

The Role of Cardiology in Search of a Paradigm of Psychiatry

S.V. Rosman^{1,*} and L.V. Lebedeva²

¹Physician of functional diagnostics of SBIH, Regional, psychoneurological clinic, Tver, Russia

²Deputy chief physician for expert work, Tver, Russia

Abstract: The paper proposes a new integrated approach to the search for a paradigm of psychiatry, is based on a thorough study of entropy neuron-glia networks of the brain using a unique research method, the variance of the amplitude-frequency characteristics of the alpha rhythm of the EEG, which merged to form a new unit with modern methods of monitoring cardiovascular activity of heart rate variability and dispersion parameters of ECG.

Keywords: Paradigm of psychiatry, Entropy neuron-glia networks of the brain, Cerebro-cardiac interactions, Paranoid schizophrenia, Vegetative violations.

INTRODUCTION

This unusual name of the article is not a publicity stunt. The most successful scientific solutions are on the intersection of science. Currently, there is an urgent problem to revise our ideas about mental illness – the search for new paradigms of psychopathology [11], and in these ways requires the efforts of various scientific disciplines. Understand that in the pages of the journal of cardiology a little strange to read the statement that there is something more important than heart disease, however any sane person would prefer to have a sick heart than a sick mind. The cardiovascular system and Central nervous system are complex management relations, the essence of which is not completely clear so far. The significance of their mutual influence on each other fully manifested in the cerebro-cardiac and cardio-cerebral syndromes, leading often to fatal consequences. Furthermore, heart manifestations of its activities are a unique display unit that allows you to look into the mechanisms of functioning of the vegetative nerve-system. Noah is a mysterious managerial mechanism governing the internal organs.

Therefore, in search of new paradigms of psychiatry, which could be the basis of modern approaches to understanding the causes of psychopathology, we can obtain the explanation of many neurophysiological phenomena, if we keep the means of investigation of the cardiovascular system. Problems of diagnosis of diseases are inseparable from problems of their treatment. Treatment of mental diseases is accompanied by the prolonged use of

cardiotoxic drugs, about what there are numerous researches [1, 3]. The solution to all these problems, you need to take an integrated innovative approach.

This article presents the results of applying an integrated device that allows to simultaneously examine the neurophysiological indicators of brain activity (EEG) and cardiac parameters (heart rate variability and variance ECG). We are talking about "Detector neuropsychiatric disorders" (DNPD) production limited liability company "MCS", Zelenograd, Russia, which allows you to simultaneously record all these changes in visual visualized form with verified and measurable indicators to present to the researcher.

This work provides a new view of psychopathology as a consequence of increasing entropy neuron-glia networks of the brain (NGNB). A marker of this process is a unique phenomenon – the dispersion of amplitude-frequency characteristics of the alpha rhythm of the EEG (DAFCAR), which is manifested by the splitting of the spectrum of the alpha rhythm with an increase in the severity of psychopathology. Currently, there is quite an extensive literature on the subject [6]. As an example of applying this method in practice, here is a graphic reflection indices DAFCAR, which is called the dispersion index of the alpha rhythm (Figure 1).

Visualized data are accompanied by a verified quantitative indicators (indexes) which enable to identify the correlation between separate nosological forms and to monitor the pathologic process in dynamics. The results of a comprehensive assessment of all these data is integrated in the form of graphs (Figure 2).

Mechanism, governing neurophysiological processes in the brain and a compensating increase of

*Address correspondence to this author at the Physician of functional diagnostics of SBIH, Regional psychoneurological clinic, Tver, Russian Federation, Russia, Tel: +7-903-800-11-05; Email: seros2005@mail.ru

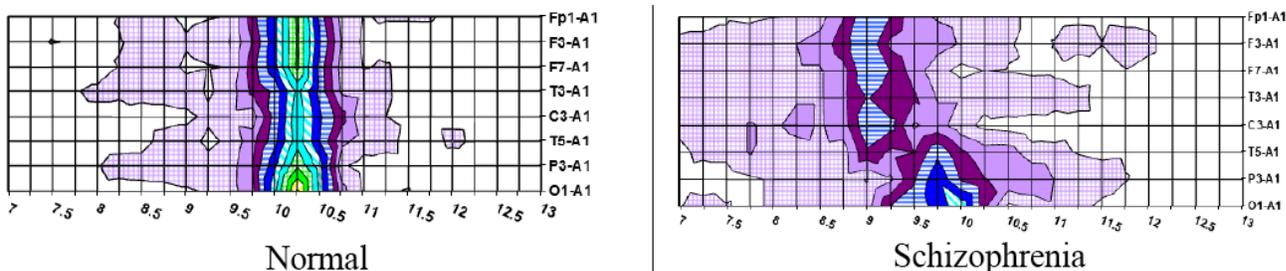


Figure 1: The dispersion diagrams of the alpha rhythm in norm and in schizophrenia (the left hemisphere). Clearly shows the growth of entropy NGNB and slowing of the alpha rhythm in the frontal divisions (functional hypofrontality) [7].

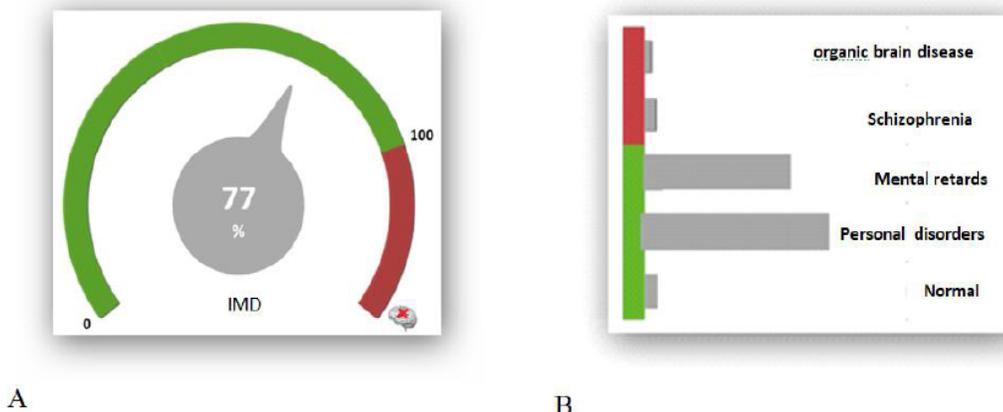


Figure 2: Integral assessment of the mental state of the patient according DNP. **A** - the index of mental disorders(IMD); the potential level of likelihood of organic brain damage in the patient. **B** - the level of potential probability of individual nosological forms of mental diseases the patient.

entropy NGNB is the activity of the autonomic nervous system. There are many methods registration autonomic reactions, but most of them are either cumbersome and in practice not applicable or not verified. However, there is a method that is largely free from these weaknesses - the study of heart rate variability by R. M. Baevsky [2]. This technique, which is based on mathematical analysis of the structure was indicators, is a more adequate assessment of heart rate, in the concept which includes not only heart rate, duration of intervals R - R, but their sequence.

These changes accurately reflect the relationship between the two parts of the autonomic regulation of the activities of the internal organs – sympathetic and parasympathetic. The whole range of parameters present DNP in this publication are excessive, however, the integral parameter of the autonomic nervous system, computed using the DNP - "the index of activity of regulatory systems" (IARS), which is in the form of an index and a very graphic form is presented in the results (Figure 3).

However, the whole complex of research will be incomplete if we do not have information about the status of the "indicator" - the heart muscle. And then the study of ECG is insufficient, since this method is not sufficiently sensitive to tiny changes, reducing them to amorphous and undefined "diffuse changes of a myocardium" or "cardiomyopathy". The necessary device intended for registration and analysis of variance of microfluctuations (microalternations) of both ECG – teeth R and T (the method of dispersion mapping). It cardio-vascular is a highly sensitive diagnostic method that is specific for monitoring the functional a gamogenetic and electrical instability of the myocardium [12]. With this purpose in part D included the "CardioVisor-06C" which uses a unique method of non-invasive rapid control of the functional state of the heart, based on computer calculations and build a 3D model of "heart portrait". "CardioVisor – 06C" allows for early detection of pathological changes of the myocardium in various diseases: coronary heart disease, hypertension, cardiomyopathy, malice, intoxication, etc [4].

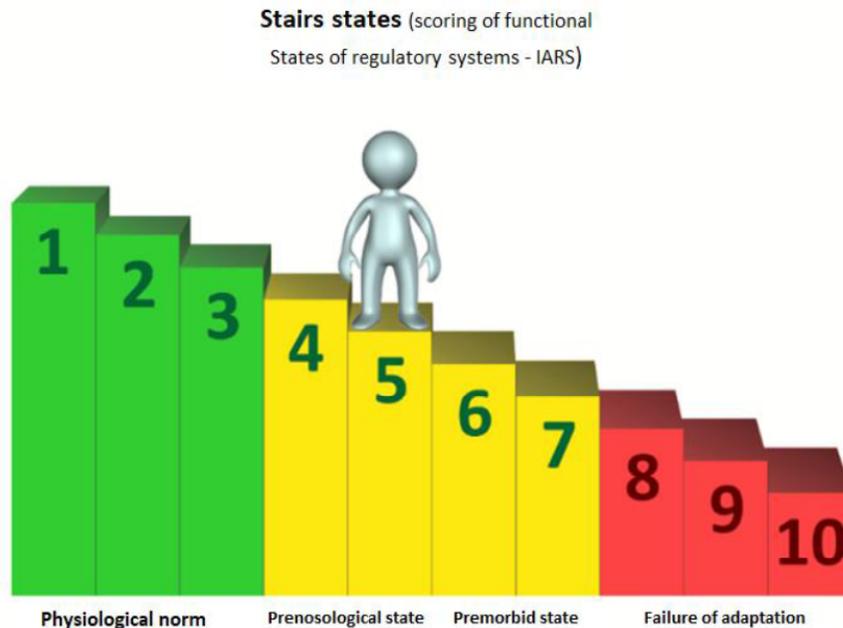


Figure 3: Symbolic representation of level of functional abilities of adaptive mechanisms according to the variability of the heart rhythm (IARS).

In this system the graphical presentation of the results and quantitative parameters of the studied processes (Figure 4).

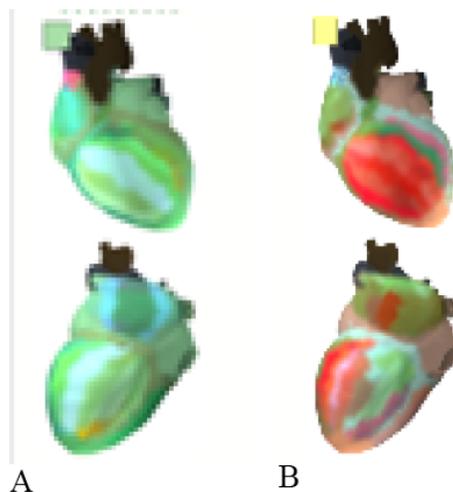


Figure 4: Fragment of a representation of graphical data in the CardioVisor: A – normal, B – pathology. Upper image – the right atrium and the right ventricle, the lower – left atrium and left ventricle.

To demonstrate the capabilities of monitoring changes in the myocardium under the influence of various factors using CardioVisor the results of tests with nitrosorbidum.

It is clearly seen that the dispersion parameters of the myocardium under the action of the drug is improved, especially in the left ventricle. When a

standard ECG study in this re-gastronauts nonspecific changes, not amenable to verification.

It should be noted that the method DAFCAR is currently one of the few dimensional methods in psychiatry, allowing to differentiate mental illness and to study the pathogenetic mechanisms of their occurrence. Cardiointervalogram by R. M. Baevsky and CardioVisor in the complex allow us to understand and evaluate the role of autonomic mechanisms underlying the pathogenesis of psychopathology and, in particular, schizophrenia and to evaluate the cardiotoxic effects of psychotropic drugs.

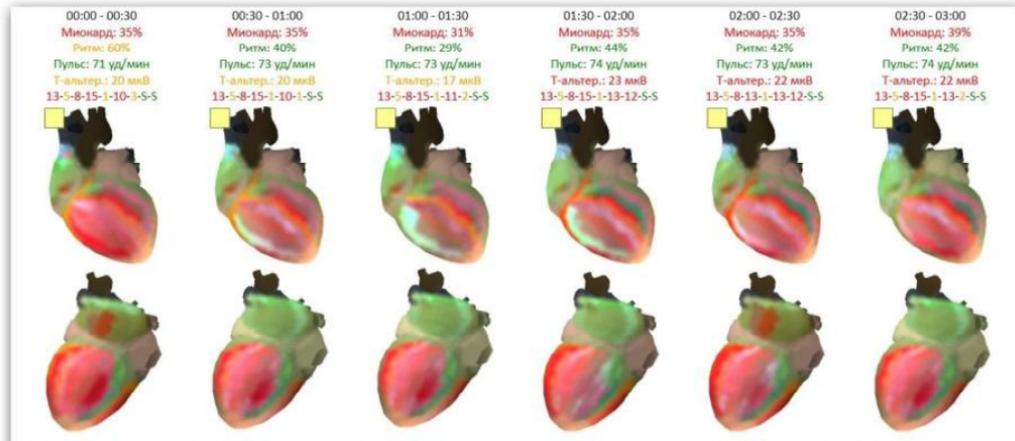
The purpose of the study in the framework of a new conception of schizophrenia as the consequence of specific entropy NGNB to clarify the role of the autonomic nervous system in this process due to cardiotoxic treatment.

MATERIAL AND METHODS

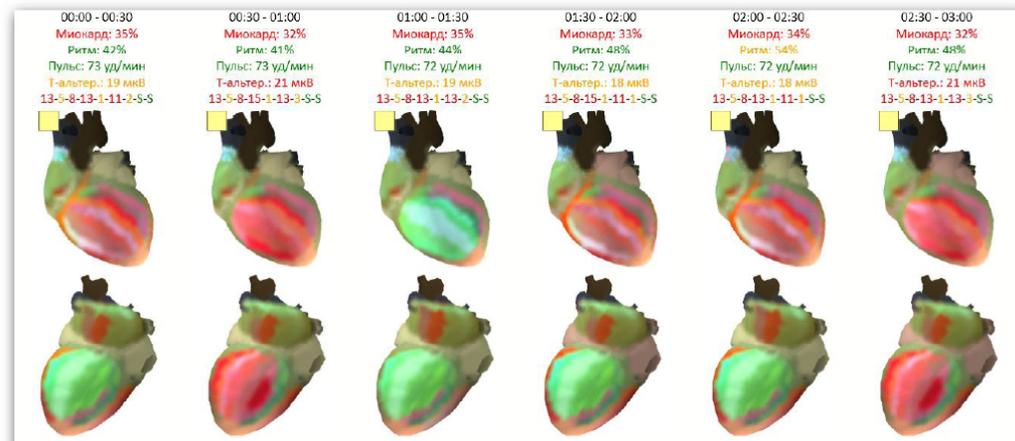
To achieve this goal we examined 46 men aged from 18 to 57 years (mean age of 38.9 ± 1.8 years) and 35 women aged from 22 to 55 years (mean age of 35.9 ± 3.3 years) with schizophrenia.

Research methodology using DNPД is the recording of electrical oscillations on the surface of the skin according to standard methods of ECG and EEG studies. The patient in the sitting position superimposed electrodes according to the international

The beginning of the study, 9:13



The result is logged every 30 seconds for 3 min.9:22
Nitrosorbidum 5 mg under the tongue



After 10 min, 9:32

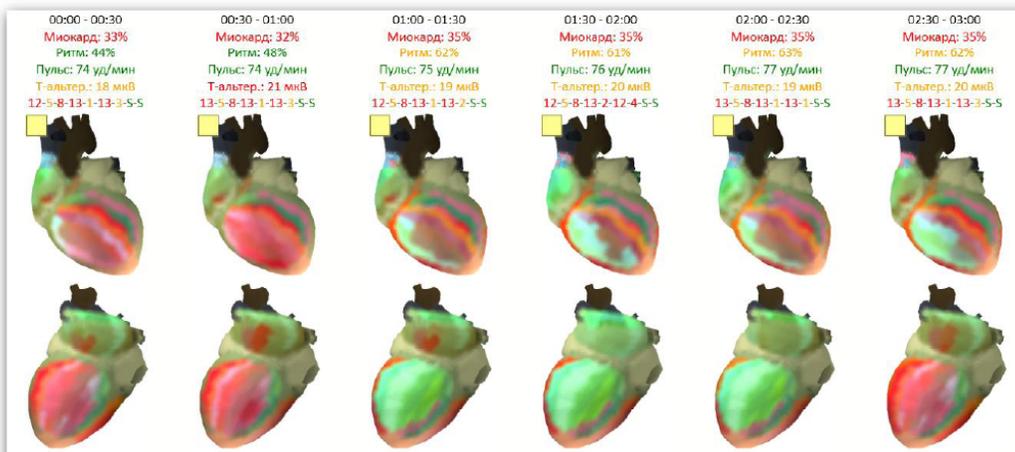


Figure 5: The results of the sample with nitrosorbidum (check with device CardioVisor).

scheme "10-20%" with the average reference electrode for EEG and standard limb electrodes for ECG recording. The shooting is done with my eyes closed in

a darkened room for 3 minutes. The results of the research receive in automatic mode on PC monitor or printed on a color printer.

Table 1: Themajor Indexes DAFCAR Normal

Hemisphere	Leads of EEG	Modal Frequency (Mof), Hz	The Difference Mof «Occipital - Frontal», Hz	CD α 1, c.u.	CD α 2, c.u.	The Kurtosis of a Normal Distribution, c.u.	The Asymmetry of the Normal Distribution c.u.
Left	Frontal	10.088	-0.06	0.192	0.563	5.366	2.256
	Occipital	10.148	0.06	0.269	0.714	6.685	2.599
Right	Frontal	10.048	-0.17	0.16	0.499	3.08	1.743
	Occipital	10.226	0.17	0.28	0.729	6.582	2.553

MC: less than 16% - the norm; 16-19% - it is borderline state; 20-23% - unexpressed pathology; 24-47% - pathology; more than 47% - severe pathology.

IARS: 1-3 – the physiological norm; 4-5 – prenatal condition; 6-7 – premorbid condition; 8-10 – failure of adaptation.

As a first experience of application of DNPД stated objectives is tracked with the following parameters: 1) index DAFCAR; 2) MC, reflecting the results of dispersion mapping of ECG in the CardioVisor, 3) IARS, giving a General overview of the level of adaptation possibilities of organism.

Values of indexes of DAFCAR, MC and IARS were received by the software of DNPR. Mean values of these indexes were subjected to a statistical analysis of average sizes in normally distributed selection by

means of computing opportunities of programs Microsoft EXCEL and Statistica 10.0. The distinction of indexes was considered statistically as reliable at a significance level of 95% and more ($p \leq 0,05$).

Graduation these indicators are the following [4], Table 1.

RESULTS

The indices DAFCAR presented in Table 2.

Table 2: The Indices of DAFCAR

Hemisphere	Indexes	Women		Men	
		Mean CI	CV%	Mean CI	CV%
Left	O Mo f	9.575	14	9.566	11
		8.951-10.199		8.726-9.906	
	O – F	0.713	127	0.515	223
		0.289-1.136		0.114-0.915	
	CD α 1	0.15	33	0.158	32
		0.127-0.173		0.14-0.176	
	CD α 2	0.48	23	0.511	26
		0.427-0.532		0.466-0.557	
	IIDA	2.156	119	2.081	115
		0.96-3.353		1.246-2.916	
	ADA	1.439	53	1.538	42
		1.083-1.795		1.313-1.763	
	IIH	0.602	279	1.985	155
		-0.185-1.389		0.914-3.056	
	AH	1.066	49	1.427	56
		0.82-1.312		1.15-1.704	
Alpha-1/Alpha	0.413	54	0.434	46	
	0.308-0.517		0.365-0.504		
Alpha-2/Alpha	0.428	39	0.454	40	
	0.351-0.505		0.391-0.518		
Alpha-3/Alpha	0.187	83	0.135	62	
	0.114-0.26		0.106-0.164		

Right	O Mo f	9.638	16	9.515	10
		8.915-10.36		8.712-9.918	
	O - F	0.888	171	0.551	167
		0.179-1.596		0.23-0.873	
	CDα1	0.112	33	0.134	38
		0.094-0.129		0.116-0.151	
	CDα2	0.378	27	0.425	30
		0.331-0.426		0.381-0.469	
	IIDA	1.52	121	2.588	110
		0.66-2.38		1.597-3.58	
	ADA	1.402	40	1.605	49
		1.14-1.664		1.329-1.88	
	IIH	0.907	252	1.692	158
		-0.162-1.975		0.759-2.624	
	AH	1.09	61	1.365	54
		0.778-1.403		1.107-1.623	
Alpha-1/Alpha	0.393	60	0.43	48	
	0.283-0.503		0.357-0.502		
Alpha-2/Alpha	0.444	41	0.467	41	
	0.359-0.529		0.399-0.534		
Alpha-3/Alpha	0.163	88	0.104	58	
	0.096-0.23		0.083-0.125		

Note= The index values DAFCAR. Gender differences are statistically significant.

1. Mo f is the Modal frequency of the alpha rhythm in the occipital (O1, O2) leads
2. O – F - the difference between the modal frequency was in the frontal (F3, F4) and occipital (O1,O2)leads
3. Alpha-1/alpha, the proportion of power of low frequency alpha-rhythm in the gross capacities of all the electrodes of the hemisphere (alpha-1(7-9 Hz)/alpha summary. [%] - the overall slowing of the alpha rhythm in the hemisphere);
4. Alpha-2/alpha the same for mid-frequency alpha-rhythm (alpha 2(9-12 Hz)/alpha summary. [%]);
5. Alpha-3/alpha the same for high frequency of the alpha rhythm (alpha-3(12-14 Hz)/alpha summary. [%]) is the total acceleration of the alpha rhythm in the hemisphere;

Dispersion the index of the alpha rhythm shows degree of deviation of power distribution of the alpha rhythm in the spectrum from normal:

6. CDα1– main index characterizing the degree of splitting of the spectrum of alpha-rhythm power ratio of alpha rhythm modal frequency to the total power of the alpha rhythm in the range 7-13 Hz. CDα2– power ratio of alpha rhythm in the range of Mo±0.5 Hz to the total power of the alpha rhythm in the range 7-13 Hz
7. IIDA – integral index of dispersion of the alpha rhythm – the kurtosis of a normal distribution CDα1 in occipital leads (O1, O2)
8. IIH – integrated index of hypofrontality - the kurtosis of a normal distribution CDα1 in the frontal leads (F3, F4)
9. ADA – the asymmetry of the dispersion of alpha-rhythm asymmetry of the normal distribution CDα1 in occipital leads (O1, O2)
10. AH – hypofrontality asymmetry – asymmetry normal distribution CDα1 in the frontal leads (F3, F4) [6].

The results of the parameters obtained using R. M. Baevsky (Table 3). Cardio Visor and heart rate variability by

Table 3: Results of a Research of Cardiovascular System by Means of DNPD

Indexes	Women	CV%	Men	CV%
MC	14.9	16	15.765	10
	13.8-16.0		15.2-16.3	
IARS	6.8	37	7.1	21
	5.2-7.4		6.5-7.5	
Puls1/min	91.85	19	98.3	18
	83.5-100.1		92.1-104.4	

DISCUSSION OF THE RESULTS

The obtained data provide us a wide field for interpretation.

1. The index values of DAFCAR consistent with previously obtained values in schizophrenia, which is characterized is the increase in entropy NGNB, mainly in frontal departments, resulting in the phenomenon of functional hypofrontality – index values DAFCAR reduced compared to the norm (Table 1). Especially characteristic is the increase in the difference between modal frequencies in the frontal and occipital departments – more than 0.7 Hz. In fact, the frontal and occipital parts of the brain work in different modes, which creates considerable difficulties in the evaluation of afferent information.

2. There is some, though vaguely expressed, the correlation between the index values DAFCAR and

variability of heart rate (Table 4). First of all, the values of IARS are mainly in the field of breakdown of adaptive mechanisms (Figure 5), despite the fact that the average value of it is in the area of premorbid changes. The IARS correlated with the main index DAFCAR - CDa1, and correlation on the inverse – the higher the value CDa1, the lower the value of the IARS. Increasing the value of CDa1 shows the reduction of entropy NGNB, and a reduction of IARS indicates an increase of adaptation reserves. Thus, the more entropy increases NGNB, the lower the adaptation reserves. In addition, the correlation parameter TPVLF with the major indices, especially in the right hemisphere, indicates an increase in tension of the sympathetic nervous system. The interesting point here is the fact that the right and left hemisphere in relation to this parameter has the opposite trend. Such functional asymmetry has been repeatedly noted by many authors. In conjunction with the acceleration of

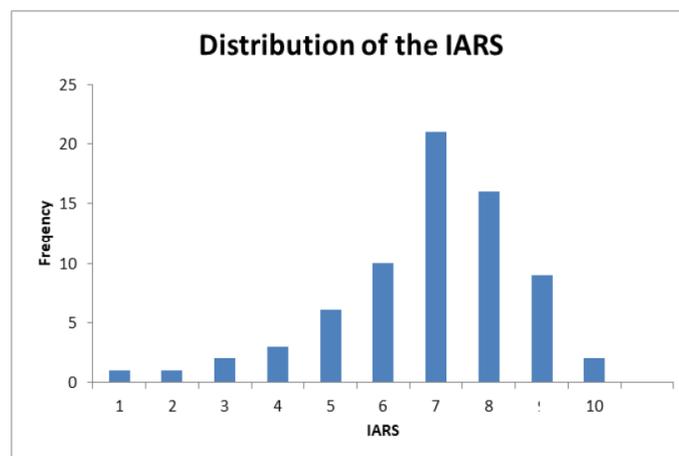


Figure 6: A histogram of the distribution of the parameters PARS among schizophrenia patients (men and women in total in connection with the statistical unreliability of gender differences).

Table 4: Cross-correlation a Comparative Analysis of Indices DAFCAR and Indicators of Heart Rate Variability (Correlation Coefficient r , False Values Filtered), STATISTICA 10.0

Hemisphere	Indexes	LF %	HF %	ULF/ LF	TPULF ms^2	TPVLF ms^2	Amplitude of Mode %	IARS
Left	Alpha-1/Alpha	-0.146	0.219	0.139	-0.069	-0.288	0.060	-0.081
	O Mo f	0.189	-0.224	-0.282	0.053	0.317	-0.161	-0.116
	CDa1	-0.308	0.149	-0.003	-0.185	-0.101	0.049	-0.280
	CDa2	-0.220	0.129	-0.066	-0.147	-0.064	-0.013	-0.193
Right	Alpha-1/Alpha	-0.153	0.190	0.163	-0.109	-0.322	0.048	-0.065
	O Mo f	0.306	-0.325	-0.229	0.110	0.312	-0.227	-0.133
	CDa1	-0.211	0.090	0.012	0.281	0.289	-0.284	-0.283
	CDa2	-0.047	0.023	0.010	0.356	0.284	-0.219	-0.192

Note= Red font shows a statistically significant correlation coefficient r .

the pulse (the tendency to tachycardia) it creates an overall picture of sympathicotonia. It is possible that there is present evidence "dopamine participation" in the formation of the schizophrenic process, however, it is possible that the dopamine mechanism is designed to mitigate the violations that occur in schizophrenia is to accelerate and synchronize the activity of neurons in the frontal lobes. This is supported by the fact that in the early stages of schizophrenia there is "supersynchronous" alpha-rhythm in all departments, which disappears when the stressful situation – for example, during hyperventilation test (HVT).

These observations are fully consistent with the previously described for other mental States, the tendency to violent crimes [8], pedophilia [10], with "professional burnout" [9] - with all these processes were observed reduced adaptive reserve NGNB, detectable in HVT.

3. It is obvious that the MC indicators not comply with the age regulations and are located in the border zone. The most likely reason for this is the treatment cardio toxic drugs, mainly neuroleptics, especially because data about it has long been known from scientific publications [12, 13].

CONCLUSIONS

1. The use of the device «Detector neuropsychiatric disorders" produced by "MCS", Zelenograd, Russia expands the diagnostic capabilities of physicians in the diagnosis of mental illness and promotes the search for new paradigms of psychopathology.

2. Synchronization time analysis of electroencephalographic and cardiovascular indicators allows to reveal new links in the pathogenesis of schizophrenia to search for more successful methods of treatment.

3. The use of such integrated devices allows not only to find new Les drug treatment for mental illness, but also to secure their effective use by a highly sensitive monitoring.

ABBREVIATIONS

- **DSch**: debut of paranoid schizophrenia (F20.09x ICD-10).
- **DAFCAR**: Dispersion of Amplitude-Frequency Characteristics of the alpha rhythm EEG.
- **NGNB**: Neuron-Glial Network of the brain.

- **HVT**: Hyperventilation test.
- **CDa1**: Coefficient of Dispersion of alpha-Rhythm EEG-1 (the quotient of the modal values of power of alpha rhythm to his total power in the range of 7-13 Hz).
- **CDa2**: Coefficient of Dispersion of the alpha-Rhythm EEG-2 (the quotient of the power of the alpha rhythm in the range of "a modal value ± 0.5 Hz" to his total power in the range of 7-13 Hz).
- **Mo f**: Value of the Modal Frequencies in Occipital Electrodes.
- **F Mo f**: Value of the Modal Frequencies in Frontal Electrodes.
- **Mo f - F Mo f**: Value of the Difference of Modal Frequencies Between the Occipital and Frontal Electrodes.
- **IIDA**: Integral Index of Dispersion of the Alpha rhythm EEG (Value of the Kurtosis of the Normal Distribution CDa1 in the Occipital Electrodes).
- **ADA**: Asymmetry Distribution of the Alpha rhythm EEG (Value of the Asymmetry Distribution CDa1 in the Occipital Electrodes).
- **IIH**: Value of the Index Hypofrontality (Kurtosis of the Normal Distribution CDa1 in the Frontal Electrodes).
- **AH**: Value of the Asymmetry of CDa1 in the Frontal Electrodes.
- **IARS**: index of activity of regulatory systems (a comprehensive assessment of the reserves of adaptation according to the heart rate variability).
- **MC**: complex parameter of dispersion mapping of ECG.
- **CV%**: the coefficient of variation.
- **CI**: Confidence interval.
- **c.u.**: conditional unit.

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