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ELECTRO-PHOTONIC EMISSION ANALYSIS AND HARDWARE-SOFTWARE RECORDING OF HEART RATE VARIABILITY DURING AN OBJECTIVE STRUCTURED CLINICAL EXAMINATION

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The article is dedicated to the blessed memory of the author of HRV method and the cybernetic model of cardiac activity dual-circuit regulation by R. Baevsky (August 3, 1928 - May 31, 2020)

Practical issues of studying the role of electromagnetic phenomena of cardiac activity and tissues of the human body in the diagnosis of the functional state of the human body are presented in the article. The purpose of the publication is to determine the clinical diagnostic potential and feasibility of using computerized techniques for a short recording of Heart Rate Variability and Electro-Photonic Emission Analysis as part of the instrumental component of an Objective Structured Clinical Examination in the clinic of Internal Medicine. The results of the examination of functionally healthy people and compensated patients with Noncommunicable Diseases are presented in the article.

Key words: Non-communicable diseases, Objective Structured Clinical Examination, Electro-photonic Emission Analysis, Heart Rate Variability.

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АНАЛІЗ ЕЛЕКТРИЧНОЇ ЕМІСІЇ ФОТОНІВ І АПАРАТНО-ПРОГРАМНИЙ ЗАПИС ВАРІАБЕЛЬНОСТІ РИТМУ СЕРЦЯ В СТРУКТУРІ ОБ'ЄКТИВНОГО КЛІНІНІЧНОГО ОБСТЕЖЕННЯ

У статті представлені практичні питання вивчення ролі електромагнітних явищ серцевої діяльності і тканин організму людини в діагностиці функціонального стану організму людини. Мета публікації – визначити клінічний діагностичний потенціал і можливість використання комп'ютеризованих методів запису короткої записи варіабельності серцевого ритму і аналізу електричної емісії фотонів при виконанні інструментального компонента об'єктивного клінічного обстеження пацієнта в клініці внутрішніх хвороб. У статті представлені результати обстеження функціонально здорових людей і компенсованих хворих на неінфекційні захворювання.

Ключові слова: неінфекційні захворювання, клінічне об'єктивне обстеження, варіабельність серцевого ритму, аналіз електричної емісії фотонів.

This research work is a fragment of the initiative research project "Development of algorithms and technology for introducing a healthy lifestyle in patients with non-communicable diseases based on the study of psycho-emotional status,"(State registration No. 0116U007798.

The progress of the fundamental sciences led to the emergence of new knowledge about the structure and functioning of the human body. Today it is understood that electromagnetic phenomena determine the basis of the life of the human body. New technical capabilities and new knowledge open up new approaches to the study and understanding of electromagnetic phenomena in living systems and humans [6, 8, 9]. Therefore, progress in the interpretation and practical application of modern methods for assessing the electromagnetic phenomena of the human body is important for a practicing physician. For example, the assessment of the results of the electrical activity of the heart can provide a lot of additional information to the physician about the functional state of the patient's body. This became possible as a result of the use of modified computerized hardware-software recording of Heart Rate Variability (HRV) techniques. Promising methods for assessing the functional state of a patient based on the study of electromagnetic phenomena from the surface of the human body have also been created. An example of a promising technique is the Electro-Photonic Emission Analysis (EPEA) from human fingers. The introduction of these modern techniques during an Objective Structured Clinical Examination (OSCE) can improve the efficiency of diagnostics of Noncommunicable Diseases (NCDs) and it can help practical health care to win over the NCDs pandemic. The use of these techniques in physical examination can help achieve the goals of 4P-medicine as well.

The purpose of the work was to determine the clinical diagnostic potential and feasibility of short HRV recording in OSCE patients and EPEA from human fingers as an instrumental procedure and to help solve the problem of NCDs by improving diagnostics based on the study of electromagnetic phenomena in the body using modern high technology.

Materials and methods. An open, non-randomized, controlled study was performed at the Educational and practical Center of Biophotonics and Valeology of the Department of Internal Medicine and Emergency Medicine of the Ukrainian Medical Stomatological Academy (UMSA, Poltava, Ukraine). 82 people were recruited to participate in the study. 32 compensated patients with NCDs were included in Group 1 (average age – 56.06±14.56 years; men – 10(32%) were examined. Anamnestically healthy 50 students and postgraduate students of the UMSA (average age – 25.04±8.37 years; men – 18(36%) were examined in the course of the annual preventive training department strategy "Doctor in the fight against NCDs: start with yourself" (2020-2021) and they amounted to Group 2 (control). The study was approved by the Ethics Committee of the UMSA. It was carried out in compliance with all applicable ethical rules.

The study design included the following steps: 1) performing EPEA from all fingers of the patients; 2) HRV-short recording (background recording (BR) – 5 minutes and Orthostatic test (OT) – 3 minutes); re-performing EPEA from patients' fingers.

HRV was assessed using a certified medical complex (model Poly-Spectr, Neurosoft Company, Ivanovo, Russia). Technical requirements and commercial recommendations for the implementation of the research methodology were observed. Blood pressure was measured before and after recording HRV. The analysis of the results of HRV recording was carried out automatically by the hardware-software complex Poly-Spectr. Evaluation automatic conclusion included indicators of variation heart rate or Variational Pulsometry (according to R.M. Baevsky [1-3]) (Mode (Mo), Mode Amplitude (AMo, %), Regulatory systems Stress Index (SI, c.u.), Variation Range (VR), Vegetative Balance Index (VBI=AMo/VR), Indicator of the adequacy of regulation processes (IARP=AMo/Mo), Vegetative Rhythm Index (VRI=1/Mo□VR), Index of Tension of regulatory systems or Baevsky Index (TI=AMo/(2VR□Mo) and Spectral Analysis (Total power (TP, ms2); Very low frequency (VLF, ms2, %) – 0033-0.04 Hz; Low Frequency power (LF, ms², %) 0.04-0.15 Hz; High Frequency power (HF, ms², %) – 0.15-0.4 Hz; a ratio of Low Frequency to High Frequency (LF/HF ratio) [1-4].

The EPEA was performed on a Bio-Well GDV Camera 2.0 (Bio-Well, San Petersburg, Russia). This instrument is being used in a wide range of scientific and practical applications in more than 65 countries. Bio-Well camera has CE, EU and FDA certifications. This method, promising for medicine, was based on the physical phenomenon of the electro-photonic emission – flow of electrons from a conductive object under the influence of high frequency high intensity electro-magnetic impulse that creates photonic emission (Glow) in the air gas discharge visualization (GDV). The modern digital software package Electro-Photonic Imaging (EPI) was used as the basis for recording the parameters of the phenomenon of electro-photonic emission from human fingers in the Bio-Well GDV Camera 2.0 device and analyzing the results. The EPI is based on computer image analysis of photons, emitted by a subject in strong impulse electromagnetic field. We used the Full scan mode in our study. Full Scan was regime of capturing GI of human fingers (all ten) in the Bio-Well Software that allows to get maximum parameters about functional (energetic) state of a person, his/her systems and organs, based on intersection of each finger into sectors according to acupuncture points concept and more than 20 years of clinical studies. We assessed the parameters Energy of Glow (E, J), Area (A, number of pixels of the Glow Image (GI), Form Coefficient (FC; it's calculated according to the formula: FC=L2/S, where L is the length of the GI external contour and S is the GI Area), Entropy Coefficient (EC; it's the ratio of outer contour to the inner contour lengths), Stress (S), Balance (B), Balance left (BL), Balance right (BR) in our study [5, 6].

Statistical analysis was performed using the Prism 5.0 software package. The data obtained are presented as mean values with their mean error (M±m). Unpaired t test and F test to compare variances were used to determine the statistical significance of differences between groups. Differences were considered significant at $p < 0.05$.

Results of the study and their discussion. The results of registering clinically significant indicators of short recording of HRV among respondents are presented in table 1.

The short recording of HRV was developed for diagnosing the functional state of the patient and this is its clinical value. It is suitable for group analysis of results as well. It is necessary to exclude from the data of the group analysis the results of HRV recording with pronounced areas of rhythm disturbance, since this leads to an incorrect mathematical calculation in the form of large unrealistic values of the spectrum power indices. This makes it possible to obtain data on the function of the body, and not to register pathological phenomena of rhythm disturbance. This is a fundamental difference between the method of short recording of HRV and Holter monitoring, the purpose of which is to identify precisely pathological symptoms.

Table 1

Comparative characteristics of the parameters of the spectral analysis and variation heart rate/Variational Pulsometry monitoring

	Group 1 (n=271)		Group 2 (n=50)	
	BR	OT	BR	OT
HR, bpm	72.61±13.14	84.13±15.34	70.37±11.16	93.49±10.66
Mo, s	0.818±0.188	0.737±0.645*,**	0.874±0.153	0.645±0.09*,**
AMo, %	62.44±17.14*	63.5±18.69*,**	42.1±15.6*	49.23±12.2*,**
SI	391.1±357.4*,**	449.5±395.5*,**	143.2±160.7*,**	224.6±129.2*,**
TP, ms^2	926.8±1178*,**	1157±1153**	3069±2533*,**	3917±13022**
VLF, ms^2	303.8±233.7	517.7±453.9**	1066±897.8	1365±3795**
LF, ms^2	253.7±358.9*,**	351.4±671.6**	844.2±729*,**	2097±7729**
HF, ms^2	369.2±772.7*,**	291.0±719.7**	1165±1428*,**	455.4±1570**
VLF, %	48.64±21.5*,**	63.5±22.95*,**	41.08±16.45*,**	40.88±16.63*,**
LF, %	24.68±10.43*	22.58±16.89*	29.4±9.2*	47.9±16.14*
HF, %	26.68±21.27	13.91±13.06**	29.53±17.74	11.22±6.7**
LF/HF	1.79±1.8	3.39±4.6	1.6±1.4	6.28±4.8
VR, s	0.267±0.242	0.223±0.211	0.348±0.217	0.279±0.128
TI	322.9±343.3*,**	446.5±488.1*,**	112.4±116*,**	175.5±101.1*,**
IARP	80.52±27.8*	91.63±37.4**	51.34±26.0*	78.14±22.4**
VBI	512±532.9*,**	595.1±566.8*,**	177.5±157.4*,**	222.2±135.7*,**
VRI	9.04±8.0*,**	11.85±9.8*,**	4.53±2.9*,**	6.75±2.8*,**

Note 1 – Data from five patients were excluded from the final calculation due to a statistically significant rhythm disturbance (Extrasystoles). * – the difference Unpaired t test is reliable at p<0.001 between the characteristics Group1. Group2 before and after OT. ** – the difference F test to compare variances is reliable at p<0.001 between the characteristics Group1. Group2 before and after OT.

Therefore, the results of recording four patients from group 1 were excluded from the statistical processing of the background HRV recording after the study. Statistically significant extrasystole appeared in one patient of group 1 after performing the orthostatic test and its results were excluded from the analysis as well. The short recording of HRV showed significant sensitivity to changes in cardiac activity parameters depending on the level of health according to the results of this study. It was found that the indicators of Group 1 significantly differed from the control group and from the normal levels in a number of cases (tab. 1). We believe that TP assessment is of particular clinical importance as an objective indicator of the level of energy activity of the heart and the functional level of the state of the body. It was found that TP is significantly lower in group 1 and below the normal level of 1500 ms2; this demonstrates an objective decrease in the energy output of cardiac activity in NCDs and may be another new objective indicator of the health level. Indices of variation heart rate monitoring (according to R.M. Baevsky [1-3]) are of great clinical importance for assessing the functional state as well (tab. 1). Therefore, the evaluation of the parameters of the short-form method indicated in our study can be recommended for use at OSCE to improve the diagnosis of NCDs.

The EPEA EPI method was designed for a personalized approach to the diagnosis of a patient's functional state and this is its clinical value. However, to assess the validity of EPEA EPI scores, we analyzed the scores in groups (tab. 2).

Table 2

Comparative characteristics of the parameters of the EPEA

	Group 1 (n=32)			Group 2 (n=50)		
	BR	OT	P value	BR	OT	P value
E,*10-2J	51.57±4	53.21±3.4	0.08/0.4	53.15±4	53.76±3.8	0.44/0.7
FC	3.11±0.4	3.92±0.3	0.29/0.1	2.96±0.4	2.70±0.3	0.91/0.1
EC	2.70±0.3	2.67±0.3	0.7/0.9	2.65±0.3	2.95±0.4	0.34/0.6
S, c.u.	4.44±1.1	4.12±1.3	0.3/0.9	4.43±1.3	4.18±1.3	0.34/0.8
B, %	97.1±2.7	97.07±1.86	0.96/0.04	96.47±3.37	96.96±2.41	0.41/0.007
BL, %	83.83±7.68	89.11±6.19	0.46/0.24	86.67±9.07	92.11±5.93	0.006/0.004
BR, %	89.18±7.01	92.19±5.41	0.06/0.15	91.7±6.9	93.83±4.78	0.08/0.01

Note: P value of the Unpaired t test/P value of the F test to compare variances

The EPEA showed a sufficient level of repeatability and stability of the recorded parameters of the functional state of patients, since there were no significant differences between the indicators re-made after HRV registration. We found that there was no statistically significant effect of OT performance on EPEA scores (tab. 2). There were no significant differences between the indicators of Group 1 and Group 2. The E level was in the range of the optimal level (40-70*10-2 J) in both groups. The balance between the total luminescence energies of all fingers of the left and right hands was in the range of the optimal level (90-100%). The absence of fundamental deviations from the norm in Group 1 can be explained by the fact that all patients were compensated and they did not have severe pathology and life-threatening metabolic disorders at

the time of examination. EPEA showed that the level of stress/arousal was increased in both groups (0-2 c.u. corresponds to a state of relaxation, 2-3 c.u. corresponds to a normal calm state; 3-4 cu corresponds to a state of anxiety; 4-6 cu corresponds to an excited state; 6-8 and 8-10 c.u. is a high level of stress or arousal).

Our comparison of the clinical significance of the short recording of HRV and EPEA EPI methods showed that these methods reflect fundamentally different aspects of a person's functional state and they can be complementary in OSCE. The clinical significance of short recording of HRV lies in identifying the functional state of the cardiovascular system, adaptation mechanisms, assessing the levels of the body's functional reserves, it allows predicting the patient's vital resources and dynamically monitoring them during treatment. The EPEA EPI method reflects the fundamental bioenergetic aspects of the functioning of the human body at the tissue level. Therefore, it probably does not respond as quickly as HRV and its energy performance is less labile than HRV. It is this feature of the EPEA EPI method that has determined the variety of its use in psychophysiology, sports and in the unique possibility of studying the human body during and after dying [7, 8].

The progress in the development of quantum physics gave an understanding of the energy balance in Nature. The fact was understood that all matter consists of diametrically opposite supersymmetric complementary entities of the particle-wave type, which have the ability to annihilate when added. These physical laws have changed the scientific knowledge about the organization of living matter at the micro level and they completely change the theoretical scientific views on the human body. Now each structure of the human body (atom, molecule, cell, organ, physical body) can also be described in two different ways (both as matter and as energy) from modern physical positions. This postulate makes scientifically substantiated the possibility of describing the human body as a result of the manifestation of field structures forming its living matter (atom, molecule, cell, organ, physical body), explains the presence of field structures in the human body, opens up new prospects for the scientific study of energy processes in it in the course of his life. Therefore, the use of methods for assessing electromagnetic phenomena in an OSCE is the next level of penetration into the essence of the fundamental functioning of the human body. These methods are a source of information about the systemic informational energy processes of the human body and they can supplement traditional clinical methods (examination, palpation, percussion, auscultation) when making the initial diagnosis and assessing the patient's status in medical practice. HRV and EPEA are well-known methods for studying electromagnetic phenomena. HRV and EPEA results are of clinical value for objective assessment of the functional status of patients during OSCE. The use of HRV and EPEA methods gives the doctor an unprecedented opportunity to get in 15-20 minutes clear information about the levels of stress and adaptation, functional reserves, the nature of metabolic processes at tissue and organ levels, the state of the patient's autonomic regulation, and this can become an important addition to a personalized and systemic approach. to determine the tactics of medical management of this patient.

Conclusions

1) There was established a significant difference between the indicators of the spectral power of the heart and the variation heart rate in patients with NCDs and the indicators of functionally healthy respondents.

2) The TP indicator can be considered as a new objective criterion for assessing the health level and prognosis of the patient's health.

3) The method of short recording HRV is quite sensitive, it has clinical significance and it can be recommended as an addition to OSCE.

4) The EPEA EPI method allows you to objectively display the total level of fundamental energy processes in the body and it has a sufficient level of repeatability and stability of results according to preliminary data.

5) The EPEA EPI method can be used in a comprehensive assessment of the functional state and energy status during the OSCE.

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FEATURES OF CHANGES IN PLATELET FUNCTIONAL ACTIVITY IN PATIENTS WITH CORONARY ARTERY DISEASE AND HYPERTENSION DEPENDING ON SENSITIVITY TO ANTIPLATELET DRUGS

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Hypertension is an urgent problem of cardiology, due to its prevalence and adverse complications. The purpose of the study was to optimize the diagnosis and treatment of patients with coronary artery disease and hypertension based on the researching of functional activity of platelets and the effectiveness of antiplatelet therapy. A total of 147 patients were included, the control group consisted of 30 people. It was determined that 54% of patients treated with acetylsalicylic acid had impaired sensitivity to treatment and 27% – to thienopyridine drugs. The most noticeable changes were observed in the degree of induced platelet aggregation with arachidonic acid and collagen among patients receiving acetylsalicylic acid, and thienopyridines as for adenosine diphosphate – and adrenaline-induced platelet aggregation. Given the heterogeneity of indices in groups of patients with hypertension and various forms of coronary artery disease, the study of vascular-platelet hemostasis in the whole blood by express method makes it possible to more accurately determine the degree of sensitivity to antiplatelet therapy.

Key words: hypertension, coronary artery disease, vascular-platelet hemostasis, sensitivity to antiplatelet therapy

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ОСОБЛИВОСТІ ЗМІН ФУНКЦІОНАЛЬНОЇ АКТИВНОСТІ ТРОМБОЦИТІВ У ПАЦІЄНТІВ З ІШЕМІЧНОЮ ХВОРОБОЮ СЕРЦЯ ТА ГІПЕРТОНІЧНОЮ ХВОРОБОЮ В ЗАЛЕЖНОСТІ ВІД ЧУТЛИВОСТІ ДО АНТИТРОМБОЦИТАРНИХ ПРЕПАРАТІВ

Гіпертонічна хвороба є актуальною проблемою кардіології, що пов'язано з її поширеністю і несприятливими ускладненнями. Метою роботи було оптимізувати діагностику та лікування хворих на ішемічну хворобу серця з гіпертонічною хворобою на підставі вивчення особливостей функціональної активності тромбоцитів та ефективності антитромбоцитарного лікування. Було включено 147 пацієнтів, група контролю – 30 осіб. Визначено, що 54 % хворих, які отримували у складі терапії ацетилсаліцилову кислоту мали знижену чутливість до проведеного лікування та 27 % – до тієнопіридинів. Найбільш помітні зміни спостерігались у ступені індукованої агрегації тромбоцитів арахідонової кислотою та колагеном серед пацієнтів, які отримували ацетилсаліцилову кислоту, та у ступені аденозиндифосфат- та адреналін-індукованої агрегації тромбоцитів – тієнопіридини. Враховуючи гетерогенність показників, у групах пацієнтів з гіпертонічною хворобою та різними формами ішемічної хвороби серця, дослідження тромбоцитарної ланки гемостазу експрес-методом у цільній крові дає можливість більш точно визначити ступінь чутливості до антитромбоцитарної терапії.

Ключові слова: гіпертонічна хвороба, ішемічна хвороба серця, тромбоцитарний гемостаз, чутливість до антитромбоцитарного лікування

The work is a fragment of the research project: "Features of changes in coagulation systems in the comorbid course of coronary artery disease and hypertension, laboratory and genetic predictors of thrombotic complications. Determining the features of the hemostasis system with hypertension and comorbid conditions", state registration No. 0118U001391.

Hypertension is an urgent problem of cardiology, due to its prevalence and adverse complications [7, 15]. In the absence of complete treatment, hypertension leads to coronary artery disease (CAD), heart failure (HF), stroke, renal failure, and early mortality [13]. Increased attention of physicians is explained by the fact that these diseases often develop in able-bodied active people, significantly limiting their social and labor activity, exacerbating socio-economic problems in society [8, 11].

According to the official statistics of the Ministry of Health of Ukraine in 2017, 7,751,199 people with coronary artery disease and 10,388,376 patients with hypertension were registered, most of whom were women – 6,310,243 people [5]. Atherothrombotic complications of hypertension – myocardial infarction and stroke, occupy a special place. Platelets play a leading role in the pathogenesis of these diseases: changes in their number and functional properties are accompanied by the release of vasoactive mediators that provoke local vasospasm and increase platelet aggregation, which increases the risk of thrombotic complications [2, 3]. According to modern concepts, one of the main mechanisms of development and progression of CAD is also