW is probably triggered, which leads to the neutralization of bacteria in the case of sulfide MW.

According to someauthors, a temporary increase in IL-1β, IL-8, and TNFα leads to bacterial eradication. In addition, restoring the disturbed redox balance and activating neutrophils as one of the most critical defense systems, can help reduce the number of bacteria present [22, 26].

A course of inhalations using highly mineralized sodium chloride MW (brine, leach) provides the powerful effect of correcting the impaired protective mechanisms of the mucous membranes of pulmonary patients. The mucolytic properties of highly mineralized sodium chloride MW are supplied by high osmolarity, a complex of minerals, and the breakdown of ionic bonds of the mucus gel, regulation of its secretion by inducing vascular changes in the mucous membrane [26, 32].

Italian scientists claim that the effectiveness of sulfate MWs in treating chronic inflammation and/or irritation of the upper and lower respiratory tract [33], particularly hydrocarbonate-sulfate sodium MW, which are effective in the upper respiratory tract catarrhal conditions. The same authors systematically searched databases for the effects of radon MW for inhalation in treating inflammatory diseases of the upper and lower respiratory tracts. They concluded that radon-enriched inhalation therapy improves objective indicators of nasal respiratory function in allergic rhinitis and chronic rhinosinusitis, and eliminates pulmonary obstruction in bronchial asthma [34].

**Baths.** One of the methods of spa therapy for patients of various nosological groups is baths of different chemical compositions and mineralization, both gas and gas-free. The mechanism of the impact of baths on the body includes thermal, mechanical, chemical and psychotherapeutic effects. Their synergistic combination causes complex local and general neuro-reflex, neuro-endocrine and immunological reactions in the body [16]. Baths also have a beneficial effect on the higher regulatory mechanisms, causing normalization of the functional state of organs and systems, anti-inflammatory and sedative effects, improving trophic processes in organs and tissues, restoring microcirculation, regulating metabolic processes, and having an anti-oxidant effect [20, 35].

The therapeutic effects of baths depend on the chemical and gas composition, temperature, and mineralization, which justifies a differentiated approach when prescribing therapy for various diseases and conditions [36]. For instance, warm water, particularly MW, increases blood flow and promotes muscle relaxation. The hydrostatic effect of water can relieve pain by reducing peripheral oedema and weakening the activity of the sympathetic nervous system [37]. Moreover, immersion in warm water will specifically affect the cardiovascular system, while cold water will affect the neuromuscular system. These effects of water of different thermality should be considered in cases of various disorders in patients who have suffered Coronavirus disease.

Let us consider the effect of balneotherapy on **respiratory pathology.** Thus, carbon dioxide baths increase pulmonary blood flow, microcirculation, and lung ventilation. An increase in the level of carbon dioxide in blood has an anti-spasmodic effect, reduces hyperventilation, and increases oxyhaemoglobin dissociation and oxygen release [16]. Positive changes in pulmonary function and arterial blood gases were demonstrated before and after a two-month exercise programme in a thermal pool with MW in patients with stable chronic obstructive pulmonary disease. Thus, exercises in a pool with hot spring water can be helpful in treating chronic obstructive pulmonary disease [33] and, therefore, in treating post-COVID-19 disease respiratory disorders. This

data is confirmed by the results [38] of 16 studies on the effect of exercise in water on the respiratory system in people with respiratory diseases. It was concluded that high-intensity exercise training once a week for six months was sufficient to avoid deterioration in respiratory function, compared to baseline and to achieve significant functional improvement in respiratory muscle function.

Some scientists have already proposed using baths with highly mineralized sodium chloride MW to rehabilitate patients after Coronavirus disease with medium-term respiratory consequences, anticipating apparent positive effects on the functional state of the respiratory system [32].

The development or progression of musculoskeletal system pathology can result from Coronavirus disease, with patients often suffering from migratory pain and fibromyalgia, joint syndrome.

Balneotherapy is effective in muscle pain and tension [39]. Moreover, as has been shown [40], the effectiveness of intermittent (twice a week for five weeks) and consistent balneological outpatient treatment (five times a week for two weeks) for fibromyalgia syndrome is almost the same. Another 12-month open randomized clinical trial involving 220 patients with fibromyalgia compared immediate and delayed (six months later) 18-day spa therapy. The results showed a clinically significant improvement after six months in those who received primary treatment, the effect of which lasted up to 12 months [39].

Japanese scientists [39] reviewed systematic data with meta-analysis based on randomized controlled trials of balneo- and spa therapy in patients with chronic pathology of the musculoskeletal system and connective tissue. Conclusions were drawn concerning pain relief, restoration of functions and improvement of life quality after the courses of balneotherapy. Experimental studies from Japan report accelerated skeletal muscle regeneration in rats with a model of their injuries by increasing the myogenin level when bathing in water with carbon dioxide ($CO_2$). The authors [41] analyzed the properties of MW, including thermal MW containing hydrogen sulfide, in various cell cultures (primarily synoviocytes, chondrocytes, and peripheral blood cells). The results confirmed the anti-inflammatory, anti-oxidant, chondroprotective and immunomodulatory role of balneotherapy at the cellular level. This result coincides with the data of the authors [42] who searched PubMed and Google Scholar databases (1997–2020). Only *in vitro* studies, randomized controlled trials (RCTs) or clinical trials were selected.

It has been demonstrated that thermal waters containing $H_2S$ have anti-inflammatory and immunomodulatory effects. It has also been suggested that it is the $H_2S$ molecule that counteracts the inflammatory processes in arthritic fibroblast-like synoviocytes and chondrocytes by reducing circulating levels of pro-inflammatory molecules, such as TNF-α, IL-1β and C-reactive protein, and increasing anti-inflammatory molecules, such as IGF-1 in musculoskeletal diseases.

Among the consequences of Coronavirus disease, chronic fatigue (asthenia), anxiety-depressive, and other neuropsychiatric disorders are found in almost half of the cases.

It has been shown that, compared to muscle relaxation, balneotherapy is more beneficial in terms of the subjective effect of relaxation and is advisable for reducing the salivary cortisol level [43]. These results confirm the positive impact of balneotherapy on cortisol levels in healthy people, increasing stress resistance. Thus, balneo- and spa therapy can be helpful interventions for controlling stressful conditions.

In a randomized controlled clinical trial, the effects were investigated of balneotherapy with highly mineralized thermal MW (108 g/l) on distress and health risk [44]. The impact of distress was measured using a scale of general symptoms. After two weeks of treatment, a significant positive effect on distress was found: the number of stress symptoms decreased by 60%, while the intensity of stress symptoms decreased by 41%.

Scientifically interesting is a study [45] which evaluated the effect of MW baths with different mineralization (20, 40 and 60 g/l) on the healing process. The course of baths lasted two weeks. Long-term results were also studied for three months. Questionnaires, a doctor's examination, and general blood and urine tests were used. After two-week treatments, participants who received all types of hydrotherapy showed a significant therapeutic result compared to the control group, especially in the subcategories of fatigue and mental state. The most significant overall healing effect immediately after therapy was observed in the group receiving a 40 g/l treatment dose, followed by the 20 g/l group. The slightest impact was seen in the tap water group. The most significant post-therapeutic healing effect after three months was provided by procedures using 40 and 60 g/l MW.

Due to the anti-apoptotic, anti-oxidant, neuroprotective, vasorelaxant, anti-platelet and anti-inflammatory effects of $H_2S$, hydrogen sulfide balneotherapy positively impacts neuropsychiatric disorders and improves cognitive functions [45]. The pronounced protective effect of $H_2S$ on neurons is associated with the inhibition of the accumulation of reactive aldehyde species, maintenance of glutathione homeostasis, suppression of pro-inflammatory cytokines against the background of increased release of anti-inflammatory interleukin-4 (IL-4) and interleukin-10 (IL-10), mobilization of intracellular calcium stores, activation of chloride and potassium membrane channels in astrocytes and microglia cells.

When studying the effect of sulphide baths on the treatment of neurasthenia, it has been established that balneotherapy with the use of baths with low-mineralized low-sulfide, chloride-hydrogen carbonate MW in the conditions of the low-mountain resort of Nunisi, Georgia, eliminates complaints and pathological changes in the neurological state of patients, improves perception, attention and memory, state of the autonomic nervous system and the functional state of the brain, restores cardio-haemodynamics and lipid metabolism, as well as the excretion in the urine of adrenaline and norepinephrine, neutral 17-ketosteroids, free and a total of 17-oxycorticosteroids.

From the point of view of eliminating dermatological problems in patients who have had Coronavirus disease, it is advisable to pay attention to thermal, highly mineralized sodium chloride (brine) and sulfide MW, which are helpful in dermatology due to their keratolytic, regenerative and antioxidant effects [30, 31]. In addition, bathing in thermal MW of different temperatures can remove microbial peptides that cause many skin diseases, reduce inflammation, improve microcirculation by expanding capillaries, and regulate immune processes, releasing several immunomodulatory mediators, such as β-endorphin, enkephalin and irisin [46].

A study in France has confirmed the immunomodulatory effect of MW; when studying immunotropic effects of Avène thermal water in patients with chronic inflammatory skin diseases demonstrated the tolerogenic potential, anti-radical and anti-inflammatory properties of MW through the effect on inflammatory mediators and the immune response, in particular mast and dendritic cells, CD4+ T-cells, and a stimulating effect on keratinocyte differentiation [47].

Other articles [48] provide generalized data on the results of experimental and clinical studies to identify the immunomodulatory effect of individual physicochemical components of MW for balneotherapy. For example, sulfur can inhibit T-cell proliferation and the production of cytokines, such as interleukin (IL)-2, IL-8, IL-23, IL-17, and interferon (IFN)-γ, depending on the dose. Sulfur and manganese have bactericidal activity against *Staphylococcus aureus*, in atopic dermatitis. Magnesium and zinc strengthen the skin barrier and the immune system, and the combination of magnesium and calcium salts accelerates skin regeneration. Romanian authors [48] also insist on the cytoprotective, anti-oxidant and anti-inflammatory effects of hydrogen sulfide mineral healing waters, the mechanism of which is associated with the particular features of the $H_2S$ molecule, which can penetrate deep into the skin. Regarding highly mineralized sodium chloride MW, there is evidence of their effect on reducing the human leukocyte elastase enzyme and skin infections due to the bactericidal effect of high mineralization MW [49].

The effect of balneotherapy in the form of MW baths on the cardiovascular system has been sufficiently studied with positive results demonstrated by the example of Chinese pilots who received a course of baths with low-mineralized sodium chloride-sulfate-hydrogen carbonate MW. In particular, a decrease was noted in isovolumetric contraction and the ratio of isovolumetric contraction time/left ventricular ejection time, which also led to an increase in the functional reserves of the respiratory system (forced vital capacity of the lungs, peak expiratory flow rate, forced expiratory volume in one second/forced expiratory volume and forced expiratory flow rate increased by 25–75%).

It is believed that carbon dioxide baths can be an effective therapeutic tool in the rehabilitation of coronary heart disease, myocardial infarction and stroke, hypertension, chronic venous insufficiency, peripheral arterial occlusive disease, trophic ulcers, microangiopathies of various origins [48] due to the reduction of oxidative stress, the vasodilating effect of $CO_2$, facilitating oxygen delivery to tissues and antiplatelet effect [45]. This has been confirmed to some extent in experimental studies [50] in which the effect of carbon dioxide baths on blood flow and angiogenesis in the ischemic hindlimb of rat, and some plasma angiogenic factors in a peripheral ischemic model (femoral artery occlusion for two weeks). Carbon dioxide baths were held at 37 °C for four weeks (20 minutes daily, five days a week). The results showed increased blood flow in the ischemic hind limb due to increased angiogenesis in the muscles, and a decrease in ischemia-induced elevated plasma malondialdehyde levels under the influence of carbon dioxide baths.

Thus, the studied effects of balneotherapy, considering the composition of MW, temperature and frequency of their use, allow differentiated use of different types of baths to prevent and rehabilitate various post-COVID-19 disease conditions.

To summarize, Table 1 presents the main types of MW and their suitability for use in rehabilitation programmes after Coronavirus disease in accordance with the main existing consequences.

**Study limitations.** Many results have low power due to the small sample sizes. Reporting results in control groups and the significance of differences from the main groups sometimes have the necessary statistical significance. Studies with larger sample sizes would allow more convincing conclusions.

## CONCLUSIONS

The spectrum of diseases in which the external administration of MW is successfully used is vast, and this phenomenon is explained by their powerful non-specific effect on the mechanisms of sanogenesis – a complex of protective and adaptive processes aimed at achieving stable self-regulation of the body impaired by a pathological condition. The presented data opens up broad opportunities for rehabilitation programmes in patients with post-COVID complications. At the same time, further research is needed to develop differentiated approaches to using MW, depending on the leading syndromes in Coronavirus disease convalescents.

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**Table 1.** Main types of MW and their potential use for rehabilitation after Coronavirus disease

| No з/п | | Consequences /comorbidities | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Respiratory pathology | Musculo-skeletal system damage | Cardiological pathology | Neurological and psycho-emotional disorders | Allergic reactions | Immune imbalance | Metabolic disorders and obesity | Electrolyte imbalance | Gastrointestinal disorders | | | | Hepato-biliary disorders | Urinary system disorders | Anemia |
| | | | | | | | | | | General disorders | Hyperacid gastritis | Hypoacid gastritis | Functional constipation | | | |
| 1 | *Iodobromine, bromine* | | | | | | | | | | | | | | | |
| | highly mineralized | ▲ | ■ | ■ | ■ | – | – | – | – | – | – | – | – | – | – | – |
| 2 | *Sulfide* | | | | | | | | | | | | | | | |
| | weakly and slightly mineralized | ▲ | – | ■□ | – | ■ | ▲□ | ▲■□ | – | □ | – | – | – | □ | – | – |
| | medium mineralized | ▲ | – | ■ | – | ■ | ▲■ | ▲■ | – | – | – | – | – | – | – | – |
| 3 | *Sodium chloride* | | | | | | | | | | | | | | | |
| | low and medium mineralized | ▲ | – | – | – | – | ▲ | – | – | □ | – | □ | – | – | – | – |
| | highly mineralized | ▲ | ■ | ■ | – | – | ▲ | ■ | – | – | – | – | – | – | – | – |
| 4 | *Sulphate* | | | | | | | | | | | | | | | |
| | low mineralized | ▲ | – | – | – | – | – | □ | □ | – | – | – | □ | □ | – | – |
| | medium mineralized | ▲ | – | ■ | ■ | – | – | – | – | – | – | – | – | – | – | – |
| 5 | *Sodium bicarbonate* | | | | | | | | | | | | | | | |
| | low and medium mineralized | ▲ | – | □ | – | – | – | – | – | □ | □ | – | – | – | – | – |
| 6 | *Ferruginous* | | | | | | | | | | | | | | | |
| | weakly and slightly mineralized | □ | – | – | – | – | – | – | – | – | – | – | – | – | – | □ |
| 7 | *Thermal* | | | | | | | | | | | | | | | |
| | low and medium mineralized | – | – | – | ■ | – | ▲ | ■ | – | – | – | – | – | – | – | – |
| | highly mineralized | – | – | – | ■ | – | – | ■ | – | – | – | – | – | – | – | – |
| 8 | *Carbon dioxide* | | | | | | | | | | | | | | | |
| | low and medium mineralized | - | ■ | ■ | ■ | - | - | ■ | - | - | - | - | - | - | - | - |
| 9 | *Borates* | | | | | | | | | | | | | | | |
| | low and medium mineralized | - | □ | - | - | - | □ | - | □ | □ | □ | - | - | □ | - | - |
| 10 | *Silicon* | | | | | | | | | | | | | | | |
| | low and medium mineralized | - | - | - | □ | - | - | □ | □ | - | - | - | - | - | □ | - |
| 11 | *Magnesium* | | | | | | | | | | | | | | | |
| | low and medium mineralized | - | □ | - | □ | - | - | - | □ | - | - | - | □ | □ | - | - |
| 12 | *Calcium* | | | | | | | | | | | | | | | |
| | low and medium mineralized | - | □ | □ | - | - | - | - | □ | - | - | - | - | - | - | - |

Note: ■ – external use (baths); □ – drinking regimen (crenotherapy); ▲– inhalations