

# Application of natural magnesium-containing solution in correction heart failure in experiment

## Abstract

In the pathogenesis of heart failure, one of the leading places is occupied by disturbances in the redox processes in the main energy cycles in cardiomyocytes. According to modern concepts, the magnesium ion is one of the major macronutrients that activate the enzymes of these reactions. The use of mineral water with a high content of magnesium in white rats with heart failure had a significant corrective effect on cardiovascular parameters.

**Keywords:** heart failure, white rats, redox processes, magnesium

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## Introduction

Cardiovascular diseases are the leading cause of disease burden and deaths globally.<sup>1-3</sup> The UN, alarmed by the increasing burden of non-communicable diseases (NCDs) and high disease severity and case-fatality in low-income and middle-income countries compared with high-income countries, acknowledged in 2012 that the rising burden of NCDs was one of the major threats to sustainable development in the 21st century.<sup>4,5</sup>

This determines the relevance of the search for new effective and affordable methods of treatment of cardiovascular diseases (CVD). In this case, therapeutic approaches are based on dietary recommendations, physical activity regimen, prolonged use of several classes of medications, which may be accompanied by side effects and insufficient efficacy of therapy. Recently, considerable attention has been given to non-drug methods of treatment, and in particular to mineral waters (MB).<sup>6</sup> Mineral water due to the presence in their composition of many macro- and micronutrients and biologically active substances, have a powerful biological and therapeutic effect.<sup>7-9</sup> However, they do not have side effects and allergic reactions, contribute to the removal of metabolic products.<sup>9</sup> In the context of this, the use of natural mineral waters of various balneological types in the complex treatment of CVD is promising.<sup>11</sup>

Magnesium plays an important role in the implementation of physiological, metabolic, immunological processes in humans and animals, despite all this active center of enzymes of oxidation and phosphorylation: ATP and enzymes that take part in the metabolism of creatine phosphate; with the participation of  $K^+$ - $Mg^{2+}$  dependent ATP, the energy supply of transmembrane transport of ions, primarily in myocytes, is carried out.<sup>12,13</sup> Magnesium is involved in the regulation of glycolysis, Na/K membrane pump activity, participates in processes of neuromuscular excitability, etc.<sup>14-16</sup>

Because of magnesium's many functions within the body, it plays a major role in disease prevention and overall health. Low levels of magnesium have been associated with a number of chronic diseases including migraine headaches, Alzheimer's disease, cerebrovascular accident (stroke), hypertension, cardiovascular disease, and type 2 diabetes mellitus.<sup>17</sup> In connection with the above, it is of scientific

and practical interest to study the action of mineral waters containing magnesium in high concentrations on the development of a model of heart failure in white rats.

## Methods

To investigate the role of magnesium deficiency in the pathogenesis of cardiovascular diseases, a model of heart failure (HF) was recreated in rats, and the effect of natural liquid balneotherapeutic agent "Magnesium oil" was investigated with a total mineralization of  $350\text{g/dm}^3$  and magnesium concentration ( $Mg^{+2}$ )— $100\text{g/dm}^3$ , diluted to  $40.0\text{g/dm}^3$ . Reproduction of the HF model in white rats of female weighing 180–210g and at the age of 9 months was carried out by single injection subcutaneously in the right hip of an oil suspension of phosphorus at the rate of  $10\text{mg/kg}$  body weight, while in the left high intramuscularly injected ml of 1% solution of vitreous.

## Analysis

### Characterization of the HF model and features of the use of "Magnesium oil"

The HF model was verified on a 14-day basis to determine the frequency of respiration, heart rate, adenosine triphosphatase (ATP) activity and structural changes in the heart tissue. "Magnesium oil" was introduced the next day after the reproduction of the pathology, intragastric in a dose of 1% of the mass every day, course for 12 days. Intact animals served as a comparison group.

### Pathogenesis of the HF model

In rats with a CH model at day 14, an increase in the respiratory rate by 10% was found on ( $p < 0.01$ ), and the heart rate per minute by 5% ( $p < 0.01$ ). Microscopically, a fascicle and layer organization is maintained in the myocardium. Interpunched layers are swollen thick, vessels are sharply full-blooded. Cardiomyocytes are pale, without lumbar puncture, indurated, densely colored. Consequently, certain signs of dystrophic changes in the myocardium are identified. Histochemical studies showed a reduction in the activity of succinate dehydrogenase (SDH) and lactate dehydrogenase (LDH) in the tela of the myocardium by 50% ( $p < 0.001$ ): the activity of the SDH was ( $3.50 \pm 0.41$ ) of the standard density units (unit dose densities) –

against (7,00±0,15) mind. unit op dense in norm. LDH activity was (3,00±0,27) of mind. unit op dense –against (6,00±0,19) of mind. unit wholesale. in norm. That is, inhibition of the activity of oxidative-reducing enzymes is observed. Also, the decrease of activity in the tissue of the myocardium  $Mg^{2+}$  –dependent  $K^+/Na^+$ –ATPase was determined 77% ( $p < 0.001$ ) and  $Mg^{2+}$ –dependent  $Ca^{2+}$ –ATPase in 46% ( $p < 0.01$ ) indicates the suppression of energy–dependent processes of transmembrane transport.

### Corrective effect of “Magnesium oil” on the course (development) of the HF model

Under the influence of the course conducted with “Magnesium Olive”, a reduction in the respiration rate and heart rate to control group ( $p > 0.1$ ) was determined. The activity of  $Mg^{2+}$ –dependent  $K^+/Na^+$ –ATPase and  $Mg^{2+}$ –dependent  $Ca^{2+}$ –ATPase in cardiomyocytes - increased by 50% ( $p < 0.01$ ) and by 30% ( $p < 0.01$ ), exceeded the control values. In the myocardium the tufts organization has been saved. Between bunch layers are thick enough, thin. Fibroblasts with dark oval cores. Vessels of moderate stagnant blood flow. Cardiomyocytes are pale colored, but in most of them, there is a fairly distinct lumbar euphemism. The nuclei of cardiomyocytes are oval, dark colored. The activity of the oxidative-reducing enzymes has increased: the value of SDG and LDH was in cardiomyocytes (5,00±0,21) and (5,00±0,15) of mind. unit op dense. It should be emphasized that significant restoration of the structure of the myocardium ensured the restoration of the activity of the studied parameters of the cardiovascular system - respiratory rate and heart rate.

### Conclusion

Thus, application of the rather serious model of heart failure of the balneotherapeutic agent “Magnesium Olive” has a noticeable corrective effect: it leads to almost complete disappearance of the structural signs of dystrophic changes in the myocardium, while partially restores the activity of oxidative-reducing enzymes of EDD and LDH and enzymes in energy production – $Mg^{2+}$ –dependent  $K^+/Na^+$ –ATPase and  $Mg^{2+}$ –dependent  $Ca^{2+}$ –ATPase, and completely restores the breathing rate and heart rate.

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None.

### Conflicts of interests

The authors declare that there is no conflict of interests.

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