

SPEED DIAGNOSTIC AND CORRECTION OF FUNCTIONAL STATE OF ORGANISM IN PRACTICE OF SPORTS PHYSICIAN

The diagnostic functional state of the organism (FSO) has the leading role in the assessment of physical shape. The results of functional diagnostic are the basis for the application of those or other means and methods for functional rehabilitation of an athlete that is a purely medical prerogative.

Sports physician of the team has a rather poor set of technologies of functional diagnostics. This includes the evaluation of laboratory indices (General blood analysis, lactate, ALT, AST, etc.) and analysis of ECG, heart rate, and respiratory rate under the influence of significant physical activity. Such testing is used in all the leading sports federations of the world, but has a significant drawback because it is based on the analysis of indicators of cardiopulmonary system under the influence of intensive physical exercises. Therefore, this diagnostics is not applied before the competition and is contraindicated in children and in the presence of any injury or disease.

The coach and the athlete himself has still a critical need for better diagnostics the FSO on any day of the year training-competitive cycle and immediately before the competition. And this would help the sports doctor in early diagnostic of overtraining and fast optimal correction of unwanted deviations of the most important functional indicators and, thereby, to improve the FSO.

On the eve of competitions, the FSO identified often with the self-perception of athlete's health. In addition, the coaching staff not rarely organizes competitions between members of the same team a few days before the performances to determine fitness. These facts indicate that there is a problem to assess the level of the FSO in any sport.

We have solved this problem and created the new universal diagnostic technology of FSO of athletes, which is called **«Speed Diagnostic of the functional state of the organism (FSO) of athletes at rest»**.

Speed Diagnostic FSO of athletes at rest, based on the analysis of physiological changes in the body characterized for the sports activity, is carried out using a multifunctional hardware-software complex **«Integral Monitoring System «Symona 111»**. We carry out non-invasive measurements of various physiological parameters of central and peripheral hemodynamics, delivery and consumption of oxygen, respiratory function, body temperature, metabolism, activity of the central and vegetative nervous system. «Symona 111» is used as in clinical practice (cardiology, pulmonology, functional diagnostics, anesthesiology, intensive care), and in sports medicine.

Survey one athlete is performed in the horizontal supine position in a quiet relaxed state and takes no more than 10 minutes. «Symona 111» manufacturer carries out training of this technology when the device is delivered, and then continues training by counseling examination protocols over the Internet.

In the body of the athlete functional reorganization occurs under the influence of many years of training and competitive loads. Most of all it is evident in the change of muscle-articular apparatus. But the functional condition of the cardio-pulmonary system is the paramount factor limiting muscle work and the whole organism.

The changes of functional indicators reflect the levels as overall adaptation of athletes to physical loads and adaptation to special functional training exercises in the chosen kind of sport.

Under the influence of physical activity in the body there are both immediate and long-term changes. They all, ultimately, are aimed at ensuring optimal whole body energy. High level athletes at rest show the highest characteristics of the reserves and adaptive capacities of the functioning of the cardio-pulmonary system. Reusable measurement, comparison and analysis of the fluctuations of these characteristics during training-competitive period allow to judge about the FSO dynamics.

14-year experience of application of this technology in various national and club teams of Moscow and Russia (28 kinds of sports) showed that to determine the level of the FSO and monitoring of its dynamics there are very useful the following integral indicators:

DO₂I - Oxygen Delivery Index (ml/min/m²). It characterizes the intensity of the aerobic metabolic processes. In a healthy person, but not the athlete's, normal rate is 600. In athletes at rest, during the period of active recovery after exercises, DO₂I can reach 1500, while a full recovery is approaching 600 and may be even about 500. This is usually a stable individual minimum: 500 to 900. Fully recovered sprinters or athletes from playing sports usually have DO₂I 900-1100, and stayers - 500- 700.

HFI - Heart Failure index (relative units). Normal rate is 0±20. It characterizes the level of the functional state of the cardiovascular system (the formula includes 15 indicators of central and peripheral hemodynamics). With a healthy cardiovascular system, the HFI has positive values. If the HFI is less than -20, then the patient has chronic heart failure (CHF). HFI allows you to objectively monitor the effectiveness of CHF treatment.

IB – Integral Balance Deviation (rel. units). It characterizes the level of cardio-pulmonary system functioning. The normal rate for a healthy person is 0±100. IB for well-trained athletes can reach 300-700. Sick people have the reduced IB less than minus 100.

CR – Cardiac Reserve (rel. units). It characterizes the existing reserves of the heart functioning. The normal rate is 5±1 for a healthy person. CR can reach up to 12 for well-trained athletes. At any diseases or at the general exhaustion the CR is reduced and is spent on the recovery of the body. The higher the CR is - the greater the endurance and the stronger the ability to perform a large amount of work. The lower the CR is, the worse the functional state of organism. In sick people the CR is less than 4.

AR – Adaptive Reserve (rel. units). It characterizes the level of reserves of the body to perform physical (sports) and mental activity. The normal rate is 500±100. AR can reach 1500-1800 in elite athletes. AR is less than 400 in sick people.

STI - Stress Tolerance Index (rel. units). It characterizes the body's ability to endure stressful physical and mental stress without harm to health. The normal rate for a healthy person is 10 ± 2 . High stress tolerance, when $STI > 12$, normal stress tolerance, when STI is from 8 to 12, low stress tolerance, when $STI < 8$. STI can reach 25 in elite athletes.

PFI - Personal Fitness Index (rel. units). It characterizes the functional fitness and performance. The normal rate for a healthy person is 50 ± 10 . PFI is considered very high if > 150 . For outstanding athletes, it can reach 340.

PPCR - Phase Portrait of Cardiac Rhythm. This is a graphical image of the heart rhythm. Options of PPCR in normal states and pathology are demonstrated during the training of this technology. The absence of large changes in the PPCR (stability) after exercises reflects the high level of the FSO. The wrong picture of PPCR is a very early signals of overload of the heart (the overtraining, myocarditis, etc.) or difficulty breathing (laryngitis, bronchitis, pneumonia undertreated).

All these indicators are very dynamic and they objectively reflect positive and negative effects of any carried out therapy. It allows the doctor to assess the impact of treatment very early and to correct it promptly.

Tracking dynamics of DO2I, IB, CR, AR, STI, PFI, HFI and PPCR, it is possible to judge:

- intensity (adequacy) of training loads,
- speed (duration, efficiency) recovery FSO,
- level of fitness.

Although the survey is not during physical activity (after 0,5 – 3 - 10 hours after exercises or in the morning after a night's sleep), actually the technology assesses the functional response of the cardio-pulmonary system as a response to previous specific to the chosen sport training and competitive loads, as well as rehabilitation.

«Symona 111» measures 155 physiological parameters simultaneously, which are reflected in the examination report automatically in comparison with the normal value of the ordinary man and his previous data. This allows the sports physician to determine the indicators which have changed or went beyond the boundaries of the normal value to one direction or another.

Our experience has shown that athletes are seen most often following pathological syndromes, which significantly degrade the level of fitness and integral FSO indicators:

1. Decreased myocardial contractility (decreased indices of ISI, EPCI, VVI, EF, PEP)*.
2. A deficiency of potassium, zinc and magnesium (increased PEP)*.
3. Violation of cardiac rhythm (modified PPCR, an increase of CRV)*.

4. Reduction of circulating blood volume (decreased SI, CI, EDI, TFC)*.
5. Thickening of the blood - bad blood rheology (pathological correlation of ISI and EPCI)*.
6. Difficulty breathing as a result of disease of the pulmonary system (increased RR, decreased SpO₂, altered PPCR)*.
7. Deregulation of the functioning of the internal organs (increased ITB and ISA)*.
8. Overtraining (varied combination of the above syndromes).

ISI - Inotropic State Index, **EPCI** - Ejection Phase Contractility Index, **VVI** - Volume Velocity Index, **EF** – Ejection Fraction, **PEP** - Pre Ejection Period, **PPCR** - Phase Portrait of Cardiac Rhythm, **CRV** - Cardiac Rhythm Variability, **SI** - Stroke Index, **CI** - Cardiac Index, **LVEDI** - Left Ventricular End Diastolic Index, **TFC** - Thoracic Fluid Content, **RR** - Respiratory Rate, **SpO₂** - Oxygen Saturation in Arterial blood, **ITB** - Index Tension by Baevsky (parasympathetic activity), **ICA** - Index Sympathetic Activity.

The doctor has a diverse set of correction of physiological functions to improve the physiological parameters. This kit includes medicines, nutrition, physiotherapy, changing the training and competitive loads. Therapy of the abovementioned syndromes is selected individually. The efficiency of therapy is evaluated using the same technology.

In sport medicine the System is used for the following:

- Diagnostics physical shape;
- Selection to national teams, assessment of physical shape before signing the contract;
- Screening for children to determine their abilities for sports exercising;
- Rapid diagnostics overtraining;
- Optimization of individual plans of training and competition;
- Evaluation of the training loads (sufficiency, redundancy);
- Control of medical treatment and trauma prevention;
- Control of rest and rehabilitation phase;
- Control of impact of medicines and food additives.

There is more than 13 years of experience in track and field, football, basketball, handball, swimming, judo, fencing, cycling, skiing, ice hockey and many other sports.

The analysis of FSO integral indicators in combination with the simple physiological indicators raises sports medicine to a new level, helping sports physician not only to examine the FSO, but also to be active in its correction, contributing to the growth of sports results.

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