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The System of Pulse Diagnostics of the Body in the Smartphone is A New Source of Medical Information

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Abstract

Background: At present, for high-quality monitoring of the body at home, it is necessary to have many different devices with you and transfer information from them separately to the doctor. It is expensive, burdensome and inefficient. To solve this problem, a new integral patented system of "pulse diagnostics" is proposed, which provides information on a smartphone in the form of graphs of the functional activity of various organs and body systems in the continuous monitoring mode with the possibility of assessing the main biochemical parameters by calculation.

Methods: The system is based on the results of an assessment of 350 measurements of temperature pain sensitivity thresholds according to the Akabane test with simultaneous recording of photoplethysmography from the finger or wrist with the selection of the second acceleration component of the pulse wave with the analysis of its waves a, b, c, d, e, f, followed by calculation of such standard indicators of cardiac activity as SDNN, DEI, TP, EI, ETC, EI, EEI, DDI and a number of spectral characteristics of the pulse wave, on the basis of which thermal algometry indicators were calculated, which in turn reflect the activity of various organs and body systems.

Results: Significant relationships were established for a number of APG indicators with the activity of temperature pain sensitivity thresholds of 24 main AC according to the Akabane test. This allows you to evaluate the TS of these channels by calculation based on group and individual regression models, as well as using neural networks and AI. Based on the flow of these individual data in the dynamics of observation, it is possible to evaluate the functional activity of various organs and systems of the body on new physical principles.

Conclusion: the use of this technique gives rise to a new principle and source of obtaining medical information from a pulse wave in a simple and convenient way. On the basis of this system, many useful applications can be built for simple and effective monitoring of the body in normal conditions and in various pathologies. This is an early diagnosis of diseases, use in sports and fitness, individual assessment of the action of drugs and foods, biochemistry control.

Keywords: Acceleration plethysmography, Thermal algometry, Akabane test, effect of drugs and their doses, glycemic control; optimal timing of medication, symmetry and symmetry in the body

Abbreviation

AC- acupuncture channels: APG- Acceleration plethysmography: TCM -Traditional Chinese Medicine: TS- the pain thresholds in temperature sensitivity: T1D- diabetes mellitus type 1 T2D- diabetes mellitus type 2

Introduction

The pulse disease assessment system has been used in TCM for several thousand years as one of the main diagnostic methods with high efficiency. At the same time, during palpation, up to 29 types of pulse are distinguished [1,2]. Their analysis by experienced physicians makes it possible to establish a diagnosis and select an individual treatment [3]. To repeat this method at the technical level, many designs of various sensory devices for estimating the pulse wave are currently known [4-8]. However, despite all the technical tricks in this area, so far it has not been possible to connect the characteristics of the pulse wave with the assessment of the work of individual organs and body systems with the correct diagnosis. The information contained in the pulse wave itself does not come to us in the form of specific physiological or biochemical indicators of the body and therefore needs additional semantic translators for translation into the language of modern medicine. It is not clear where information about the activity of various organs and systems is located in the pulse wave, which is the main problem. Probably, it is not in "direct access", and to obtain it, you need to use a certain translator with additional processing methods.

As such a translator, we used the principles of evaluating an organism based on the influence of the AC system on it. This idea is not new. All Chinese acupuncture with thousands of years of history is based on the bioenergy paradigm and the principle of assessing information through the control of AC activity for diagnosis and treatment, and ideologically it is directly connected with pulse diagnosis. AC and the points located on them have many distinctive properties compared to the surrounding tissues. AC have low electrical resistance, as well as thermal, acoustic, light, magnetic differences with surrounding tissues [9-10].

AC are also associated with low hydraulic resistance channels in the extracellular matrix [11,12]. For example, using isotopic substances and some protein dyes, it can be traced as they migrate through AC, exactly repeating the trajectory of its projection on the body [13].

According to some ideas [16,17], the AC system is the primary signaling system in the course of the evolution of living organisms, and it arose long before the nervous and humoral ones. All animals, insects and plants have systems of biologically active points connected to channels [18].

In this case, all information is mainly transmitted in the AC system in the form of tonic signals, including those based on coherent biophotons with phase synchronization from point to point in the chain of connections up to the target organ associated with a specific AC [19-21].

Since the AC are located symmetrically on the body, this provides a rare opportunity for the first time to evaluate the violation of symmetry in the bioenergetics of the body.

Methods

To assess the pulse wave, a DPA v-2.0 device (manufactured by Meridian CO, LTD, Korea) was used to analyze it according to generally accepted standard methods, which recorded the pulse wave with the selection of its second acceleration derivative (APG) in 250 Patients with various pathologies and in 50 subjects in the "Norma" group. After recording the plethysmogram, the Akabane test was carried out on a certified device "Refleksomaster-RM 08".

To assess the diagnostic capabilities of this ligament of the two systems in diabetes, a test was performed on 359 patients with T1D and 385 with T2D along with an analysis of their main medical parameters. Data analysis was performed with the SPSS Inc. software.

Results

For an integral assessment of the body through the control of the state of the AC, the method of thermal algometry was used based on the assessment of the thresholds of temperature pain sensitivity (TS), at certain distal reflex points (Fig.1). Each of these points in the TS indicators reflects the functional activity of certain organs and systems a list of which is given in the diagram. According to modern concepts, these points have a large

representation in the cerebral cortex and therefore reflect a large flow of information. In general, individual pain sensitivity is the most important parameter of the body's adaptation to external conditions. The method of thermal algometry is known and recognized in the scientific world under the name of the Akabane test [23-27, 16.17] and has been widely used by us for 30 years.

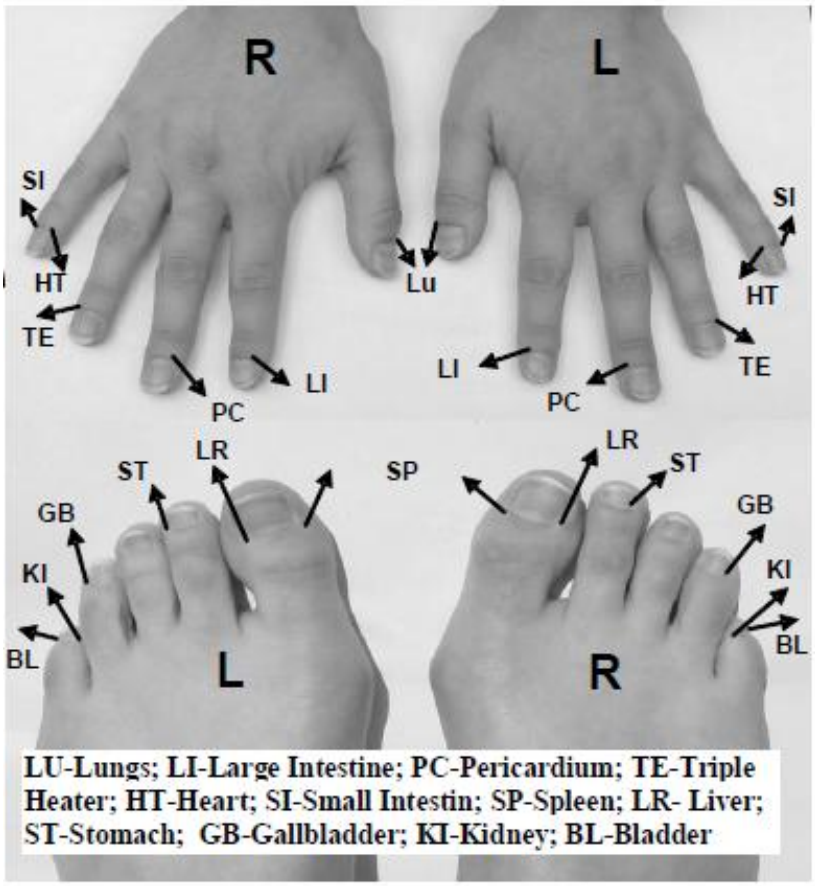


Fig1. Topography of acupuncture points, used for evaluation of the AC in Akabane test.

It was also found that at the level of 12 AC, taking into account their 24 paired branches in the TS indicators, there are internal regulatory relationships that form a stable dynamic cluster of AC, which functions according to the theory of 5 primary elements [28]. At the same time, it is worth changing one indicator, for example, during the impact on the organ associated with AC, in response, then all other indicators change as in a kaleidoscope. However, at the same time, their internal structure of connections is preserved. For example, normal TS values can be very different in magnitude, but their sum at the individual level on the right side is usually 51-52%. This is due to the fact that the right side in the test indicators reflects the level of energy accumulation - assimilation, and the left side - energy consumption and dissemilation processes [15-17]. Thus, the test allows you to control bioenergetics and metabolic processes in the body. The concept of Energy in TCM refers to the functional activity of a certain organ and AC associated with it. In addition, the Yang/Yin dipole ratio and the structure of correlations between AC are maintained at the level of AC. Normally, this ratio is 1.62 - which corresponds to the proportion of the Golden Section, as an indicator of harmony in the body. All this indicates that this bioenergetic cluster has an internal stabilization system based on the system of five primary elements, which, due to several regulatory circuits based on a pentoid structure, maintains this cluster in an optimal bioenergetic state [29-31].

This implies an important rule: *that knowing the indicators of a part of the AC, you can obtain the values of others by calculation based on, for example, individual or group regression models.*

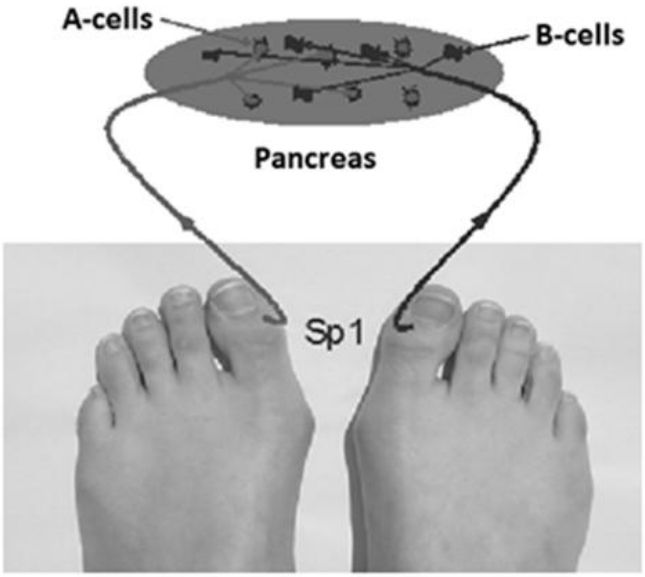


Fig2. Connections of the diagnostic point of the pancreas (SP1), with its A and B cells.

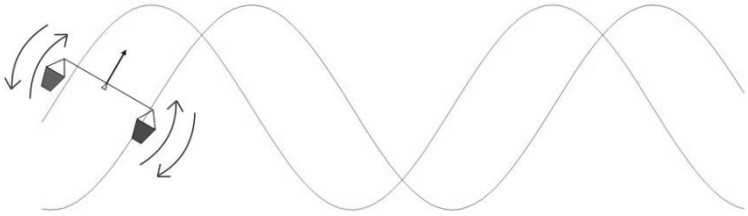


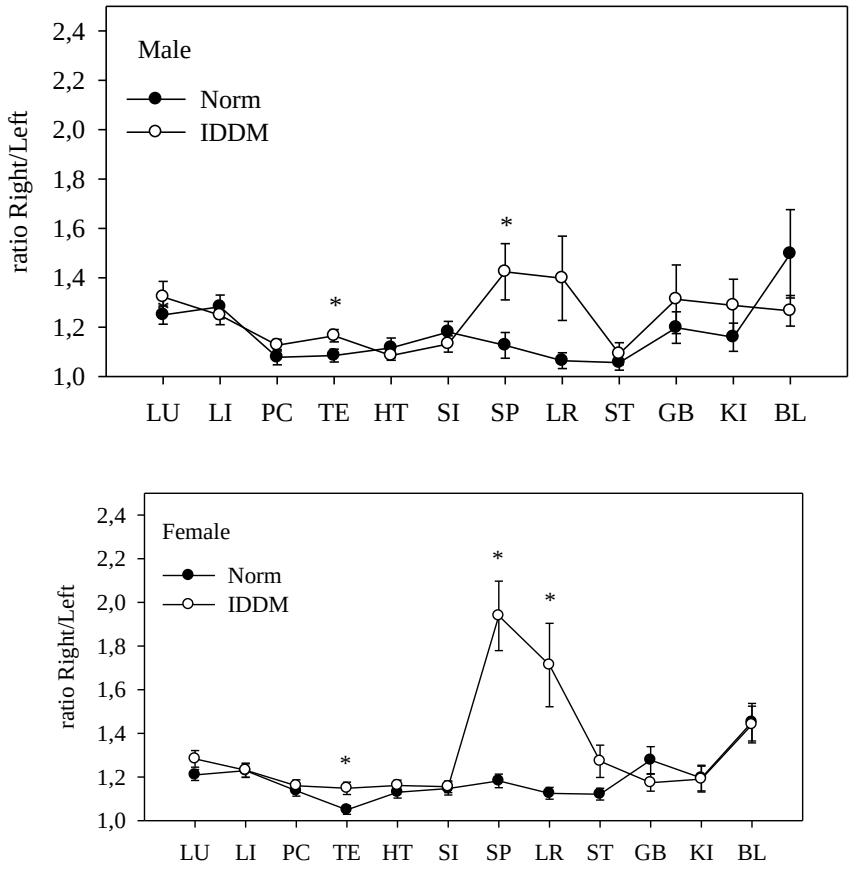
Fig3. The principle of the formation of biorhythms based on the change in the TS of the right and left points SP1 on the AC pancreas.

Consider the main diagnostic capabilities of the Akabane test using the example of monitoring patients with diabetes mellitus:

1) It has been shown that, for example, the right diagnostic point SP1 in the AC of the pancreas reflects the activity of its B-cells, which produce insulin, which reduces the level of glycemia. The left dot in its TS indicators reflects the function of A cells (Fig.2), which, due to the production of counter-insular hormone, increase the level of blood sugar [25,33,16,17]. Thus, a kind of "carbohydrate scale" is formed, on the bowls of which there are TS indicators on the right and left, reflecting at each moment of time the opposite regulatory processes of maintaining homeostasis (Fig.3). Normally, these scales are in constant rhythmic movement and reflect the biorhythm of the pancreatic organ, which can be assessed by the change in TS in the course of observation. In type 1 diabetes mellitus, with partially preserved activity of A and B cells of the pancreas, there is a sharp asymmetry in the TS according to the test, which reflects the presence of hyper or hypoglycemia at the moment [25,32,33]. At the level of all organs and physiological systems, there are similar subsystems that increase or decrease their functional activity in various spheres of life according to this principle and this is directly reflected in the violation of the symmetry of their TS on both sides.

2) For primary diagnosis, test profiles with a score of 24 Ac are important, which allows for effective diagnosis of various diseases. Each already formed disease has its own average test profile with many individual characteristics [16,17]. Thus, according to the test profile, such as, for example, a fingerprint, it is possible to carry out differential diagnosis of various diseases, and it is also possible to track, especially in the dynamics of observation, the transformation of functional disorders into a specific pathology [27]. Even more contrasting differences for differential diagnosis are obtained if we compare the test profiles with the calculation of the TS asymmetry coefficient in the dynamics of

observation for 12 AC. So, for example, Fig.4 shows test profiles for T1D with the calculation of the asymmetry coefficient R / L for T1D in comparison with the norm. A high significant difference with the norm is visible.



** - significant differences, t-test*

Fig4. Ratios of Right/Left TSs of channels when comparing healthy subjects and those with T1D (IDDM).

3) According to the level of deviation of the indicators of some AC in the dynamics of observation, it is possible to assess by which organs and systems the body reacts to the influence of pathology, for example, to the influence of hyperglycemia. This makes it possible to assess the body's compensatory mechanisms for precise targeted correction, for example, with the help of drug therapy.

4) Since, with individual measurements in the dynamics of observation with diabetes in the test profiles, the level of asymmetry for certain AC as a whole increases in proportion to the level of glycemia, this allows us to estimate its value by calculation method using TS indicators, for example, using regression analysis with an accuracy of more than 90% [25,32-34]. Even better results are achieved with the use of calculations on neural networks after their training in the course of individual monitoring.

5) What principle underlies the assessment of quantitative indicators? The test yields 24 TS values measured in Joules. Moreover, all these indicators are interconnected on the basis of the system of 5 Primary Elements, as the Fibonacci number. If at the same time, depending on the state of the body, one of the indicators changes, all the others change, as in a kaleidoscope. Here we can draw an analogy on the principles of operation of this system with the recently widely used method of identifying a person from a photograph using neural networks and AI (https://trends.rbc.ru/trends/industry/6050ac809a794712e5ef39b7). The essence of the method lies in the fact that it detects the

points of the eyes, nose and mouth on the face from a photo or video shooting - usually 7 points or more. Then, neural networks determine the sizes of the distance vectors between them with a set of fixed-length numbers, which are compared with each other in databases and thus the person's personality is determined. A great influence on the accuracy of personality assessment is also the assessment of symmetry violations in these data [35]. For example, the recognition accuracy of the FRT system, as one of the most advanced in this area, was 99.97%.

By this analogy, with the rmoalgometry, we evaluate 24 reference indicators in the form of an interconnected cluster, which, unlike the indicators on the face, are not static, but reflect in their totality the main changes in the body, up to biochemistry, which allows us to carry out the proposed monitoring and diagnostics in in general, on new physical principles by calculation due to a larger number of analyzed data.

6)) If the level of deviation of the sensitivity thresholds of a certain AC changes in proportion to the change in the level of glycemia, then this AC is the most significant marker for controlling the action of drugs in diabetes. High glycemia figures give a proportional increase in the asymmetry of this AC, and a properly selected drug levels this asymmetry, which underlies the new patented method for assessing the effects of drugs at the individual level [36-39]. Thus, it is possible to determine the effectiveness of a particular drug in various diseases, its negative effects on individual organs, to establish the optimal dose and time of administration based on an assessment of symmetry in the body.

7) Since dynamic changes are constantly taking place in any living organism, the frequency response of various organs and systems also has a constant drift in time, reflecting both external influences and endogenous biorhythms of individual organs and systems. Normally, this deviation from the baseline does not exceed 10-15%, but in pathology it can be significantly higher. At the same time, for example, in diabetes, due to the buffering properties of the blood, changes in glycemia occur later than changes in the TS in certain AC, which makes it possible to carry out a preventive forecast of crisis conditions on this basis [41,42]. In general, especially in the norm, biorhythms are quite stable, which makes it possible to predict the state on new principles. To do this, on the group of "training measurements" at the individual level, a regression model is built on which those ACs that make the greatest contribution, for example, to the formation of glycemia, are determined. Then, on the basis of Kosinor-analysis [37.43], their individual biorhythms are evaluated with extrapolation for 1-2 days ahead. Moving along the distribution diagram of these biorhythms with the help of a special program, they are digitized along the time axis with the data entered into the regression equation, which ultimately makes it possible to estimate the probable level of glycemia in advance [17]. At the same time, due to the fact that there are different periods and phases of rhythmogenic activity of the AC, due to their interference, problematic periods arise with high or low levels of glycemia. Thus, we get an explanation why even with the most meticulous control of the diet and the use of strict therapy, the level of glycemia in practice is not predictable [38]. The use of this patented technique allows not only to predict the level of glycemia, but also to control the level in a new way, for example, blood pressure in hypertension and a number of other important parameters [16,17].

In general, the method of thermoalgometry, as a system for monitoring the bioenergetics of the body, has many useful applications that allow monitoring the body on new principles in various fields using simple equipment (www.chimaster.me). However, for such monitoring, it is necessary to make many measurements of the TS in the dynamics of the observation, followed by a complex analysis, which makes this technique not very popular in practice. Therefore, we turned to the Pulse Diagnostics system in the hope of creating a technique that would repeat the diagnostic capabilities of Eastern doctors in this area, but would be carried out by creating special equipment for these purposes.

To identify specific associations of AC with the activity of the heart, an assessment was made of the correlation and regression relationships of thermoalgometry parameters with indicators of cardiac activity according to the data of the esophageal electrophysiological examination (EPE) and echocardiographical examination [44]. At the same time, connections were analyzed for such parameters as the Conductivity function with the Wenkenbach point (Wp) estimate. Automatism of the sinus node function was assessed through the indicator for sinus node function recovery (TSKFR) and the corrected time necessary for sinus node function recovery (CTSKFR). AV junction's conductivity was assessed through the effective refractory period (AVcERP). The ejection fraction (EF) and on the size of the left atrium and the myocardial circulatory contractility rate (Ec) reflect myocardial contractility, which is undoubtedly reflected in a number of pulse wave parameters. For all these important indicators, significant correlations were obtained with the activity of certain AC, which indicates the direct effects of these AC on the work of the heart. These dependencies were also confirmed when assessing the relationship between AC and HR in violations of the rhythmogenic function of the heart [45].

Further, our attention was drawn to a number of publications devoted to the analysis of the second acceleration derivative (APG) of the pulse wave, in particular, to assess the activity of certain Chakras in Ayurveda. Ayurveda, a well-established medical system originated around 5000 years ago. The concept of energy chakras is mostly prevalent in India and they are very similar to the bioenergetic paradigm of medicine, which is most developed in China to explain the purpose of AC. According to the results of our research, Chakras consist of certain AC, but the structure of the Chakras and their topics and relationships with specific organs are more blurred in contrast to AC, which in the form of BAPs have a clear structure and connections with certain organs [16,17]. Auerveda distinguishes three components of the body: Vata is the nervous system, Pitta is the digestive system and enzymes, and Kapha is mucus, reflect the health of a person, and their violation leads to illness. The coordination of these three components affects the health of the human body, and disharmony leads to disease [46]. From the point of view of TCM, according to the system of 5 primary elements, these 3 components correspond to the primary elements of Wood, Earth and Metal with the corresponding AC within each. For the first time, the second derivative of the finger pulsation profile was used to determine the level of Pitta, which indirectly confirms our initial hypothesis about the relationship of certain AC with the pulse wave [47,48, 16,17].

APG of the pulse wave to a greater extent reflects the contractile function of the myocardium, for the assessment of which standard waves a, b, c, d, e, f are used with the determination of their duration, amplitude and their ratios (Fig.5). At the same time, the wave initial positive (a) is initial positive, early negative (b) is early negative, re-increasing (c) is re-increasing, late re-decreasing (d) is late re-decreasing and diastolic positive (e) diastolic positive, (f) –diastolic negative From these determinants, the following parameters can be calculated: b/a ratio, c/a ratio, d/a ratio, e/a ratio- based on their ratios, additional parameters for statistics collection are calculated. The technique for separating these waves is described in detail [49, 50].

To conduct a more extended search for AC connections with a pulse wave, we estimated a number of additional parameters. These are the spectral components of the pulse wave in 3 spectral ranges (LF, HF, VLF), and their ratios, which mainly reflect the rhythmogenic function of the heart. Further, on this primary basis, other, more generalized photo plethysmographic parameters, known in cardiac physiology as SDNN, DEI, TP, EI, ETC, EI, EEI, DDI, etc., are calculated [51]. In addition, for a more accurate assessment of AC parameters based on APG, we introduced an additional ECG recording with an assessment of a number of additional time intervals P-a, Q-a, R-a. S-a, which significantly improve the quality of calculation models, especially for various heart diseases. [40]. As a result of the correlation analysis of these indicators of

APG, ECG and spectra of heart rate variability with the values of AC thermoalgometry indicators, their reliable relationships were obtained, presented in Table 1. In the body, everything is interconnected and, as a result, is reflected in the pulse wave. All this ultimately allows, based on the analysis of the main pulse wave, to calculate the activity of various AC and, based on them, already judge the functional activity of various organs and systems of the body, as well as calculate a number of additional biochemical and physiological indicators.

Table 1. Summary table of stepwise linear regression of connections between acupuncture channels and phase and spectral parameters of the pulse wave of patient 1.

AC	R-squared %	SE	MSE
LUr	95,2316	0,47032	0,241865
LUl	92,0995	0,439913	0,267999
LIr	85,5497	0,446997	0,256419
LIl	93,6198	0,618719	0,224814
PCr	98,517	0,181673	0,098615
PCl	95,182	0,296451	0,130852
TEr	96,9835	0,286557	0,175682
TEl	98,236	0,16301	0,081891
HTr	88,2439	0,358394	0,241076
HTl	78,7432	0,463017	0,299105
SIr	93,9816	0,400612	0,236069
SIl	84,0741	0,657689	0,344325
SPr	85,1375	0,336333	0,18218
SPl	95,6525	0,644805	0,319116
LRr	92,3039	0,468922	0,21705
LRl	99,356	0,550159	0,134014
STr	97,5002	0,493452	0,248938
STl	98,9596	0,160815	0,0782715
GBr	87,0933	0,690409	0,523139
GBl	97,208	0,629321	0,293873
KIr	82,887	1,15428	0,54468
KIl	81,356	1,91169	0,750065
BLr	95,5598	2,78782	1,54001
BLl	92,3946	3,17734	1,42006

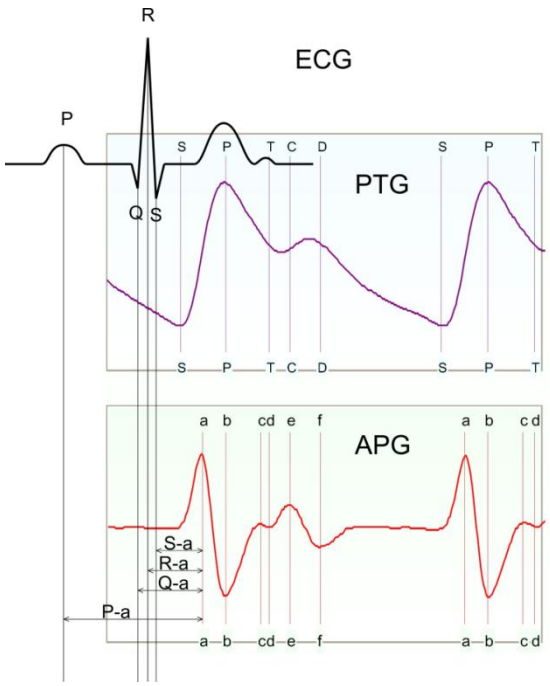


Fig5. A fragment of a synchronous recording of a plethysmogram (PTG), its acceleration component (APG) and an electrocardiogram (ECG) with a scheme for evaluating additional waves and time intervals.

Two devices can be used for body monitoring based on APG: a) for discrete monitoring in the form of a miniature pencil with a pulse sensor and a heat emitter for individual calibration of the system according to the Akabane test. b) for continuous monitoring in the form of a bracelet on the wrist with a pulse sensor [40]. However, in this case, it is necessary to have an additional calibrating device with the Akabane test. All these devices are integrated via Bluetooth with a Smartphone for primary data processing and transferring them to a server for final processing.

To start working with this system, it must be calibrated at the individual level. To do this, after recording 2-minute segments of APG, at least 10-15 Akabane tests are initially performed. These "system learning" data are transmitted via Smartphone to the server, where all calculations are made with the construction of regression dependencies between heart rate indicators and thermoalgometry data with the construction of individual conversion matrices from heart rate indicators to AC activity, followed by the construction of tables and graphs of the functional activity of certain organs at the moment on Smartphone.

As an example, let's consider the construction of a matrix for calculating the AC activity indicators of the right lung from the pulse wave indicators based on the regression model of relationships presented in Table 2.

Table 2. Regression model of relationships between pulse wave parameters and the right branch of the lung channel (LUr). Multiple Regression - Dependent variable: Lur

Parameter	*Estimate*	*Error*	*t*	*P-Value*
CONSTANT	-136,876	18,0929	-7,56515	0,0001
DDI	-16,4451	2,94081	-5,59202	0,0005
DEI	0,407878	0,170826	2,38768	0,0440
e_a	28,5148	4,90534	5,81302	0,0004
EI	4,90983	0,720476	6,81471	0,0001
Etc	0,0663494	0,0109238	6,07383	0,0003
HR	0,501279	0,0897322	5,58638	0,0005
LF	0,0014523	0,000330727	4,39123	0,0023
MeanNN	0,0956981	0,0122489	7,81277	0,0001
RMS_SD	-0,101564	0,0312083	-3,25439	0,0116

R-squared = 95,2316 percent: R-squared (adjusted for d.f.) = 89,8672 percent: Standard Error of Est. = 0,47032: Mean absolute error = 0,241865

This stepwise model explains 95.23% of the variance with a mean absolute error (MAE) residual of 0.24, which is quite acceptable for calculations. The distribution polygon of observed and predicted results also has a good distribution. Such calculation matrices are built for each AC on the server, which allows, for example, every 3-5 minutes, averaging the APG indicators on a Smartphone, to have 24AC values in the monitoring dynamics.

In addition, using a continuous flow of data about AC for each person, it is possible to build a dynamic model of AC relationships and thus additionally control the accuracy of primary calculations from random artifacts. Also, to reduce the "noise level", you can use the principle of assessing the asymmetry by the sum of the AC and the calculation of the Yang / Yin dipole [15-17].

If there are large samples based on observations, the clustering method can be used to identify homogeneous groups of users of this system with the same type of regulation of bioenergetics, which will allow the use of standardized signal processing algorithms in the calculation matrices. In this way, the "learning period of the system" can be shortened.

It has also been found that the use of neural networks, for example, to assess blood sugar levels based on the Akabane test, increases the accuracy of its assessment from 90 to 95%. For the development of the system, it is also planned to use AI at all levels of signal processing.

Discussion

One of the important issues in modern physiology is related to understanding the principles of the AC system and its role in the regulatory system of the body.

According to the literature data, the heart begins to form long before nerve fibers are attached to it [52-54]. The conduction system of the heart is formed in the prenervous period as a special myocardial tissue that performs self-sustaining complex work of the heart rhythm [55-58]. First, the Hiss bundle is formed with the size of the embryo 6-7 mm, after which the auricular-ventricular node is formed; the last is the sinoatrial node, which is formed when the size of the embryo is 12-14 mm. The heart is the first organ to have life and the last to lose it. By the end of the 23rd day, isolated fragments of cardiac tissue are already contracting even before the fully developed rhythmic activity begins.

Taking this into account, the conduction system of the heart can be considered a material representation of the AC series of the heart, which is the starting point for the development of a living organism [16,17]. The AC system itself at the level of the embryo grows out of the conduction system of the heart and, at the same time, forms the spatial framework of the body, in which the fate of the initial cells of the embryo will be determined by their topography in the body space [58]. This framework of AC will influence the diversity of future organ formations under the control of certain AC.

Taking into account the previously presented information about its work, it can be assumed that the AC system is a specific signaling system that appeared at the beginning of the evolution of living matter and until now it has a huge impact on the regulation of the main organs and physiological systems of the body. In this capacity, it can be important for us as a specific translator of information that is embedded in the pulse wave. Using the unique qualities of this system in the regulation of the body, we have proposed a number of devices to control various aspects of its life [59,60].

Thus, by including AC in the data evaluation chain, a theoretical bridge is built on how to obtain the values of various AC from the phase and spectral parameters of the pulse wave, and through them, on the basis of individual models, by calculation, already obtain various physiological and biochemical indicators of the vital activity of the organism.

Conclusion

In general, the creation of such a simple and convenient system for monitoring the body through the analysis of the pulse wave on new non-invasive principles can serve as the basis for many useful applications at the software level for the Smartphone. For example, this system can be used to monitor a healthy lifestyle, in sports and fitness, to control stress levels, especially in emergency situations, to assess the impact of various food products, sleep and rest patterns, etc. Huge opportunities open up in the field of individual pharmacology through assessing the impact of various drugs on various organs with the possibility of assessing their combination of beneficial and negative properties, assessing the optimal dose and time of administration based on chronopharmacology and individual biorhythms of certain organs based on proven methods. This system can become indispensable for monitoring various diseases, as illustrated by the example of diabetes.

In our opinion, the pulse diagnostic system can become one of the basic monitoring systems of the 21st century.

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