Development of a method for assessing the effects of chronic stress on the human body

I N Muzychchenko¹, L Zhang¹, I A Apollonova², A P Nikolaev², A V Pisareva², and S G Malikova²

¹Harbin Institute of Technology, 11 Siling Street, Nangang District, Harbin 150001, P.R. China
²Bauman Moscow State Technical University, 5/1, 2-ya Baumanskaya street, Moscow, 105005, Russia
E-mail: pavpav.06@mail.ru

Abstract: The link between stress and health was supported by many studies. However, probably due to problems in the stress measures used, the issue of chronic stress monitoring still remains. Higher levels of chronic stress exposure were contributors to an increased risk for several mental and physical health conditions, such as asthma, rheumatoid arthritis, cardiovascular disease, chronic pain, chronic fatigue, fibromyalgia, posttraumatic stress disorders, irritable bowel disease, anxiety disorders, depression and others. In order to prevent development, maintenance, or stimulation of them, the method for assisting the effects of chronic stress on the human body was developed based on the results of the previous studies in the field.

1. Introduction
Consolidated knowledge of functional state diagnostics allowed researchers to collect a huge amount of information about effects of chronic stress on the human body. At the same time, a large number of current limitations and problems in the stress assessment was discovered.

2. Materials and methods
Mental state—the result holistic reaction of the body and mind in response to changes in external and internal-renney's environment aimed at achieving—result of the activity and expressing—available in the empowerment of the and in feelings, feelings, experiences human [11, 18].

3. Research result
The influence of life stress on a human body can be represented as the following (Fig.1):
Figure 1 - The Life Stress and Health [10].

Until recently, the most important principles of preventive medicine were the principles of clinical examination in order to identify diseases with subsequent observation and treatment of patients [13,16]. The key principles for early detection of diseases are formulated and approved by WHO. However, annual research by non-selective methods is not very informative and represents an additional waste of time, money and effort.

Big Data, technological innovations and their application allow us to constantly monitor the current state of human health and take preventive measures for the onset of diseases in time - instead of waiting for its appearance or a qualitative change in the health state [12,19]. It is also economically rational as in any other industry, for example technical, where preventive measures are mandatory. At the same time, in the healthcare industry, most of the resources are invested in caring for the sick and less focused on keeping people "healthy" [12]. On the one hand the reason for this is the rather young status of economic initiatives in the field of "Wellcare", on the other hand, almost all the equipment and medicines are focused on the diagnosis and treatment of diseases [20].

Nevertheless, new trends are emerging. A considerable number of insurance companies pay closer attention to the correlation between the risk of disease occurrence and the payment need. As a consequence, they invest a large amount of money in risk management. Also, in the corporate world, a large number of companies consider it necessary to maintain the health of their employees at the optimum level to improve the company's overall performance through investment in sports, relaxation, a healthy team atmosphere, food and rest time [19]. Thus, they not only can be sure that the employees are in the best condition and will be more productive, they will reduce insurance costs and get more loyal company workforce as well [6].

In just the last few years, scientists have paid closer attention to the development of tools and methods that help to study the relationship among biological processes that connect the perceived psychological stress of a person with the pathogenesis of various diseases (Fig.1) [10,15]. The mechanisms of the stress response, has not been fully understood, but there is already a clear evidence that the main mediator is the cognitive-affective appraisal, followed by neurological triggering mechanisms, that start a stress response by using the neural and endocrine systems of the body [3]. Normally, these mechanisms are designed in us to protect from danger, therefore they mobilize the body's resources. But nowadays, the way these mechanisms work is unhealthy: centuries ago the danger was represented by a situation in which we had to flee from the hungry beast or fight the enemy, and these days the same psychophysiological reaction can be caused by deadline at work or a fight with the best friend. It is very important in this case to say that the time factor plays one of the key roles [16]. With a prolonged reaction, the hormonal imbalance causes the body's systems to work at their limits, which can develop into a habit of the organism and lead to the development of chronic diseases, which were mentioned earlier (fig.1). As a matter of fact, the brain remembers and associates many details with the already recognized threatening situation, and in an attempt to warn us against a hypothetical trauma, it can trigger a protective neuroendocrine reaction time after time, even if the dangerous situation isn't there anymore.

Scientists have proven that combinations of psychological stimulus and reactions of the organism are very specific. One of the first to attract attention to that fact was R.Lazurus [14]. In 1958 J.I. Lacey, in turn, noted that individuals show considerable persistence in the types of reactions to various stressful situations. Over the past sixty years, scientists have identified a number of factors that affect these mechanisms. A partial list is: stress resilience, individual behavior patterns, available resources for coping, biological and genetic predispositions of a person [17].

As a result of the growing research interest in this problem, a large number of studies have been conducted in an attempt to link individual characteristics of vulnerability to stressors and psychophysiological response with a focus on genetic, biological and psychological factors [15]. A striking example of that is the work of Italian scientists published in the European Health Journal in 2005 [1], in which they investigated the relationship between personality traits and heart rate variability (HRV) in a group of people who were diagnosed with a heart attack. These people had no history of mental illness and did not take any psychotropic substances [18]. The study showed that with a high
probability, people with low emotional sensitivity had a greater chance of developing coronary diseases and having a heart attack again.

The choice of personality traits as a part of the study was not accidental, because they are an external manifestation of the structure of our nervous system’s features, and when the nervous system is not balanced, it affects the psychophysiological response of the body. This can clearly be seen in the studies conducted by The SCOPE Project, when the scientists investigated the physiological responses of a group of Portuguese policemen on duty, and by The Vital Surgeon Project, when the operating surgeon’s cardiovascular activity data was collected. The obtained data showed that the HRV rate was extreme during the especially psychologically intense moments of the operation [15].

Heart rate variability is not the only physiological indicator used to assess the somato-vegetative status of the body. During the literature review on the topic of non-invasive stress diagnostics on PubMed, more than 9,500 articles were found with the keyword HRV, more than 12,000 works with the keywords respiration and stress, electromyography and stress -2604, electrodermal and stress-311, skin conductivity and stress - 71, etc. However, in the context of chronic stress there are not so many articles: HRV - 139, electromyography - 195, electrodermal - 20, skin conductivity - 5, respiration - 954, pupil diameter - 38, etc. The fact that there is such a rapidly growing number of studies in this field and a variety of diagnostics, suggests that there is an active search for the most optimal way to solve this problem.

The effects of chronic stress are analyzed best in detail in the examples of already seriously developed diseases, such as post-traumatic stress disorders or hypertension. While it is known that when a source of acute stress is removed, the body returns to a state of homeostasis [8], but chronic tonic status may, over time, serve as a basis for a host of psychiatric and psychophysiological disorders [4,8]. It is clear that the development of methods for assessing chronic stress is a new vital task that scientists are working on.

In order to develop a method for assessing the effects of chronic stress on the human body, it is important to understand that we can not measure all of the components of the system at the same time, because McEwen in his works has shown that the network of mediators is nonlinear, a change in any of a stress response mediators leads to compensatory changes in other mediators and secondary reactions such as heart rhythm, blood pressure, temperature, etc [5,6,16]. Nevertheless, the most accurate assessment requires the measurement of several parameters simultaneously in the context of allostasis (the process of adaptation to changes in the environment) [12].

There are a number of requirements that should be met in order to create a tool for assessing the effects of chronic stress on the human body: the device must be mobile, the measurements of the indicators should be accurate, the biological data should be processed objectively and accurately, and the method should be non-invasive. The complex should allow for the accumulation of information and analysis, both in real time and in dynamics [14]. The results of the analysis should be easily accessible, the complex should include the ability to visualize the information collected and the results of its analysis [7]. The complex should allow for monitoring of the functional state without limiting the mobility of the person. The device should be comfortable for day to day use, should operate for a sufficient period of time without recharging, should be moisture resistant and keep personal information confidential. Also, storage must be provided before the information is transferred to the cloud server.

The measured parameters should be reliable and vary in small variability and should have a clear relationship with the body systems. The parameters should rely on international standards for evaluation, physiological interpretation and clinical use. The collected information should enable us to make an objective assessment of the balance state of the body's regulation systems as a whole. Based on previous studies, it can be concluded that the main well-studied parameters for non-invasive diagnosis of the effects of chronic stress are heart rate variability (HRV), hair cortisol, blood pressure (it's limited on constant monitoring), skin galvanic reaction (with higher temperature and humidity levels, it may not be that accurate, thus imposing a restriction on the measurement during physical activity) [9], the non-invasive blood composition test, pulse [2], temperature, EEG (requires laboratory assessment).

Changes in these parameters is a signal of an ANS imbalance, which can help to judge the activation of internal resources of the organism and its possible fast allostatic overload (Fig.2).
The existing methods for the constant diagnosis of the health state have a number of limitations, and many of them do not meet the requirements for detecting early stages of Selye’s adaptation syndrome [20]. For example, in some complexes it is necessary not only to make an adjustment for the mobility of a study subject, but also to conduct an additional survey regarding his psychoemotional state at each moment of the time period, which is not convenient. The system architecture of the complex is shown in Figure 3. The user is equipped with a medical wearable device, from which medical data and location are extracted. Then the information goes through the initial processing, during which the artifacts are identified and removed, and enters the cloud server, where it will be further stored in the database. Received data is compared with the existing database using special software and returned to the user in the form of visual information. Access to the database is also provided to specialized staff who can consult the user in case of an emergency (Fig.3).

Understanding how predispositions to a stressful outcome are integrated at the individual level and how they affect the functional state can contribute to the development of innovative methods of treating patients and preventing health outbreaks [5,13]. Thus, a more accurate classification of neuroepidotinophenotypes of stress and the use of this classification in the development of diagnostic methods are a topic for future research. In this paper, it is proposed to use methods of machine learning that will allow us to identify and classify the anomalies of the results, and also gradually adjust the device to the
individual user by comparing the common database with the user’s data (fig.4), with subsequent accumulation of knowledge about the physiological status of this particular user (states of rest, relaxation, stress, physical activity) and comparison of data with the results of psychological testing of the user.

4. Conclusion
What can such an approach to studying the effects of chronic stress on the human body help to achieve? It will allow us to monitor the change in physiological status dynamically, thereby giving more opportunities for functional diagnostics and will allow the user and his treating physician (if necessary) to consider the data in the long term for clarifying the emerged problems. This method of evaluation will allow early detection and prevention of the occurrence and the development of possible diseases. The user will be able to take actions to adjust his behavior in order to improve performance, which, with a systematic approach, will change the already formed habits of the body.

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