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The Influence of the Course of Electrostimulation by the Device "VEB-1" on Metabolic Parameters of Practically Healthy Men

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Introduction. While constructing and creating the generator design for electrotherapy and stimulation of human nerve centers, we based on the following provisions. The influence of impulses of a rectangular shape (range 7-18 Hz) made it possible fix the frequency ranges of each basic nerve node. Low frequency had minimal effects of stimulation on the corresponding nerve node, while high frequency - the maximum effect. For the effective excitation of nerve centers, the frequency beat method is used which consists in obtaining oscillations with close frequencies.

To obtain the effect of the frequency, beats are generated by impulses of a rectangular shape to two signal channels. The channels differ in frequency which is known to be the beat frequency. For example, for obtaining a beat frequency of 6 Hz, impulses in the first channel were formed at a frequency of 30 Hz, in the second channel at a frequency of 36 Hz. When the first impulse is formed on both channels with a phase shift of 0o, we obtain an absolute zero current in the output.

Figure 1 shows a periodic signal generated by frequency beats voltage in two channels to form a common output signal *(a)*. Figure 1 is a graph of the current of the output signal *(b)*. Such effect creates a shock wave through the object at the desired frequency. It also spins an electromagnetic field in the object.

The generator has been assembled on the basis of the patent of Ukraine for the utility model 105875 "Portable device for electrotherapy and stimulation" [4]. Its operation is described in [6].

The generator has been assembled on the basis of a two-channel circuit using two frequency synthesizers, amplifiers, each of them generates its own frequency.

Figure 2 shows a block diagram of the device indicating the movement of the electric current.

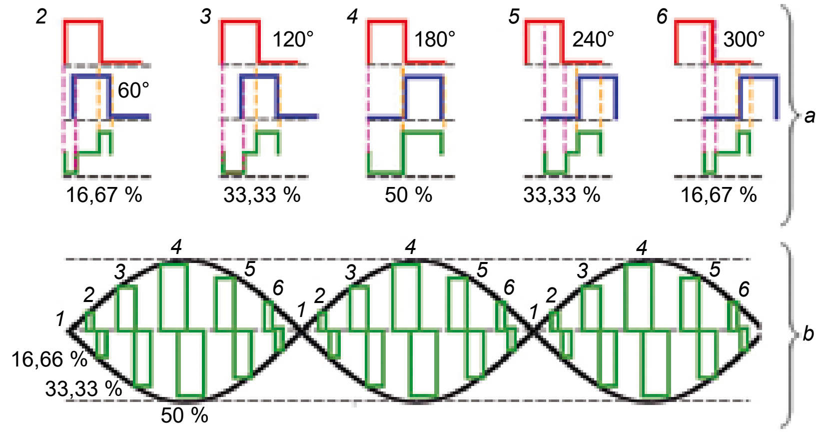

Fig. 1. A periodic signal *(a)* received by frequency beats and a current diagram of the generated output signal *(б)*

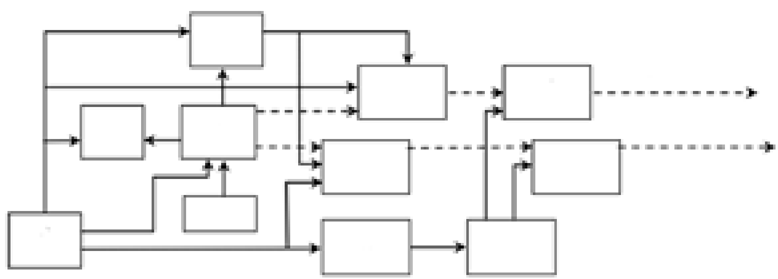

Fig. 2. A block diagram of the generator

1 - a display; *2* - a synthesizer of the signal with a sampling frequency up to 0,001 Hz; *3* - a micro-controller; *4* - an encoder; *5* - a channel A signal synthesizer; *6* - a synthesizer of the channel B signal; *7* - a channel A signal amplifier; *8* - an amplifier of a signal of the channel B; *9* - a battery 5 V; *10* - a voltage converter 5-24 V; *11* - a voltage regulator; *12* - an amplitude control of the output signal.

The transmission of the electrical signal to a patient is carried out by means of contact copper electrodes through wires. The generator operates as follows: the device software sets the operating frequency of the pulse beats of 0,01-100 Hz with a degree not more than 0,001 Hz on each channel. Discreteness of not more than 0,001 Hz in each channel is provided by a clock synthesizer *(2)*. It forms the frequency corresponding to the number of filling of the thirty two-bit synthesizer frequency *(5,6)* divided by 1000.

In our previous article [5] it was said that 20 parameters of ECG were identified, in which the volunteers' neurodynamics before and after the course of electrostimulation differed considerably. The neurotropic stimulation effect has a modulating character, namely: the initially decreased spectral power density (SPD) of the alpha-rhythm in the loci F3, F4, T4, T5 as well as of theta-rhythm in P3 locus increases; the decreased SPD of beta-rhythm in the loci F3, C3, C4, P3, P4 and O2 as well as the amplitude of beta-rhythm becomes even smaller; the initially increased SPD of delta-rhythm in the loci Fp1, F8 and P4 rises further. Thus, a four-day electrostimulation course makes a notable neuro-modulating effect on men with the dysfunction of the neuro-endocrine-immune complex and metabolism. This article deals with the effects of electrostimulation on some parameters of metabolism.

Materials and methods. The objects of observation were 14 men aged 24-59 years (including three authors of this article) without any clinical diagnosis but with the dysfunction of neuro-endocrine-immune complex and metabolism, characteristic for the premorbid (intermediate between health and illness) state. In the basal conditions we determined the level of some metabolic parameters in the blood: cholesterol, bilirubin, urea, creatinine, glucose, amilase, alanine and asparagine aminotranspherase as well as protrombine by means of uniform methods as described in the handbook [7]. Then the volunteers were subjected to an electrostimulation session for 21 minutes during four days. One day after the last session metabolic tests were re-registered.

Results and discussion. The results of the medical research were published previously [1-3].

The primary examination has revealed a number of deviations of metabolic parameters from the average norm. In particular, the level of asparagine aminotranspherase has exceeded by 83 %, alanine AT by 61 %, unconnected bilirubin by 57 %, amilase by 38 %, cholesterol by 31 %, urea by 13 %, glucose by 11 %, while the levels of creatinine and hemoglobine have remained quite normal (+5 % and –4 % respectively), and only the level of prothrombin has reduced by 9 %.

For the purpose of the adequate comparative assessment of deviations and changes in the metabolic data, they are transformed into the normal parameter Z, calculated by formula [8]: Z=(V/N - 1)/Cv; where

V - is the individual value of a variable; N - is its mean of normal (reference) value;

Cv - is a coefficient of variation (SD/N) in norm.

It has been found out that metabolic effects of electrostimulation are ambiguous (Fig. 3-4).

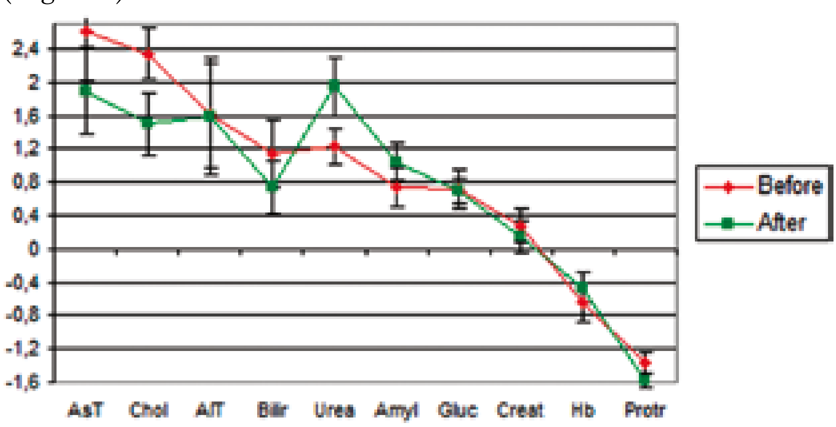

Fig. 3. Metabolic profiles before and after the course of electrostimulation

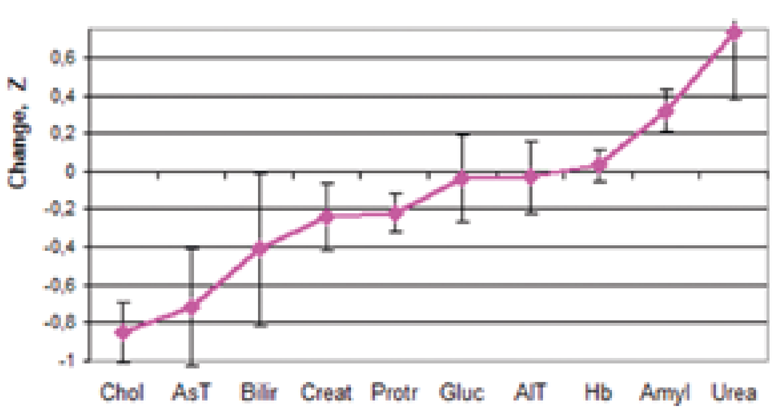

Fig. 4. Changes in metabolic profile caused by the course of electrostimulation

On the one hand, the elevated levels of asparagine aminotranspherase, cholesterol and unconnected bilirubin have reduced, while such levels as urea and amylase have increased even more and the level of prothrombin has become even lower.

If the favorable character of changes of the four parameters is indisputable, it is possible to discuss the two other issues. The increase of the level of urea against the background of the decrease in creatinine levels can be interpreted as the expression of the activation of protein metabolism, but not the deterioration of kidney function. We also consider the favorable and moderate increase of blood amylase, which obviously is accompanied by the simultaneous increase and trypsin with its subsequent excretion into the urine, that is, the increase of its proteolytic activity.

In order to integrate the assessment of individual metabolic changes in each volunteer, the discriminant analysis was conducted. The program included parameters 7 in the model (Table 1 and 2).

The information about the parameters is condensed in the canonical discriminant root, which correlates with some of them negatively, and with others positively (Table 3). This table shows the Raw Coefficients and Constant for discriminant variables which have been calculated, based on the individual values of the metabolic parameters, the individual values of the canonical root before and after the electrostimulation course (Fig. 5).

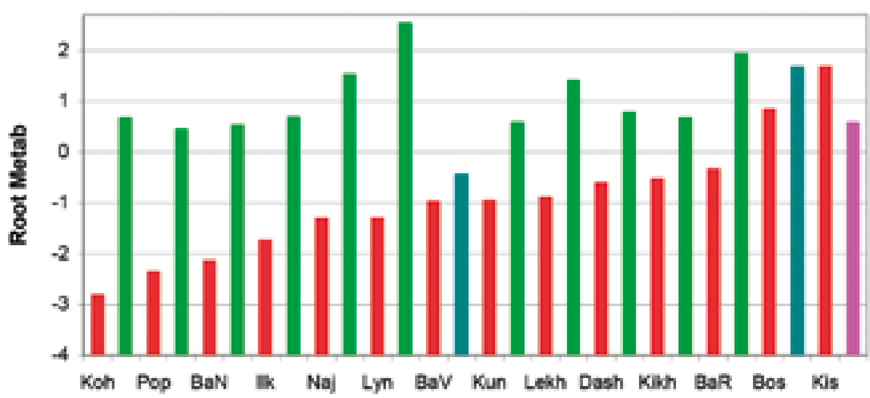

Fig. 5. Individual values of the canonical discriminant root before (red columns) and after (green and other columns) four-day electrostimulation course with the device "VEB-1"

It has been revealed that in 11 volunteers, favorable metabolic changes are significant, in two cases - insignificant and only in one case these changes are slightly unfavorable. In general the significant changes in metabolism are documented by calculating the square of the Mahalanobis distance between the recognition parameters before and after the course of electrostimulation: $D^2M = 4.0$ ($F = 2.9$; $p = 0.030$).

Table 1

Summary of Stepwise Analysis. The scale of ranks for variables

Variables	F to enter	p-level	Λ	F-value	p-level
Cholesterol	3.0	.098	.898	3.0	.097
Urea	4.7	.040	.756	4.0	.030
Glucose	1.7	.202	.705	3.3	.036
Protrombin Index	2.4	.138	.639	3.2	.030
Bilirubin Nonconjug	2.3	.140	.578	3.2	.025
Alanine AT	1.4	.253	.542	3.0	.030
Asparagine AT	1.7	.204	.499	2.9	.030

Table 2

Summary of Discriminant Function Analysis

Step 7, N of variables in model: 7; Grouping: Before&After (2 groups)

Wilks' Lambda: 0.499; approximately $F_{(7.2)}$ = 2,9; p = 0.030

Current Variables in the model	**Norm level (n = 30)**	**Initial level (n = 14)**	**Final level (n = 14)**	**Change after 4 Seanses**	**Wilks' Λ**	**Partial Λ**	**F-remove (1,2)**	**p-level**	**Tolerancy**
Cholesterol, mM/L	4.10 ± 0.10 0	5.39 ± 0.17 +2.34 ± 0.31	4.92 ± 0.21 +1.50 ± 0.38	-0.47 ± 0.09 -0.85 ± 0.16	.639	.781	5.6	.028	.531
Asparagine AT, units	20 ± 1.2 0	36.6 ± 3.8 +2.61 ± 0.60	32.1 ± 3.4 +1.90 ± 0.53	-4.6 ± 2.0 -0.72 ± 0.31	.542	.921	1.7	.204	.102
Protrombin Index, %	97.5 ± 1.1 0	89.0 ± 0.8 -1.36 ± 0.13	87.7 ± 0.6 -1.57 ± 0.10	-1.4 ± 0.6 -0.22 ± 0.10	.602	.829	4.1	.056	.634
Urea, mM/L	5.0 ± 0.3 0	5.67 ± 0.14 +1.23 ± 0.21	6.17 ± 0.26 +1.95 ± 0.35	+0.51 ± 0.24 +0.73 ± 0.35	.606	.823	4.3	.051	.571
Bilirubin NC, µM/L	1.70 ± 0.16 0	2.67 ± 0.35 +1.15 ± 0.41	2.34 ± 0.27 +0.75 ± 0.32	-0.34 ± 0.34 -0.41 ± 0.40	.559	.893	2.4	.138	.692
Glucose, mM/L	4.70 ± 0.14 0	5.24 ± 0.17 +0.72 ± 0.23	5.22 ± 0.11 +0.69 ± 0.15	-0.03 ± 0.17 -0.04 ± 0.23	.556	.898	2.3	.148	.588
Alanine AT, units	23 ± 1.6 0	37 ± 5 +1.61 ± 0.63	37 ± 6 +1.59 ± 0.70	0 ± 2 -0.03 ± 0.19	.570	.875	2.9	.107	.096
Amylase, units	45 ± 4 0	62 ± 5 +0.74 ± 0.23	69 ± 5 +1.05 ± 0.23	+7 ± 2 +0.32 ± 0.11	.482	.966	.68	.42	.843

Table 3

Standardized, Structural and Raw Coefficients and Constant for variables

Variables	**Standardized**	**Structural**	**Raw**
Cholesterol	-.908	-.336	-1.268
Protrombin	-.734	-.210	-.338
Asparagine AT	-1.247	-.167	-.094
Bilirubin NC	-.555	-.137	-.480
Urea	.787	.293	1.113
Glucose	.588	.027	1.189
Alanine AT	1.614	.006	.078
Eigenvalue	1.00	Constant	25.16
R = 0.708; Wilks' Λ = 0.498; $\chi^2_{(7)}$ = 15.6; p = 0.029			

The selected 7 parameters can be used to identify the initial or final status of a particular volunteer. This is achieved through the calculation of classification functions on the basis of the obtained Coefficients and Constants (Table 4).

Table 4

Coefficients and Constants for Classification Functions

Variables currently in the model	**Before course**	**After course**
CHOL	26.53	24.08
UREA	-7.81	-5.66
GLU	-15.70	-13.40
PRI	26.72	26.07
BILNC	11.30	10.37
ALT	-2.39	-2.24
AST	1.64	1.46
Constants	-1196	-1147

The accuracy of the classification is 85.7 % for the initial state (2 errors), 92.9 % after the course (one error) and 89.3 % as a whole.

In the following articles we will give data on the influence of electrostimulation on parameters of autonomous and hormonal regulation, immunity as well as gas discharge visualization. After that, there will be a detailed discussion.

Acknowledgment. We express our sincere gratitude to the laboratory assistants for conducting biochemical analysis. Special thanks to the volunteers.

Compliance with ethical standards. Tests on volunteers were conducted in accordance with the positions of Helsinki Declaration of 1975, revised and complemented in 2002 and the directive of National Committee on ethical principles for medical research. Before conducting the tests the written consents had been received from all participants and all measures were taken for providing the anonymity of participants.

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RESEARCH ARTICLE

The Influence of the Course of Electrostimulation by the Device "VEB-1" on Metabolic Parameters of Practically Healthy Men

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Background. We have created and patented the device for electrostimulation "VEB-1" which is intended to activate the functional systems of a body by the influence of waves on a nerve plexus by means of a frequency beat method. This article is the second one in a series of articles on the influence of this device on the parameters of the neuroendocrine-immune complex and the metabolism of various categories of people.

Materials and methods. The objects of the observation were 14 men aged 24-59 years without any clinical diagnosis but with the dysfunction of neuro-endocrine-immune complex and metabolism. In the basal conditions we determined the level of some routine metabolic parameters in the blood: cholesterol, bilirubin, urea, creatinine, glucose, amilase, alanine and asparagine aminotranspherase as well as protrombine. Then the volunteers were subjected to an electrostimulation session which lasted for 21 minutes during four days. One day after the last session, the metabolic tests were re-registered.

Results. It has been found out that metabolic effects of electrostimulation are ambiguous. On the one hand, the elevated levels of asparagine aminotranspherase, cholesterol and unconnected bilirubin have been reduced, while such levels as urea and amylase have increased even more and the level of prothrombin has become even lower. Such changes were rated as favorable.

Conclusion. A four-day electrostimulation course has made notable modulating favorable effects on men with the dysfunction of neuro-endocrine-immune complex and metabolism.

Key words: electrostimulation, frequency beat method, metabolic parameters.