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Article

Methodology for the Rehabilitation of Elderly Patients with Neurovegetative Regulation Disorders Using Bioacoustic Correction

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Abstract: Vegetative dystonia syndrome (VDS) is most often the diagnosis of the underlying disease in young people and is determined much less frequently in elderly people. According to the World Health Organization (WHO), as of 2020. In the context of vegetative dysfunction syndrome in elderly patients, BAC (bioacoustic correction) therapy can become an effective supplement to traditional treatment methods owing to its ability to influence the autonomic nervous system (ANS) and improve the body's adaptive capacity. By modulating sympathetic and parasympathetic activity, BAC therapy helps restore the harmony of autonomic regulation, which helps reduce VDS symptoms such as orthostatic hypotension and tachycardia. Improved circulation and reduced stress levels through BAC therapy increase the body's adaptive reserves, allowing it to cope better with physical and emotional loads. Regular use of BAC therapy can reduce asthenic conditions, raising energy levels and improving muscle responsiveness, which lowers the risk of falls and other accidents.

Keywords: rehabilitation of elderly patients, neurovegetative regulation, vegetative dysfunction syndrome, bioacoustic correction, BAC therapy, geriatrics, non-pharmacological methods.

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1. Introduction

Demographic ageing of the population is one of the key challenges for modern healthcare. The growing share of elderly and senile people is inevitably accompanied by a rise in the prevalence of combined pathology, among which chronic disorders of the central and autonomic nervous systems occupy a special place. Neurovegetative regulation disorders in geriatric patients manifest in a wide range of clinical signs: pronounced orthostatic instability, lability of blood pressure, weather sensitivity, sleep disturbances, and progressive decline in cognitive functions. These symptoms substantially reduce quality of life, limit everyday autonomy, and increase the risk of disability[1].

The pathogenesis of neurovegetative disorders in old age is multifactorial. It is determined by the combined effect of natural involutional processes (reduced neuroplasticity, neuronal degeneration, depletion of neurotransmitter systems) and chronic cerebral ischemia against the background of atherosclerotic vascular lesions and arterial hypertension. As a result, the integrative activity of the suprasegmental structures

of the autonomic nervous system, including the limbic-reticular complex, is impaired, leading to desynchronization of cortico-subcortical relationships[2-3].

Standard approaches to treating such conditions are traditionally based on pharmacotherapy (nootropic, vascular and vegetotropic drugs, sedatives). However, in geriatric practice drug treatment faces serious limitations. Senile changes in pharmacokinetics and pharmacodynamics, reduced detoxification function of the liver and kidneys, and forced polypharmacy sharply increase the incidence of adverse drug reactions and reduce patient compliance. In this connection, a relevant vector of modern rehabilitation medicine is the search for, development and introduction of effective non-pharmacological technologies with a gentle systemic action and a high safety profile[4].

One of the most promising directions in this field is the method of bioacoustic correction (BAC). This technology implements the concept of sensory EEG-dependent neuromodulation, in which the parameters of auditory stimulation are rigidly synchronized with the patient's current bioelectrical brain activity. Unlike classical biofeedback methods, BAC does not require an elderly person to consciously follow complex instructions or concentrate attention, which makes it accessible even in cases of moderate cognitive deficits. Perceiving the sound image of one's own electroencephalogram activates endogenous mechanisms of neuroplasticity and self-regulation, promoting restoration of the functional state of the central nervous system and harmonization of the work of the sympathetic and parasympathetic divisions of the autonomic nervous system. The present study is devoted to the scientific and methodological substantiation and evaluation of the effectiveness of BAC therapy within the structure of complex medical rehabilitation of elderly patients with neurovegetative dysfunction syndrome[5-7].

Aim of the study. to evaluate the clinical effectiveness of the bioacoustic correction (BAC) method in the complex rehabilitation of elderly patients with neurovegetative regulation disorders for normalizing autonomic tone, improving cognitive functions, and enhancing their quality of life.

2. Materials and Methods

A total of 130 elderly patients diagnosed with vegetative dysfunction syndrome were examined and divided into two main groups depending on the nature of the dysfunction: Group I (sympathicotonia): 72 patients (mean age 68.3 ± 3.9 years) and Group II (vagotonia): 58 patients (mean age 64.1 ± 4.5 years).

In the course of studying treatment effectiveness, each of the groups was divided into a main and a comparison group: Group I (72 patients): main subgroup 48 (66.6%) and comparison subgroup 24 (33.3%) patients. Group II (58 patients): main subgroup 37 (63.7%) and comparison subgroup 21 (36.2%) patients. Patients of the main group received BAC therapy as an addition to standard therapy, whereas patients of the comparison group received standard therapy alone for the treatment of VDS[8].

The following treatment methods were applied: to objectify the clinical response and comprehensively evaluate the effectiveness of the developed methodology for the rehabilitation of elderly patients with neurovegetative regulation disorders using bioacoustic correction (BAC), a multidisciplinary diagnostic complex was used. Indicators were recorded twice: before the start of the therapeutic course and after its completion.

1. Neuropsychological screening testing: In order to verify cognitive deficit, assess the structural and functional state of the cerebral cortex, and correct the psycho-emotional status under the influence of BAC therapy, the following standardized scales were used:

Mini-Mental State Examination (MMSE): used for a general rapid assessment of the cognitive sphere (orientation in somatic space and time, perception, concentration of attention, memory, speech functions).

Frontal battery (FAB): used for the differential diagnosis of cognitive impairment with emphasis on conceptualization, verbal fluency, dynamic praxis, simple and complex sensorimotor reaction, as well as the detection of impulsivity and grasp reflexes, which is critically important in vascular brain pathologies in the elderly[9].

Clock Drawing Test (CDT): served as a sensitive marker for detecting disorders of visuospatial praxis, gnosis and regulatory functions (goal-setting, abstract thinking).

Hamilton scale (Hamilton Anxiety/Depression Rating Scale, HAM-A / HAM-D): used for quantitative analysis of the severity of anxiety and depressive symptoms induced by somatic and neurovegetative imbalance, in order to evaluate the sedative and antidepressant effects of BAC.

2. Study of cardiorespiratory reserves and tolerance to hypoxia. To determine the functional state of the life-support systems and their adaptive reserves, exercise and hypoxic tests were performed:

Cardiorespiratory Stange test: consisted in recording the duration of breath-holding on inspiration after a deep exhalation. The indicator served as a marker of the body's resistance to mixed hypoxia and hypoxemia, reflecting overall endurance and reactivity of the autonomic centers regulating respiration[10].

Ruffier index: calculated from the dynamics of heart rate (HR) at three stages — at rest, immediately after a standardized physical load (30 squats in 45 seconds) and after 1 minute of rest. This test made it possible to quantitatively characterize the adaptive potential of the myocardium and the rate of recovery of the cardiovascular system.

Skibinskaya index: calculated by integrating vital capacity (VC), breath-holding time (Stange test) and baseline HR. The index was used for a comprehensive assessment of the functional capabilities of the cardiorespiratory system and the overall physical working capacity of geriatric patients[11].

3. Mathematical analysis of heart rhythm (autonomic status). Cardiointervalography (CIG) was used as a direct method for objectifying the state of the suprasegmental and segmental mechanisms of neurovegetative regulation.

The method is based on continuous recording of the electrocardiogram in the time and frequency domains with subsequent mathematical analysis of heart rate variability (HRV).

Key parameters were calculated: mode (Mo), mode amplitude (AMo), variation range (ΔX), as well as integral indices (Baevsky's stress index of regulatory systems, autonomic balance index). This made it possible to differentiate, with high accuracy, the tone of the sympathetic and parasympathetic divisions of the autonomic nervous system, to assess the degree of centralization of heart rhythm control and the level of stress strain of the organism.

3. Results and discussion

Following treatment, cognitive function was assessed in patients with vegetative dystonia syndrome using the MMSE scale. In the main subgroup of Group I the MMSE (28.2±2.3), Frontal Assessment Battery (18.2±3.2) and Clock Drawing Test (9.4±2.6) scores were higher than in the comparison subgroup (MMSE – 26.4±3.2, Frontal Assessment Battery – 16.5±1.9, Clock Drawing Test – 7.6±2.3)[12].

In Group II the differences between the subgroups were also significant: the main subgroup showed better results (MMSE – 27.3±2.4, Frontal Assessment Battery – 17.4±2.6, Clock Drawing Test – 8.2±2.5), while the comparison subgroup demonstrated the most pronounced cognitive impairment (MMSE – 25.6±2.6, Frontal Assessment Battery – 15.3±3.4, Clock Drawing Test – 6.8±3.2) (Table 1).

Table 2. Changes in the assessment of psycho-emotional disorders by the Hamilton scale in elderly patients with VDS (%)

Group	Subgroup	HDRS						HAM-A					
		No depression		Mild depression		Moderate depression		No anxiety		Mild anxiety		Moderate anxiety	
		abs	%	abs	%	abs	%	abs	%	abs	%	abs	%
Group I (n= 72)	Main (n= 48)	40	83.3	8	16.7	-	-	22	45.8	26	54.2	6	12.5
	Comp. (n= 24)	18	75.0	6	25.0	-	-	7	29.2	17	70.8	7	29.2
Group II (n= 58)	Main (n= 37)	25	67.6	11	29.7	1	2.7	20	54.1	16	43.2	10	27.0
	Comp. (n= 21)	10	47.6	9	42.9	1	4.8	9	42.9	12	57.1	5	23.8

Table 3 shows the changes in the cardiorespiratory tests (Stange test, Ruffier index and Skibinskaya index). Group I: patients of the main subgroup (n= 48) showed significant improvement in all tests: the Stange test increased from 42.3±3.7 points, Ruffier index — 6.3±1.0, Skibinskaya index — 20.4±1.2. The comparison subgroup (n= 24) did not demonstrate significant changes: the Stange test increased to 35.2±2.4, Ruffier index — 12.1±1.0, Skibinskaya index — 12.1±1.0.

Table 3. Changes in the cardiorespiratory tests: Stange test, Ruffier index and Skibinskaya index

Group	Subgroup	Stange test (seconds)	Skibinskaya index (points)	Ruffier index (points)
Group I (n= 72)	Main (n= 48)	42.3±3.7	20.4±1.2	6.3±1.0
	Comp. (n= 24)	35.2±2.4 (**p<0.01**)	12.1±1.0 (**p < 0.05**)	8.2±1.1 (**p < 0.05**)
Group II (n= 58)	Main (n= 37)	52.4±3.2	29.6±0.5	4.7±0.6
	Comp. (n= 21)	40.1±2.6 (**p<0.01**)	18.3±0.5 (**p<0.01**)	6.5±0.7 (**p<0.01**)

Group II: the main subgroup (n= 37) showed significant improvement in all tests: the Stange test increased to 52.4±3.2, Ruffier index — 4.7±0.6, Skibinskaya index — 29.6±0.5. The comparison subgroup (n= 21) did not demonstrate significant changes: the Stange test increased to 40.1±2.6, Ruffier index — 6.5±0.7, Skibinskaya index — 18.3±0.5.

Table 4 shows the changes in cardiointervalography indicators. Group I, main subgroup (n= 48), showed a significant decrease in the LF/HF ratio from 2.0 ± 0.5 to 1.5 ± 0.4 ($p < 0.05$), an increase in mean RR from 0.85 ± 0.05 to 0.90 ± 0.04 sec ($p < 0.05$) and a stable RR standard deviation (0.02 ± 0.01 → 0.02 ± 0.01), which indicates improved ANS balance and increased parasympathetic activity. The comparison subgroup (n= 24) did not demonstrate significant changes in ANS indicators: LF/HF decreased from 2.0 ± 0.5 to 1.95 ± 0.5 ($p = 0.30$), mean RR increased from 0.85 ± 0.05 to 0.86 ± 0.05 sec ($p = 0.40$) and the RR standard deviation was stable (0.02 ± 0.01 → 0.02 ± 0.01). Group II: the main subgroup (n= 37) showed a significant decrease in the LF/HF ratio from 1.8 ± 0.6 to 1.2 ± 0.3 ($p < 0.001$), a significant increase in mean RR from 0.80 ± 0.06 to 0.95 ± 0.03 sec ($p < 0.001$) and a decrease in the RR standard deviation from 0.03 ± 0.02 to 0.02 ± 0.01, which indicates a significant improvement in ANS balance. The comparison subgroup (n= 21) did not demonstrate

significant changes: LF/HF decreased from 1.8 ± 0.6 to 1.75 ± 0.6 (p = 0.40), mean RR increased from 0.80 ± 0.06 to 0.81 ± 0.06 sec (p = 0.50) and the RR standard deviation was stable (0.03 ± 0.02 → 0.03 ± 0.02)[15].

Table 4. Cardiointervalography: changes in ANS indicators after treatment

Group	Subgroup	LF/HF (balance coefficient)	Mean RR (sec)	RR standard deviation
Group I (n= 72)	Main (n= 48)	2.0 ± 0.5	0.90 ± 0.04	0.02 ± 0.01
	Comp. (n= 24)	1.5 ± 0.4 (**p<0.01**)	0.85 ± 0.05 (**p<0.05**)	0.02 ± 0.01 (**p<0.05**)
Group II (n= 58)	Main (n= 37)	1.8 ± 0.6	0.95 ± 0.03	0.03 ± 0.02
	Comp. (n= 21)	1.2 ± 0.3 (**p<0.01**)	0.80 ± 0.06 (**p<0.005**)	0.02 ± 0.01 (**p<0.01**)

4. Conclusion

The results of the study indicate high effectiveness of bioacoustic correction (BAC therapy) in the combined treatment of vegetative dysfunction syndrome in elderly patients. Patients who received BAC therapy (subgroups A) demonstrated significant improvement in orthostatic test indicators, the cardiorespiratory Stange tests, the Ruffier and Skibinskaya indices, as well as cardiointervalography indicators, compared with subgroups B, which received only standard therapy.

Effect of BAC therapy on orthostatic hypotension: in patients of both groups who received BAC therapy, a significant decrease in systolic and diastolic blood pressure, as well as in heart rate, was observed. This indicates a positive effect of BAC therapy on the regulation of the cardiovascular system and an improvement in the body's adaptive reserves. A particularly pronounced improvement was observed in patients with vagotonia (Group II), which may be due to more pronounced ANS disorders and a high degree of comorbidity.

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