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Research on Aires Defender's Influence on the Variability of Heart Rhythm
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Research objective: Verify the effectiveness of using Aires Defender's to enhance the body's ability to adapt, through heart rhythm analysis.

Introduction

Heart rate variability (HRV) is an expression of fluctuations in the frequency of heart contractions relative to its average level [1]. Determining HRV is presently recognized as the most informative noninvasive quantitative way to estimate autonomic regulation of heart rhythm [4]. As an important tool for assessing the function of the autonomic nervous system (ANS) and the body's overall adaptive response under the influence of various stressors, research based on HRV analysis is already experiencing renewed popularity in our country. Its initially came into vogue at the end of the 1970s when articles by R.M. Bayevsky, who researched strain on the body's adaptive systems, described numerous HRV-based studies in the field of space medicine. An HRV estimate reflects the activity of the regulatory systems that allow the body to adapt to various environmental conditions. It is based on interpreting the functioning of the cardiovascular system as an indicator of the body's adaptive responses.

The relevance of questions related to humans' ability to adapt to actual living conditions today has increased sharply due to the systematic effects of man-made electromagnetic fields on the body. And with the appearance of more and more new sources of electromagnetic radiation, the electromagnetic safety of the public has become a socially significant problem.

As high-tech universal systems for protecting the body from the negative effect of man-made electromagnetic radiation, Aires coherent transformers, which were developed by Aires Technologies, solve this problem by triggering a spatial-temporal amplitude-frequency harmonization of the spatial domain's structural characteristics, instead optimizing the body's physiological functions.

To achieve the established objective, we used the Omega M system of hardware and software, which was designed to analyze the body's biological rhythms extracted from a wide band of frequencies. The method is founded on a new information technology for analyzing biorhythmic processes - fractal neurodynamics. Because any physiological system, as a result of its fractal structure, is regularly reflected in other systems, an analysis of rhythmic heart activity provides a real-time cross-section of information about body state from all fundamental levels of function regulation, specifically:

1) secondary or autonomous, reflecting the regulatory state of cardiac activity at the level of the heart;

2) autonomic, reflecting the ratio of sympathetic and parasympathetic influences at the level of centers of autonomic innervation in the medulla.
3) pituitary-hypothalamus, reflecting the state of higher autonomic centers that simultaneously perform nervous and humoral regulation;
4) central, reflecting both regulation of neurohumoral body functions and the body's connection with its environmental conditions, indicating the body's overall ability to adapt.

Method of analyzing heart rhythm variability

Temporal and frequency HRV analysis are different. Temporal analysis includes geometric (graphical) and statistical methods of studying intervals between consecutive heart contractions (RR intervals). Frequency HRV analysis is most frequently performed using a spectral method. Spectral analysis is based on a physical transformation of the heart rhythm fluctuations into simple harmonic oscillations (fast Fourier transform) with a different frequency.

In our research, we evaluated the heart rhythm variability analysis using the following indicators:

Mode (Mo) - the range of values of the most frequently encountered cardiac signals. This indicates the predominant level at which the sinoatrial node is operating. The mode normally varies between 0.7 to 0.9.

Mode amplitude (AMo) - the ratio of the number of RR intervals equal to the Mo to the total number of RR intervals, expressed as a percentage. Normal values are 30-50%. This indicator reflects the degree of rigidity of the rhythm.

Variability range (VR) - the difference between the maximum and minimum cardiac signal values. VR is treated as a parasympathetic indicator. Normal VR values range from 0.15 to 0.45.

Index of Regulatory System Stress IRSS=AMo/2*^X*Mo - reflects the degree of centralization of heart rhythm regulation. It normally fluctuates between 10-100 c.u. This indicator is sensitive to increased tonus of the sympathetic nervous system.

Index of Autonomic Equilibrium IAE=AMo/^X - indicates the ratio of activity of the sympathetic and parasympathetic areas of the ANS. Normal values range from 35 to 145 c.u.

Autonomic Rhythm Indicator ARI=1/Mo*^X - makes it possible to judge the autonomic balance in terms of the autonomic regulatory circuit. Normal values fall between 0.25 and 0.6.

Regulatory Processes Adequacy Indicator RPAI=AMo/Mo - reflects the consistency between the activity of the parasympathetic area of the ANS and the sinoatrial node's leading functional level. Normal values are between 15 and 50 c.u.
High-Frequency Spectral Component Power (HF - 0.15-0.40 Hz)- reflects the preeminent role of the parasympathetic area of the ANS in the generation of fluctuations in this frequency range. The power in this frequency range increases while breathing with a certain frequency and depth.
Low-Frequency Spectral Component Power (LF - 0.04-0.15 Hz) - The physiological interpretation of this indicator is complex. It is believed that the power in this range is affected by changes in both the tonus of the parasympathetic and the sympathetic areas of the nervous system.
Very Low-Frequency Spectral Component Power (VLF - 0.003 - 0.04 Hz) - The physiological meaning of these frequency ranges is unclear. However, some believe that the power of these frequency ranges grows considerably as the body's regulatory systems are distressed. There is data suggesting that VLF is a sensitive indicator of control of metabolic processes and characterizes the activity of the sympathetic area of the ANS from the level of super-segment regulation.
Power ratio LF/HF - characterizes the ratio of sympathetic and parasympathetic influences. Moreover, if the tonus of the sympathetic area rises, this indicator increases significantly. In the event of sympathetic imbalance, the opposite happens. Reciprocal changes in LF and HF power have been noted in many instances. LF power has been observed to rise significantly in healthy persons under mental stress and a moderate physical load. Thus, recently the opinion was spread that power in the LF range and the LF/HF indicator reflect the activity of the sympathetic area of the ANS.
Full Spectrum (TP) - (less than 0.40 Hz) is an integrated indicator that reflects the influence of both the sympathetic and parasympathetic areas of the autonomic nervous system. Increased sympathetic influence leads to lower overall spectral power, while the activation of sympathetic imbalance leads to the opposite effect.

1. Methodological issues

1.1. How the research was organized and conducted

The research employed a computer version of heart rhythm variability analysis in accordance with the "Standards of Measurement, Physiological Interpretation, and Clinical Research of Heart Rhythm Variability", which were developed by a group of experts at the European Society of Cardiology and the North American Association of Rhythmology and Electrophysiology (European Heart Journal, 1996).
13 apparently healthy volunteers, ages 40 to 59, participated in the study. The research was conducted in stages during the day.
1. Registration of cardiac signals by recording 300 RR intervals.

2. Placement of the Aires Defender on the projection of the celiac plexus on the chest below the xiphoid process for 20 minutes.
3. Another registration of the cardiac signal by recording 300 RR intervals.

1.2. EKG recording method

The electrodes are placed on the subject's hands near the wrists. The EKG is recorded with the subject in "sitting" position. The hands must be relaxed and immobile on the subject's knees.

To reduce noise during the EKG registration, other persons must not move within a radius of 1.5-2 meters of the subject.

During EKG registration, the remote module must not be placed near sources of electromagnetic radiation.

1.3. Research conditions

1. The research is conducted after a 10-minute rest with peaceful breathing.
2. The heart rhythm should be recorded on an empty stomach or 1.5-2.0 hours after a meal.
3. The length of the recording required for a proper statistical sampling must be 300 cardiac signals (roughly 5 minutes).
4. The room where the research is conducted must provide comfortable conditions (temperature, humidity).

1.4. Reproducibility of the features of heart rhythm variability

Due to the research methodology, the reproducibility of heart rhythm variability (HRV) results depends on the research subject and the task assigned to him or her by the researcher.

In methodological recommendations regarding HRV research, R.M. Bayevsky et al. [5] note the impossibility of achieving 100% reproducibility of HRV research results. Moreover, when discussing the reproducibility of results of HRV analysis, we must consider the autonomic nervous system's high sensitivity to external and internal influences, and the subject's typological features and health".

Research results and discussion

Because the HRV is subject to considerable changes with the subjects' age [2], when interpreting the results we evaluated indicators for the 40-59 year old group, in accordance with guidelines for this group (as per O.V. Korkushko, 2002).

The high degree of differences between subjects was notable, even within the same age group.

It should be noted that the subjects' baseline indicators differed in their stress level. In 76.9% of subjects the IRSS exceeded normal values and 50% of these exceeded by a factor of 2-4, which is indicative of a condition of long-term stress on the body's regulatory systems.

HRV indicators, which characterize the state of various parts of the body's autonomic regulation before and after the application of the Aires Defender (AD), are shown in Tables 1, 2, and 3.

The following may be noted with respect to how the indicators in the spectral HRV analysis changed when the AD was applied (Table 1):

1. Autonomic imbalance toward a stronger parasympathetic tonus (HF, LF - increased; LF/HF - reduced; for example, see 3, 4, 5, 6, 7, 8, 10), which may be interpreted as a reduction in stress on the body's regulatory systems.
2. Increased activity of the vasomotor center, stronger connection of the central and autonomic regulatory circuits (LF, VLF, LF/HF - increased; for example, see 1, 11), which may suggest greater harmonization of the system at every level.
3. Increased activity at the level of energy- and metabolic regulation (HF, LF - decreased; VLF, LF/HF - increased; for example, see 2; LF, VLF - increased; for example, see 1, 3, 7, 8, 10, 11) may be the result of activation of central regulatory mechanisms (the pituitary-hypothalamus level).

The VLF parameters characterize the highest autonomic centers' influence on the cardiovascular subcortical center and are used as a reliable indicator of the connection between autonomic (segmental) levels of circulatory regulation and supersegmental levels, including the pituitary-hypothalamus and cortical levels [3].

In order to achieve a useful adaptive result, we may observe that the activity in one area of the ANS declines while it increases in another due to the principle of "functional synergy" [6]. Subject 6 is an example of this interaction (HF - decreased, LF - increased, IAE - increased as per Table 3).

Spectral HRV analysis revealed the relative value of each of the components of total power (TP), as a percentage.

Based on the research results (Table 2), in which the HF and LF indicators increased in 77.8% of subjects, while the VLF indicator decreased in 88.9% of subjects, it may be stated that the AD produces a pronounced effect on the various levels of autonomic regulation, enhancing the system's ability to adapt to various stressors.

The reduction in ARI and simultaneous increase in IAE in subjects 2 and 7 may be viewed as a result of the activation of the highest autonomic centers and the cortex in the regulatory process, which is confirmed by the increased in the VLF indicator in these subjects.
The rise in activity of the autonomic regulatory circuit (ARI - increased, IAE and RPAI - decreased in 69.2% of subjects; this may be illustrated by the examples of subjects 1, 3, 4, 5, 8, 9, 10, 11, and 12 as per Table 3).
In all, the vagotropic type of the cardiovascular system's response to the influence of the AD (TP - increased in 92.3% of subjects) may suggest the activation of the system's self-regulatory mechanisms in order to increase the level of its harmonization.
The AD's influence on the change of activity of various parts of autonomic regulation normalizes the autonomic balance, which may reflected by the reduction of the IRSS indicator in 92.3% of subjects, in whom the greatest change was observed in those with considerable baseline stress.
An assessment of the effectiveness of AD's influence on the body, based on integrated indicators of functional state, is shown in Table 4.
The adaptive effect obtained, which reflects the various levels of the regulatory system, is determined by an increase in the following indicators:
1. Adaptation level of the cardiovascular system - 13.5%
2. Level of autonomic regulation - 11.5%
3. Level of central regulation - 9.7%
4. Indicator of psycho-emotional condition - 8.8%
5. Integral health indicator - 10.9%

Conclusions

We may draw the following conclusions based on the research results:
1. Aires Defender affects the mechanisms of autonomic regulation, enabling optimization of indicators of autonomic balance.
2. Aires Defender's influence reduces tension on the body's regulatory systems, having an anti-stress effect and increasing the body's adaptive abilities.
3. The use of heart rhythm variability analysis as a method to assess the body's adaptive ability may be of practical interest when conducting research on the effect of electromagnetic radiation on the body.

The selected research method proved to be adequate for the established objective. The results may serve as the basis for further research in this area.

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pg. 236

Appendix

Table 1. Spectral analysis indicators (m/s^2)

No.	HF		VLF		LF		LF/HF		TP	
	Baseline	AD	Baseline	AD	Baseline	AD	Baseline	AD	Baseline	AD
1	446	615	133	395	253	417	0.3	0.64	832	1427
2	56	36	398	274	375	519	7.04	7.56	829	830
3	9	16	105	150	158	212	12.25	9.39	272	378
4	159	487	72	213	239	118	0.45	0.44	470	888
5	246	1833	785	1923	1473	1116	3.19	1.05	2505	4872
6	246	154	96	293	79	70	0.39	1.91	422	517
7	259	363	211	270	288	366	0.81	0.74	759	999
8	338	613	451	733	480	1086	1.33	1.19	1269	2433
9	177	177	307	443	725	292	1.74	2.5	1209	912
10	122	229	128	153	98	230	1.04	0.67	348	612
11	40	40	165	425	94	266	4.17	11.02	299	430
12	1373	1723	513	1024	1119	895	0.37	0.59	3005	3642
13	220	1440	2020	943	785	610	9.16	3.65	3025	2993

Table 2. Spectral diagram indicators (relative to the total power

No.	HF		LF		VLF	
	Baseline	AD	Baseline	AD	Baseline	AD
1	54	43	16	28	30	29
2	4	7	33	48	63	45
3	3	4	39	40	58	56
4	34	60	15	26	51	14
5	10	38	31	39	59	23
6	58	30	23	57	19	13
7	34	36	28	27	38	37
8	27	25	36	30	38	45
9	15	19	25	49	60	32
10	35	37	37	25	28	38
11	13	5	55	58	31	36
12	46	47	17	28	37	25
13	7	48	67	32	26	20

Table 3. Indicators of variational pulsometry

No.	IAE		ARI		RPAI		IRSS	
	Baseline	**AD**	**Baseline**	**AD**	**Baseline**	**AD**	**Baseline**	**AD**
1	285	114	0.15	0.21	44.0	37.9	142.9	88.6
2	282	296	1.17	0.15	46.6	45.8	141.1	137.2
3	695	485	0.11	0.15	78.2	71.0	434.2	288.7
4	446	326	0.15	0.17	66.9	55.6	293.6	185.4
5	120	56	0.32	0.36	38.3	20.5	75.0	29.4
6	519	554	0.13	0.30	68.5	70.9	360.0	385.2
7	265	272	0.20	0.19	53.8	50.6	166.1	162.2
8	224	97	0.26	0.30	57.6	29.3	147.8	55.3
9	302	210	0.21	0.27	63.0	56.8	186.3	146.4
10	732	368	0.11	0.15	83.7	53.6	435.9	200.0
11	446	286	0.18	0.21	80.3	60.0	349.0	198.7
12	89	84	0.28	0.30	25.2	25.2	46.6	42.1
13	101	100	0.39	0.33	39.5	33.8	73.7	63.3

Table 4. Integrated indicators of the functional state
of subjects by group

No.	**Characteristics**	**Indicators (normal: 60-100%)**	
		Before application of AD	**After application of AD**
1	ADAPTATION LEVEL OF THE CARDIOVASCULAR SYSTEM	42.2	55.7
2	LEVEL OF AUTONOMIC REGULATION	45.5	57.0
3	LEVEL OF CENTRAL REGULATION	38.9	48.6
4	INDICATOR OF PSYCHO-EMOTIONAL STATE	40.0	48.8
5	INTEGRAL INDICATOR OF HEALTH	41.5	52.4