

## **DIAGNOSTICS AND CORRECTION OF FUNCTIONAL STATE OF ORGANISM IN PRACTICE OF SPORTS PHYSICIAN**

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The diagnostics functional state of the organism (FSO) has the lead role in the assessment of physical shape. The results of functional diagnostics 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 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 diagnostics 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 sports shape. These facts indicate that there is a problem 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 **«Diagnostics of the functional state of the organism (FSO) of athletes at rest»**.

Diagnostics 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.

Read more about physiological basics of this technology in the article «**Diagnostics functional state of the organism (FSO) of athletes at rest**» (Russian language). <http://symona.ru/sport/>

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 allows to judge about the dynamics of the FSO.

Six-year experience of application of this technology in various national and club teams of Moscow and Russia (23 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:

**DO<sub>2</sub>I - Oxygen Delivery Index** (ml/min/m<sup>2</sup>). 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, DO<sub>2</sub>I 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 Sprinter or athletes from playing sports usually have DO<sub>2</sub>I 900-1100, and stayers - 500-700.

**IB - Integral Balance Deviation** (±Δ%). It characterizes the level of functioning of the cardio-pulmonary system at rest compared to a normal person of the same sex, age, weight, height. The normal rate is 0±100 for a healthy person, but not the athlete. Fully recovered athletes in a calm state always have IB above 100, and in elite athletes IB can reach 400-700. If good recovered professional athlete (after the day of rest) demonstrates IB dropped significantly and it rates less than 100, it is a sign of overtraining. A drop IB after training or competition reflects the physiological value of the transferred physical exertion. A negative value IB after exercises speaks about the redundancy of the transferred load and bad fitness of the athlete.

**CR - Cardiac Reserve** (conventional unit). It characterizes the existing reserves of the heart. The normal rate is 4 to 6 for a healthy person, but not the athlete. In the well-rested and recovered elite athletes in a calm state, CR can reach up to 10.5. After exercises it is reduced and spent on the

recovery of the body. In well trained athletes at rest and after exercises or competition CR is not reduced below 4.5. The higher the CR is the greater the endurance. The lower the CR is the worse the FSO, the lower the level of fitness.

**AR - Adaptive Reserve** (conventional unit). It characterizes the level of reserves of the body to perform physical and mental work. The normal rate is 400 to 600 for a healthy person, but not the athlete. In the well-rested and recovered elite athletes in a calm state AR can reach 1400-1500. After an intense workout or competition AR may be reduced to 400. The well-trained high-level athletes after training or competition have AR not below 600. The more AR is the better the FSO, the higher the level of fitness.

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

Tracking the dynamics of DO2I, IB, CR and AR, 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 120 physiological parameters simultaneously, which are reflected in the examination report automatically in comparison with the norm of the ordinary man and the previous data of the athlete. This allows the sports physician to determine which indicators have changed or went beyond the boundaries of the norm in one direction or another.

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

1. Decreased myocardial contractility (decreased indices of ISI, EPCI, VVI, EF, PEP)\*.
2. A deficiency of potassium and magnesium (increased PEP)\*.
3. Violation of cardiac rhythm (modified PPSR, 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 SpO<sub>2</sub>, altered PPSR)\*.
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, **PPSR** - 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, **SpO<sub>2</sub>** - 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, change the training and competitive loads. Therapy of the abovementioned syndromes is selected individually. The efficiency of therapy is evaluated using the same technology.

The use of this technology for diagnostics FSO in high performance sport enabled to perform:

- ranking of athletes during training and before competitions,
- selection in national teams, assessment of the level of sports form (FSO) before signing the contract,
- rapid diagnostics of overtraining,
- evaluation of the training loads (sufficiency, redundancy),
- optimization of individual plans of training and competition,
- selective correction of disturbances of physiological functions and performance evaluation of the selected restoration actions.

Working in conjunction with sports doctors of national teams, we with all responsibility can declare that the use in "field" conditions of the mobile complex «Symona 111» and technology no load diagnostics the FSO (at rest) provides a system approach to assessing the level of fitness.

The analysis of the integral indicators of the FSO 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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