

6. Cardiometry laws and axioms

6.1 Cardiometry laws

Law No. 1

The blood moves in vessels in elevated fluidity mode (so called “third condition” in contrast to the laminar and turbulent conditions), characterized by low friction of flow resulted from the ring-shaped combination of the blood and dry blood elements.

Conclusions:

- 1) The heart and vessels anatomy is aimed at this mode of current set-up and support
- 2) Cardiac cycle consists of ten phases, each performing a definite function in process of the hemodynamics setting-up and maintaining

3) The function quality depends on the amplitude and rate of the appropriate cardio-vascular system muscles contraction

4) Maintaining the normal hemodynamic parameters ensures the function of compensatory phase mechanism that maintains the CVS muscles activity by combination of increased activity of some muscles with simultaneous decrease in activity of the neighbouring muscles.

Law No. 2

Cardiac nodes SA and AV, as well as the aorta baroreceptors BA, nervous centers are baroreceptors that generate the nervous impulses (response pulses) when the pressure of blood is applied to them.

Conclusion:

Pressure applied to the baroreceptor is the only source required for generation of the nervous impulse (response pulse) for starting the CVS muscles contraction mechanism.

Law No. 3

SA node ensures the closing of the atrioventricular valves.

Conclusion:

If the atrioventricular valves fail to close at the end of each auricular systole phase, the residual pres-

sure is built up in the atrium that has effect on the SA node. This surely will cause the repeated auricular contraction that will be represented on the ECG in the form of the second P wave (atrial arrhythmia basis)

Law No. 4

AV node controls three mechanisms of the bloodstream structure preparation in vessels:

- 1) Control of the diastolic pressure in aorta (carotid artery)
- 2) Formation of turbulent bloodflows preceding the aortic valve (carotid artery) opening

3) Aortic valve (carotid artery) opening.

Conclusion:

1) with intensive physical activity the phase L – j generation may be repeated up to 7 times.

Law No. 5

BA- baroreceptors of aorta (carotid artery) retain the bloodstream structure and maintain the elevated fluidity mode of blood flow in vessels

Conclusion:

The aorta expansion amplitude regulates the flow resistance.

Law No. 6

The amplitude of ECG phases corresponds to the cardiac muscles contraction amplitude.

The following parameters are analyzed:

- atriums contraction amplitude (P)
- IVS contraction amplitude (R)

- myocardium contraction amplitude (S)
- IVS contraction amplitude when electromechanical interface takes place (phase S-L maximum)
- aortic dilatation amplitude.

Law No. 7

Q – R – S phase functioning is an aerobic process and requires the use of oxygen, without lactate accumulation in myocards.

Conclusion:

The oxygen quantity is assessed based on the following ratio: rate of IVS contraction in Q – R phase – to – the rate of myocardium contraction in R – S phase.

Law No. 8

Phase S – L functioning takes place at presence of electromechanical interface in anaerobic process with the lactate accumulation in myocards.

Conclusion:

The lactate quantity is assessed based on IVS contraction speed in phase S – L – to – myocard contrac-

tion speed in the same phase against the background of the total tension of all cardiac muscles that took place in the previous phase and persists up to end of the systole. But it is required to take into account the effect of the pressure applied to them by the volume of blood contained in the cardiac ventricles.

Law No. 9

Phase L – j functioning is effected by electromechanical interface. The remainder of the creatinephosphate comes out and supports the ATP energetic support function in the next cardiac cycle.

Conclusion:

The creatinephosphate quantitative assessment is made based on the IVS contraction rate in

L – j phase – to – the rate of myocardium contraction in the same phase, but against the background of total tension of all cardiac muscles that took place in the previous phase and persists up to end of the systole, without taking into account the effect of the pressure applied to them by stroke volume of blood.

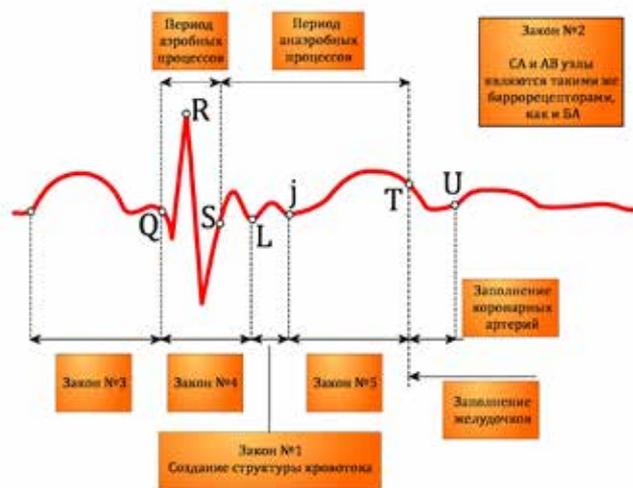


Fig. 87. Manifestation of the cardiometry laws in various parts of ECG

6.2 Application of laws in axiomatics

Axiomatics is a method of science formation used in all natural science. The axiomatics objective is to prove that the observed phenomenon represents the variety. Further on, the proved phenomenon is used in the function of the logical ratiocination for further conclusions. Both the basic laws and the following derived laws, phenomena and statements are considered to be axioms and accepted a priori and are not in doubt. As the evidentiary material is generated and accumulated, the theorems are formed that enable to apply the theory to practice.

The axioms noncontradiction is a main criterion for making decision to use it. There is a rule that determines the statements and conclusions noncontradiction in theorems that have been formulated based on the axioms accepted in the given science. Moreover, the further theorems shall prove the correct choice of the formerly accepted ones without additional proving.

All natural science is based on the principles of axiomatics. This is the principle of knowledge the truth.

The cardiometry is based on the principles of axiomatics.

To be certain in correction of the cardio signals interpretation, it is necessary to determine at least three manifestations of their form alternation caused by the same process. At that, they should not contradict one another, on the contrary, they

shall confirm the underlying cause of the process. This is the basis for precise detection of the cause of deviation from norm.

Example. In case of IVS minor contraction represented on the ECG by low amplitude of R wave, also the changes in the other phases shall be present. They are caused by the compensation mechanism meant for maintaining the hemodynamics parameters in norm. So, the S wave contraction amplitude shall be increased. If not, the pressure rise in aorta will be below normal value, that is diagnosed based on the rheogram made in the rapid ejection phase. The only conclusion that can be made is: the quality of muscles is too low to build up the pressure in ventricle. This results in low ejection of blood into aorta. At that, T wave amplitude may be increased thereby decreasing the blood flow resistance. As a consequence, the hemodynamics parameters will be normal, but the heart and vessels functioning will tend to pathological zone. The conclusion is as follows: it is necessary to recuperate the myocard metabolism, in particular the IVS contraction function shall be normalized.

The analysis of the subjective symptomatology is also very important. Three symptoms of health variations having the same cause can be identified through simultaneous analysis of ECG, RhEO and personal symptoms.

6.3 Diagnosis verification

In philosophic dictionary one can find the following interpretation of the word "verification" (Latinic "verus" means "true" and "facio" means "make"), i.e. confirmation. Assumption (hypothesis) can be confirmed. That means, the verity can be confirmed both by experience and by the logical proof [41].

This definition involves two ways of proving the verity: the first one is by experiment, the second is the logical proof.

In cardiology, the same like in medical science in general, the practical verification is done by experiment (empirically). The cardiology is based on the knowledge obtained through practical experiments. The theoretical basis (dealing with theory of the car-

dio-vascular system parts functioning) has dramatic contradictions, and at times wrong ideas and understanding of physical processes. The theory of liquid flow structure in laminar flow (that has been also used for description of blood flow in vessels) is based on assumption that all fluid particles move in parallel to walls of tube where the process takes place [3].

However, one never finds this law in theory of physics. The laminar mode by definition will concentrate all fluid elements in the center of the flow. This will result in high energy consumption for overcoming the excessive friction resulted from fluid motion [3]. It is evident from the table that coefficient of efficiency in the laminar flow is rath-

Hemodynamic efficiency provided that the laminar flow exists in the blood vessels

Vessels	Diameter, cm	Length, cm	Blood velocity, cm/sec	Reynolds number	Hydraulic efficiency of vessels, %
Aorta	1,0	40	50	1670	39,4
Great artery	0,3	20	13	130	3
Chief arterial branches	0,1	10	8	27	0,42
Terminal branch	0,06	1	6	12	1,1
Arteriole	0,002	0,2	0,3	0,02	$3,15 \cdot 10^{-4}$
Capillary vessels	0,0008	0,1	0,07	0,002	$2,5 \cdot 10^{-5}$
Venules	0,003	0,2	0,07	0,007	$1,6 \cdot 10^{-4}$
Terminal veins	0,15	1	1,3	6,5	1,5
Main branches of veins	0,24	10	1,5	12	0,44
Great vein	0,6	20	3,6	72	3,4
Vena cava	1,25	40	33	1375	40

er low and it can not exist in the vessels [42]. Here-with, the pressure in the aorta should be about 2 atm, though virtually it can't exceed 200 mmHg. This philosophy did not allow to describe the real hemodynamics mathematically.

Since the unreal model has been taken as a basis, the cardiology failed to construct a theory that allows to analyze the hemodynamic processes running in cardiovascular system.

In consequence, up to now the cardiosignals were verified through the comparison with clinical examination. One more fact is very important: the same parameters recorded by various instruments may differ sufficiently [43].

In natural science, any subject of research is considered from the point of view of logical provability/demonstrability. This is the basic principle of scientific research methodology. But it is not represented in education programs of medical schools and institutes. So, the essence of the research methodology is provided in the present paper.

In natural science there are two types of proof: direct and indirect proof [44]:

Direct method is based on:

1. Availability of the mathematical description of the process under investigation.
2. Axiomatic foundations used for the process interpretation. This an axiomatic basis that is used

for the logical derivation. The axiomatic statements must be monosemantic and unambiguous.

3. Process repeatability. The process under investigation must be recorded at least three times in various conditions.

4. Simulation and predictive modeling of the various conditions that influence the process.

Indirect method of exclusion is based on:

1. Axiomatic foundations used for construction of the logic negation and for affirmation of facts that prove the existence of the observed process.

2. At least triple recording of the process under investigation under various conditions.

The direct and indirect proves combination is the best method. The above-mentioned principles make the foundation of the proof theory and research methodology in natural science [42].

Let us remark here that in the cardiology science the principle of verification is based on the empirically proved compliance of the cardiowave shape with the other nomenclature-proved shapes taken for reference.

Drawback:

1. Lack of logical algorithm for the object of investigation interpretation, that causes the multiple discrepancies in results obtained through application of the various methods.



Fig. 88. ECG with a number of P waves. When the myocard elasticity degrades due to problems in coronary blood flow, the atriums take the load. P wave will stop to recur after the atrioventricular valves closing

Conclusion:

1. Lack of the unified logical theory of the cardio-vascular system functioning.

2. Only the explanation of special (non-systematic) cardio signals exist.

It is required to adopt the reasoning that can be used as axiomatic statement in proving the various cardiological signal forms compliance with the specific physiological processes in healthy condition and in pathology, and moreover in critical condition that is of critical importance. At that, the proof system shall include the following positions:

1. Database of various cardio signals of the same patient.

2. Existence of axioms (reasoning), including the hemodynamics mathematical model.

3. Availability of minimum three indications of the cardiosignals shape changing that can be interpreted with the use of axioms (reasons).

4. Logical justification of changes in the cardiosignals shapes depending on the biophysical processes that cause the signals.

5. Theoretical prediction (modeling) of the progress of disease depending on the conditions.

6. Practical recording of the predicted changes in the cardiosignal shapes followed after the action on the biophysical process.

The key notions of the theoretical hemodynamics must be used for reasoning. In this paper nine hemodynamic laws are specified.

Based on the established laws and physics of liquid motion in elastic tubes, the set of rules can be formulated and used as the reasoning that explains the CVS activity compensation mechanism [37].

The laws allow to verify any form of ECG by establishing its correspondence to the biophysical

processes that take place in the cardio-vascular system. Let us consider some examples.

Example 1

In Fig. 88 represented is the ECG form that has a number of P waves. In classical cardiology this ECG form is classified as the auricular arrhythmia.

Let us consider the ECG form pursuant to logic of evidence accepted and used in natural science.

1. ECG registered on the ascending aorta is most informative and represents the graphic sum of all standard leads [37].

2. For the ECG form analysis, the above-mentioned laws are used. They are the arguments and comply with the axiomatics requirements.

3. Let us consider three logically interdependent manifestations:

3.1. Weak relaxation of the myocard muscles. Absence of S wave.

3.2. Because of weak relaxation, the pressure fails to be removed from the SA node of the baroreceptor, and P wave is generated.

3.3. PQ phase is extended, so more time is required for coping the weak expansion of the myocard muscles.

4. Now we can determine the physical reasons that can cause the changing in ECG form. The logic of the examination will help to reveal the underlying cause of the changes.

Each phase of the cardiac cycle is time-limited [37]. In this particular case, the weak relaxation of the myocard muscles does not allow to fill the ventricles with blood volume sufficient for the atrioventricular valve closing (Law No. 3). Only after the valve closing, the response pulse generation can be started by AV node (Law No. 4). Therefore, the residual pressure in atriums persists affecting the SA

node, thus causing the generation of the secondary P wave. Prolongation of PQ phase is caused by low dilatability of the myocardium muscles.

There are no other changes in ECG form that would testify to other physical processes. In this case, the indirect proof method, i.e. method of exclusion, will help to come to conclusion. This approach sustains the direct proof method.

Conclusion: the weak relaxation of the myocardium muscles is the underlying cause of the ECG form changing. The medical treatment shall be aimed at curing just this pathology.

5. Process development simulation

The process simulation shall start with adequate definition of the underlying cause of the pathology. In this case, the weak relaxation is caused only by the low energetics of mitochondria, first of all by very low ATP energy. This may be caused by the coronary blood flow problem and by lack of oxygen.

Therefore, two variants can be predicted. What will happen if nothing will be done, and what will happen if we choose the correct medical treatment?

In first case it is reasonable to anticipate that the further weakening of the myocardium will cause the decreasing of the aorta resistance to the blood-flow that will be manifested by the T wave amplitude rising. This will indicate the reduction of resistance resulted from aortic dilatation. But this dilatation is limited, and in case of reaching these limits, the prerequisites for the diastolic arterial pressure buildup will arise.

No other processes can arise since there are no causes for this from the physical standpoint (method of exclusion).

In result of the proper curing, only one P wave shall be recorded, S wave amplitude will increase.

6. The medical treatment was aimed at the coronary blood flow recovery. In result the anticipated progress in ECG form comes true.

The described logic of search for the pathology cause (shown by the ECG shape) has been used for treatment of more than 2000 patients. Finally, all the possible variations occurring in ECG have been classified based on the cardiac cycle phases analysis. At that, we managed to understand and predict the lethal outcomes approxi-

mately 20 – 40 minutes before the cardiac arrest. The well-practiced methods of medical treatment allowed to reduce the mortality in clinical conditions by 80 %.

It should be noted that the supplementary information obtained through the cardiac cycle phases analysis (by means of indirect measurement of the phase volume of blood and the synchronous point rheography of aorta) allow the accurate verification of any variations in ECG [37].

Example 2

Figure 89 shows the ECG form with low amplitude of QRS complex and high amplitudes of P and T waves.

Considering the preceding detailed reasoning, we do not go into details now but follow the same logic of the pathology underlying cause search.

Based on the accepted axiomatics, three logically interdependent manifestations can be determined:

1. Low amplitude of QRS complex
2. High amplitude of T wave
3. High amplitude of P wave
4. High amplitude of SL phase.

In this particular case more than three logical manifestations are available.

Low amplitude of QRS complex, (R and S waves) indicates the weak energetic processes in mitochondria. Any other reason is excluded. High amplitude of P wave proves the weak relaxation of the myocards. The large T wave provides for aorta dilatation and reduces the blood flow resistance of the weak heart.

The high amplitude of SL phase proves the conclusion. It indicates the considerable muscle strain in muscle tension phase. This is a compensation mechanism.

As a result, the following conclusion can be made: the energetic weakness of ATP in the cardiac muscles mitochondria is the primary cause of pathology. Meanwhile the other CVS functions are in normal condition.

The patient therapy was aimed to normalize the functions of the chain of oxygen delivery to mitochondria: thrombotonin – L-carnitine, as well as to reinforce the Q-ferment effect.

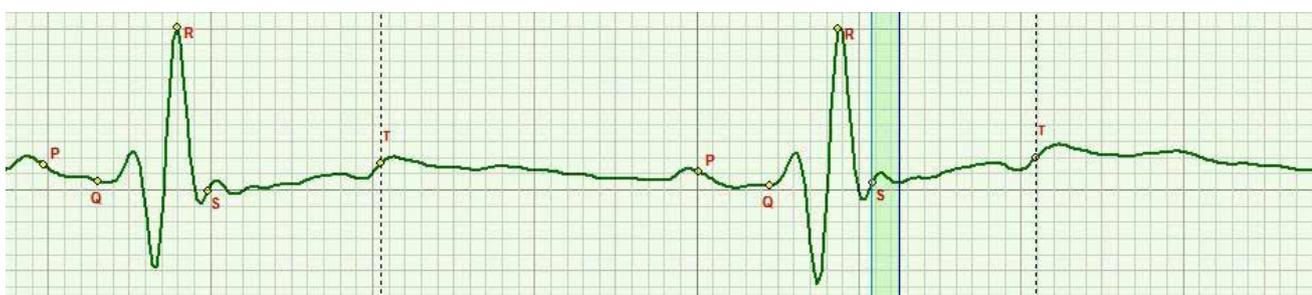
Within six months, the long-lasting therapeutic effect has been achieved and manifested by normalized phase amplitudes on the ECG.



Fig. 89. ECG represents the low amplitudes of IVS and myocard contraction



a)



b)

Fig. 90. ECG of aorta a) in lying position; and b) in sitting position

Example 3

Figure 90 represents the ECG forms obtained in result of the orthostatic test. In classical cardiology, this form is classified as the His bundle branch conduction disorder (asequence). It is a complicated pathology that can not be cured by means of the changing the body position, as it is shown in Fig. 90 (a). So, the verification is of particular importance in this case.

Three logically interdependent manifestations:

1. Weak relaxation of myocard muscles. Lack of S wave.

2. Instead of the myocard contraction, its reverse stroke is observed. On ECG, the dip in R wave leading edge is manifested.

3. Symptomatology: sensation of bulging in the left side of the body near the apex of the heart caused by the myocard reverse stroke.

In this particular case we have a rare occurrence of the IVS performance. For contraction, in the first step the IVS must relax through the sufficient

dilatation that is recorded on ECG in QR phase. We named this phenomenon “the reverse motion”, it is accompanied with muscular pressure near the apex of the heart caused by the reverse traction of muscles. This phenomenon is not stable and depends on the body position. When in horizontal position it is almost not manifested, but when in vertical position it is clearly pronounced. This type of heart performance can be explained from the point of view of the cardiac cycle phase analysis.

The point is that during QRS phase the blood circulation structure is prepared according to law No. 1 [37]. At that, the valves are closed but the bloodflow shall not stop. If it stops, it would not enter the aorta.

But the congenital abnormality of coronary arteries introduce some changes in this mechanism [45]. The coronary left ventricular fistulae contract and eject the blood into the ventricle. The blood quantity depends on the position of body,

therefore the amplitude of reverse depends on the volume of blood ejected by fistulae into the ventricle.

The people that have this phenomenon live for long. In our practice, we did not manage to normalize the IVS reverse motion.

In this section, the main arguments and logic of evidence applied in natural science are represented. There is no point to argue about the methodology on the whole. Each particular case shall be examined and require the erudition. It is

this that makes the basis of the scientific achievement.

The represented method of the ECG form verification based on the biophysical processes is an outcome of the cardiac cycle phases analysis [37]. Due to lack of this theory, great many contradictions arose in cardiology science. The new logical methods introduced into theoretical study and new knowledge about the phase structure of the cardiac cycle allowed to apply in cardiology the principles of substantiation used in natural science.