

PRACA POGLĄDOWA
REVIEW ARTICLE

EVALUATION OF THE HUMAN BIOELECTROMAGNETIC FIELD IN MEDICINE: THE DEVELOPMENT OF METHODOLOGY AND PROSPECTS ARE AT THE PRESENT SCIENTIFIC STAGE

Ozar P. Minser¹, Maksim M. Potiazhenko², Ganna V. Nevoit²

¹P.L.SHUPYK NATIONAL MEDICAL ACADEMY OF POSTGRADUATE EDUCATION, KYIV, UKRAINE

²UKRAINIAN MEDICAL STOMATOLOGICAL ACADEMY, POLTAVA, UKRAINE

ABSTRACT

Introduction: The authors focus on the unresolved problem of NCDs and on the relevance of further scientific research in accordance with the current physics-biological level of knowledge about the structure and functioning of the human body. In the course, emphasis is placed on the need for further study of methods for assessing the bioelectromagnetic field of the human body as a potential "tool" for a possible solution of the NCD problem in the framework of system medicine.

The aim is to assess the level of development of the methodology and substantiate the scientific feasibility of further exploring the possibilities of the clinical application of these methods for assessing the bioelectromagnetic field of the human body in the algorithms for examining and managing patients with NCDs to study valeological status and objective monitoring of physical phenomena in the clinic of internal diseases.

Materials and methods: The analysis of the literature data was carried out in the course of a search study of methods for the rapid assessment of valeological status as 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, UDC 613:616-052:159.942:616-03).

Review: The gnoseological aspect of the development of the methodology for assessing the bioelectric and biomagnetic fields of the human body is described in the article. The conditional time stages of the methodology are highlighted and characterized in it. It was proposed to distinguish between periods: 1) cumulative (XIII-XVIII centuries), 2) cumulative-dynamic (XII-XX centuries), 3) modern (XXI century) 4) modern (prospective). Questions of the feasibility of further research assessing the bioelectromagnetic field of the human body are discussed.

Conclusions: 1. The above gnoseological aspect of the 700-year-old methodology for studying the bioelectromagnetic field of a human body demonstrates a staged evolution of its development, the presence of a significant amount of cumulated scientific information, which requires rethinking as part of system medicine. This convinces us of the existence of a tendency of inevitable approaching the final stage of knowledge of the human bioelectromagnetic field with the widespread introduction of these techniques into the practical public health of the world.

2. The accumulated layer of scientific knowledge about the bioelectromagnetic component of the human body requires integration into fundamental medicine, transformation of the modern paradigm by creating a bioelectromagnetic-chemical concept of the exchange of matter and energy in the human body.

3. Further research on the assessment of the bioelectromagnetic field is relevant and can contribute to solving the NCD problem both at a fundamental level within the framework of system medicine and by optimizing the diagnostic assessment in patient management algorithms during diagnosis, treatment, primary and secondary prevention.

KEY WORDS: Non-communicable diseases, Ultra-Weak Photon Emission, Primo Vascular System, bioelectromagnetic human field

Wiad Lek 2019, 72, 5 cz. II, 1117-1121

INTRODUCTION

Noncommunicable diseases (NCDs) cause the death of 41 million people each year according to the World Health Organization (WHO). Each year, 15 million people die from a NCD between the ages of 30 and 69 years. This happens despite the success of instrumental diagnostics, pharmacotherapy, surgical treatment methods and the promotion of a healthy lifestyle. In connection with the global pandemic, WHO developed a *Global action plan for the prevention and control of NCDs 2013-2020*. The 2030 Agenda for Sustainable Development recognizes NCDs as a major challenge for sustainable development. As part of the Agenda, Heads of State and Government committed to develop ambitious national responses, by

2030, to reduce by one-third premature mortality from NCDs through prevention and treatment [1-4]. Therefore, further scientific and clinical search for potential ideas to solve the NCD problem remains extremely important for medicine. In recent years, systems biology and system medicine have received significant development due to the accumulation of a large number of new fundamental scientific knowledge. According to scientists, these areas may allow to generalize the principles of the functioning of cells, tissues and the organism, as well as they can provide interdisciplinary and transdisciplinary approaches to the problems of cardiology and other branches of medicine [5]. Combining systems medicine approaches with computer technologies can help create a

more complete model of the emergence and development of NCDs, which will match the new level of scientific knowledge. A new paradigm of medicine is being formed gradually and it is based on the creation of a methodology of biological and medical systems, the integration of knowledge from other branches of science. This leads to a better understanding of complex non-linear relationships of factors in the human body, which determine the multiplicity of clinical variants of the pathological pattern in NCDs. This is especially true when there is a modern problem of the multiplicity of chronic diseases in patients. As clinical practice shows, the fact that patients simultaneously have multiple pathologies on the part of various organs and systems complicates the diagnostic search, the assignment of adequate individualized treatment, and objective control over the physiological state of the patient during therapy. Modern technological advances combined with the development of computer technology can help create a more complete model of understanding the pathology of NCDs. For example, deepening knowledge of physics and systems biology against the background of technological progress made available methods for assessing the bioelectromagnetic field of the human body for clinical use. This can give systemic medicine a new "tool" for a deep fundamental study of the essence of the pathology at the field level of metabolism, and they can also significantly improve the comprehensive diagnosis of patients and optimize their objective examination. Methods for assessing the bioelectromagnetic field of a person make it possible to investigate the total indicators of the physical health of a person and his valeological status, and they are also able to detect pathology at the preclinical stage. [4]. This is a very important aspect in the early diagnosis of NCDs and it can be key research in the prevention algorithms for this pathology in case of justification of scientific hopes.

THE AIM

The purpose of this publication is to assess the level of development of the methodology and substantiate the scientific feasibility of further studying the possibilities of the clinical application of these methods for assessing the bio-electromagnetic field of the human body in algorithms for examining and managing patients with NCDs to study valeological status and objective monitoring of physical phenomena in the clinic of internal diseases.

MATERIALS AND METHODS

The analysis of the literature data was carried out in the course of a search study of methods for the rapid assessment of valeological status as 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, UDC 613:616-052:159.942:616-03).

REVIEW AND DISCUSSION

The development of the methodology for assessing the bioelectromagnetic field of the human body in the direction of additional synthesis of scientific knowledge has come a long way of forming within the framework of the existing doctrine of scientific medicine. Evidence shows such, during the analysis of literature data, we can conditionally identify the following time stages of the formation of the methodology for assessing the bioelectromagnetic component of the human body: 1) the cumulative stage (XII-XVIII centuries), 2) the cumulative-dynamic stage (XII-XX centuries), 3) the modern stage (XXII century), 4) modern (perspective) stage. Until the end of the twentieth century, the periods of scientific research were mostly purely accumulative in scientific knowledge, with very limited integration into the basic science. This was the reason for their designation by us as the "cumulative period" and "cumulative-dynamic period", respectively. At the same time, from the 13th to the 18th century, there was an accumulation of purely empirical knowledge due to the practical use of acupuncture and reflexotherapy by doctors, but without adopting the theoretical ideas of ancient oriental medicine. In the 19th century, the scientific study of the bioelectromagnetic human phenomena became possible after the scientific discovery of electricity, the invention of the electroacupuncture method and the possibility of estimating the electrical conductivity of human tissues using a galvanometer. Over the 200-year period, scientists of the world have made significant progress in understanding the electrical activity of biological tissues. Many scientists have been studying this area. In 1751, Adamson investigated the nature of the electric discharge of fish. L. Galvani (1791, Italy) discovered the existence of «animal electricity.» A. Volta (Italy) was a scientific opponent of L. Galvani, and discovered a way to generate electricity. C. Matteucci (1811-1868, Italy) proved the existence of an electrical phenomenon in biological tissues. E. Du Bois-Reymond (1848, Germany) became the founder of electrophysiology, introduced the concepts of «excitation» and «excitable tissues». J. Bernstein (1886, Germany) analyzed the form of action potential. E.-J. Marey (1875, France) used a capillary electrometer to record the oscillations of the potentials of a beating heart. N. Ye. Vvedensky (1883, Russia) used to listen to rhythmic pulses of impulses in the nerve and muscle phone, Russia). W. Einthoven (1903, Holland) created the electrocardiograph and became the founder of clinical electrocardiography, the Nobel Prize winner [6]. It is important that from the end of the 18th century until the first half of the 20th century, science was able to accumulate a significant scientific base regarding the electrical activity of the tissues of the human body, and it was able to give them the appropriate scientific interpretation, which determined the possibility of future application of electrographic methods in medicine.

The methodology for assessing the biomagnetic component of the human body had a more difficult development. The first method of recording a biomagnetic field was photographing it in an electric field (1899 by Ya. Narkev-

ich-Yodko, Poland). The discovery of this method of visualization of the biomagnetic component of the organism did not receive the correct physical explanation because of the discrepancy between the physics-biological knowledge of that period was large. Many scientists regarded this method from mystical positions and ignored it. In 1949, this method was rediscovered in the USSR, and it was called "kirlianography" by the name of the author. His studies were classified in the USSR for 15 years [7,8]. It must be said that, at that time, fundamental science was not theoretically ready to explain the essence and genesis of the results of kirlianography. This again complicated the development of this method of human biomagnetic registration. Many scientists began to perceive kirlianography as a pseudoscientific method due to a misunderstanding of the essence.

In the XX century, the method of registration of the electric fields of the body has received worldwide distribution. Many scientists of the world made a significant contribution to the study of human bioelectric potentials in the XX century. V.V.Pravdich-Neminsky (1913-1921, Russia) registered the electroencephalogram for the first time. A.F.Samoilov (1929, Russia) investigated the nature of neuromuscular excitation transfer for the first time. D.S.Vorontsov (1932, Russia) discovered trace fluctuations of biopotentials that accompany the action potential in nerve fibers. G.Bishop, J.Erlanger and H.S.Gasser (1930-1940, USA) used electronic amplifiers and oscilloscopes for the first time and won the Nobel Prize. A.L.Hodgkin with A.F.Huxley and B.Katz (1947-1952, England) used accurate methods for recording electrical potentials for the first time, studied the ion permeability of the giant nerve fiber membrane for the first time, formulated modern membrane-ion theory of bioelectrogenesis and received the Nobel Prize [6]. At the same time, electrocardiography, encephalography has become routine methods for practical public health of the world as a logical consequence of the research.

The scientific progress of the second half of the XX century led to a significant dynamic of research into the bioenergy field, which was associated with the deepening of fundamental knowledge and with the growth of technical capabilities. In the 70s of the XX century, the creation of magnetometer devices made it possible to register the magnetic field in humans. Scientific studies of the biomagnetic component of the human body were begun from this time. The use of ultrasensitive sensor-gradiometers SQUID (Superconducting Quantum Interference Device) in magnetometers opened the way to the introduction of magnetography in practical medicine. Evidence shows such, the 56-year and 51-year experience of using magnetocardiography (MCG), magnetic encephalography (MEG) gave a lot of research material about the characteristics of the biomagnetic component of the human body. Methods for assessing the biomagnetic field of striated muscles, eyes, stomach were also developed [7, 9]. In the end, all this led to the scientific understanding that magnetography and kirlianography are two different ways of objectively fixing the

biomagnetic field of the human body: hardware registration and photo visualization, respectively. Finally, by the end of the XX century, the physical nature of kirlianography was revealed. In addition, a more advanced method of recording the electromagnetic component has been developed. It was called gas discharge visualization. [7].

In the XX century, the morphological study of the tissues of the human body as a substrate of bio-electromagnetic activity was continued simultaneously with the development of technologies for recording and evaluating the bio-electromagnetic field of the human body. Scientists were engaged in substantiating the physiological mechanisms of its occurrence as well. L.Danielle, G.Dowson (1935, England) The principles of the structure of cell membranes and transmembrane transport were disclosed and a "sandwich" model of the structure of membranes was created. S.J.Singer and G.L.Nicolson (1972, USA) developed a liquid-membrane model of the membrane structure. During this period, many studies were carried out on the study of the electrical conductivity of human tissues: the electrical capacity and electrical resistance of cell membranes were determined, the electrical heterogeneity of the skin surface was determined, and biologically active points (BAT) were discovered [6, 7]. The BAT was mapped, their biophysical parameters were determined, their localization corresponded to the course of the energy meridians of ancient oriental medicine, the morphological properties, blood supply, innervation, biochemistry of the BAT area were studied. This followed from the works of scientists: GD Novinsky et al. (1959), A.P. Podshibyakina (1952, 1960), Kim Bong Ham (1960), V.G. Vogralik (1961-1988), G.M.Pokalev (1962), T.Ischikawa (1962), JEH Niboyet and A.Mery (1963), G.Kellner (1964), JFDumitrescu (1967), G.Grall (1968), J. Strongorsarello (1969), G. Cantoni (1970), J.Bossy (1973), W.Melhardt (1975), P.Rabischong et al. (1975), F.G.Portnov (1980), Goydenko V.S. et al. (1982), Woolf C.J. (1983), Velkhover ES, Kushnir G.V. (1983), A.T.Kachan (1990), G.Luvsan (1990), Willis W.D. (1991), Samosyuk I.Z. (1993), Samosyuk I.Z., Lysenyuk V.P. (1994), Woolf C.J., Doubell T.P. (1994), Woolf C.J., Salter M.W. (2000). The link between the localization of BAT and meridians with the course of the nerve trunks and/or vessels was noted and their connection with the location of dermatomes and with real "muscle contraction lines", the function of muscle chains was established, as described in R.Fujita (1955-1958), S.de Morant (1955), A.R. Kirichinsky (1959), F.Hubotter, T.Ischikawa (1962), W.Lang (1965). J. Hu, B. Shirota (1966), I.M. Zhulev et al. (1992). N.V. Mikhailov created the concept of the energy-conducting system of connective tissue in 1965. Ideas for explaining the function and genesis of the BAT's field component were described in the works of F. Kracmer (1962), A. Lebarbier (1975), V.A. Ionichevsky (1984), Yu.P. Limansky (1988), Ragulskaya MV, (2000).

The interest of medical research in this direction was due to the fundamental discoveries made by physicists in the twentieth century. «All living cells generate an electrostatic charge, individual for each type of tissue, under the

influence of metabolic processes». This fact was proved by H. Frolich (1975-1977, England). «All living cells form their own endogenous variable electromagnetic fields of the Froelich-Davydov type, which have a high degree of coherence, like laser radiation». The scientific work of G.M. Baule and R.McFee (1963), H.Frolich (1977), A.S. Davydov (1984, USSR) determined the discovery of this fact. «Living cells have the ability to automatically modulate their bioelectromagnetic fields with the structure of abiosystem. Bioelectromagnetic fields carry obvious code-frequency information and are solitons». A.S.Davydov (1984, USSR) was the founder of this area of biophysical research [6-8]. As a result, in the twentieth century, the techniques of acupuncture and electroacupuncture were studied, widely distributed within the boundaries of traditional medicine and reflexology, but they remained only partially understood. The lack of reliable data on the morphological substrate of tissues, which would be responsible for the production and transport of energy along the ancient Eastern meridians, was an additional obstacle to the understanding and recognition of electroacupuncture by academic medicine. The lack of a common bioelectromagnetic paradigm of metabolism in basic science was an obstacle to the understanding of electroacupuncture as well. Therefore, in the XX century, biomagnetic radiation of tissues was either associated with the function of the nervous system or was ignored as a fact. Accordingly, this slowed down the methodological development of the methodology.

In the XXI century, the study of the biomagnetic field component was continued and a several fundamental discoveries were made. The fact of photon emission by all living cells without external stimulation was established. This is also characteristic of the cells of the human body. The phenomenon has been assigned the term «Ultra-Weak Photon Emission» (UPE). Since the photon is a fundamental elementary particle of electromagnetic radiation, the ability of its emission is explained by the appearance of the bioelectromagnetic field of tissues during metabolic processes. Today, the spectrum and intensity of the UPE of the human body are considered recognized, and the main source, statistical distribution, and fractality are partially understood [10-14]. So, it is established that the greatest intensity of UPE is recorded on the face, with a maximum in the region of the mouth and cheeks. The photon emission mechanism is thought to originate from the generation of free radicals in energy metabolic processes. Free radicals subsequently react with lipid or protein, generating electronically excited species as byproducts. These excited molecules can further react with fluorophores through energy transfer and lead to photon emission. Higher level photon emission on facial skin might be caused by differences in the content of melanin fluorophores between facial and thoracic skin. The established absence of a significant correlation between the emission of photons and the thermal image suggests that the daily rhythm of emission of photons is not the result of a change in temperature or microcirculation. Moreover, a clear negative correlation of temporal changes in photon emission and cortisol levels may indicate that the

daily rhythm of photon emission reflects changes in cellular metabolic processes under the control of the circadian clock [15]. Another fundamental discovery is the discovery of a new anatomical formation, which was called the Primo Vascular System (PVS). This discovery radically changes the scientific view on the formation and transport of energy in the human body. [7, 16]. According to scientists, the primary vascular system / PVS is a morphological substrate that provides for the formation and transport of biophotons. The structure of the PVS is a transparent network of optical channels with DNA granules inside, which is web-like in the body on six tissue levels [17-21]. In 2002-2010, scientists Kwang-Sup Soh (Korea), Kyung A. Kang (USA), David K. Harrison (England) confirmed the discovery, which was made in 1960 by Korean biologist Kim Bong Ham [22, 23]. Thus, in the 21st century, the fact of the presence of the biomagnetic component in the human body became the undisputed scientific knowledge. Meanwhile, this scientific information was not fully integrated into fundamental medicine. Today, studies of the bioelectromagnetic field are fragmented. The development of the research methodology of the bioelectromagnetic component cannot be called complete. At the same time, it cannot be denied that the further development and implementation of biomagnetic component assessment methods carry significant scientific potential and can be a source of valuable objective clinical information for diagnosis and for studying the fundamental issues of the pathogenesis of internal diseases, including NCDs. Further research in this direction is extremely relevant and will continue. This promising research work was conditionally designated by us as the most modern stage in the development of this area.

CONCLUSIONS

1. The above gnoseological aspect of the 700-year-old methodology for studying the bioelectromagnetic field of a human body demonstrates a staged evolution of its development, the presence of a significant amount of cumulated scientific information, which requires rethinking as part of system medicine. This convinces us of the existence of a tendency of inevitable approaching the final stage of knowledge of the human bioelectromagnetic field with the widespread introduction of these techniques into the practical public health of the world.
2. The accumulated layer of scientific knowledge about the bioelectromagnetic component of the human body requires integration into fundamental medicine, transformation of the modern paradigm by creating a bioelectromagnetic-chemical concept of the exchange of matter and energy in the human body.
3. Further research on the assessment of the bioelectromagnetic field is relevant and can contribute to solving the NCD problem both at a fundamental level within the framework of system medicine and by optimizing the diagnostic assessment in patient management algorithms during diagnosis, treatment, primary and secondary prevention.

REFERENCES

1. Non-communicable diseases: what heads of state and government need to know. World Health Organization United Nations Development Program. 2016:6p/<http://apps.who.int/>
2. Global action plan for the prevention and control of NCDs 2013-2020.WHO. 2013:55 p/http://www.who.int/nmh/events/ncd_action_plan/en/
3. Montevideo Roadmap 2018-2030 on NCDs as a Sustainable Development Priority. WHO Global Conference on Non-communicable Diseases. Pursuing policy coherence to achieve SDG target 3.4 on NCDs (Montevideo, 18-20 October 2017):16 p/<http://www.who.int/conferences/global-ncd-conference/>
4. Potyazhenko MM, Nevoit AV. Neinfektsionnye zabolevaniya: poisk alternativnykh resheniy problemy s biofizicheskikh pozitsiy [Non-communicable Diseases: search for alternative solutions to problems from biophysical positions]. *Praktikuyuchiy likar (Practicing doctor)*. 2019;1:58-62. (Ru, UA)
5. Mintser OP, Babintseva LYu, Kharchenko NV. Schodo paradlgmi poednannya sistemno-biologichnih i sistemnomedichnih uyavlen dlya formuvannya novogo poglyadu na dlagnostiku ta llkuvannya IshemlchnoYi hvorobi sertsya [About the paradigm of combining systemic biology and systemic medicine representations for forming a new look at diagnostics and treatment of ischemic heart disease. *Medichna informatika ta inzheneriya (Medical informatics and engineering)*. 2018;1:5-12. (UA)
6. Muhina IV. Fiziologiya i biofizika vzbudimiyh sistem. Uchebno-metodicheskii material po programme povysheniya kvalifikatsii «Hranenie i obrabotka informatsii v biologicheskikh sistemah» [Physiology and biophysics of excitable systems. Educational and methodical material on the advanced training program. Storage and processing of information in biological systems.]. Nizhny Novgorod; 2007, 105p/<http://www.unn.ru/pages/e-library/aids/2007/31.pdf> (Ru)
7. Potyazhenko MM, Nevoit AV. Energeticheskaya sistema cheloveka: chto izvestno oficalnoj nauke [Energy system of the person: this is the evolution of a re-scientific discovery]. *Ukrayinskij medichnij chasopis (Ukrainian medical journal)*. 2019;2,II/<https://www.umj.com.ua/article/139468/energeticheskaya-sistema-cheloveka-evolyutsiya-povtor-nogo-nauchnogo-otkrytiya> (Ru)
8. Ahn AC, Colbert AP, Anderson BJ et al. Electrical properties of acupuncture points and meridians: a systematic review. *Bioelectromagnetics*. 2008;29(4):245-256.
9. Ragulskaya MV, Lyubimov VV. Pribornoe izuchenie vozdeystviy estestvennykh magnitnykh poley na BAT cheloveka: metodyi, sredstva, rezultaty [Instrumental study of the effects of natural magnetic fields on human BAT: methods, means, results.]. *Zhurnal radioelektroniki (Journal of Radio Electronics)*. 2000;11:115-120. (Ru)
10. Cifra M, Pospíšil P. Ultra-weak photon emission from biological samples: definition, mechanisms, properties, detection and applications. *Journal*
11. Scholkmann F, Fels D, Cifra M. Non-Chemical and Non-Contact Cell-to-Cell Communication: A Short Review. *Am. J. Trans. Res.* 2013;5:586-593.
12. Tinsley JN, Molodtsov MI, Prevedel R et al. Direct Detection of a Single Photon by Humans. *Nat. Commun.* 2016;7:12-17.
13. Kobayashi M, Kikuchi D, Okamura H. Imaging of Ultraweak Spontaneous Photon Emission from Human Body Displaying Diurnal Rhythm. *PLoS ONE*. 2009;4(7):e6256. режим доступа <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0006256>
14. Sang Hyun Park, Eung Hwi Kim, Ho Jong Chang et al. History of Bioelectrical Study and the Electrophysiology of the Primo Vascular System. *Evidence-based Complementary and Alternative Medicine*. 2013:14 p.
15. Kwang-Sup Soh. Bonghan Duct and Acupuncture Meridian as Optical Channel of Biophoton. *Journal of the Korean Physical Society*. 2004;45(5):1196-1198.
16. SooJaeLee, ByungCheonLee, ChangHoonNam et al. Proteomic analysis for tissue and liquid from Bonghan ducts on rabbit intestinal surfaces. *Journal of Acupuncture and meridian studies*. 2008;1(2):97-109.
17. Kwang-Sup Soh. Bonghan Circulatory System as an Extension of Acupuncture Meridians. *Journal of Acupuncture and Meridian Studies*. 2009;2(2):93-106.
18. Kwang-Sup Soh, Kyung A Kang, Harrison DK. The Primo Vascular System. Its role in cancer and regeneration. Springer; 2012, 336 p.
19. Stefanov M, Potroz M, Kim J et al. The Primo Vascular system as a New Anatomic System. *Stefanov. Journal of Acupuncture and Meridian Studies*. 2013;6(6):331-338.
20. Avijgan M. Can the Primo Vascular System (Bong Han Duct System) be a Basic Concept for Qi Production? *International Journal of Integrative Medicine*. 2013;1:1-10.
21. Kovalenko OYe, Chizhikova MYe. Suchasni poglyadi na substrat ta mehanizmi diyi akupunkturi [Modern views on the substrate and mechanisms of action of acupuncture]. *Mizhnarodnij nevrologichnij zhurnal (International Neurological Journal)*. 2017;6:120-126. (UA)

Authors' contributions:

According to the order of the Authorship

Conflict of interest:

11. *The Authors declare* Salari V, Valian H, Bassereh H et al. Ultraweak Photon Emission in the Brain. *J. Integr Neurosci*. 2015;14:419-429.
12. Milntser OP, Vatsilov DV. Fotoaktivni st biologichnih molekul yak mozh- liviy faktor koreguvannya trigerzaleznhnih sistemnih protsesiv (pershe povldomlennya) [Photoactivity of biological molecules as a possible correction factor for trigger-dependent system processes (first message)]. *Medichna informatika ta inzheneriya (Medical informatics and engineering)*. 2015;4:7-10. (UA)

13. *no conflict of interest*

14. *of Photochemistry and Photobiology B: Biology*. 2014;139:2-10,

15. CORRESPONDING AUTHOR

16. Ganna V. Nevoit

17. Ukrainian Medical Stomatological
Academy Shevchenko 23 str., 36011
Poltava, Ukraine e-mail:
natanew2017@ukr.ne

18. **Received:** 25.03.2019

19. **Accepted:** 06.05.2019

