

## **Biathlon.**

### **Diagnostics Functional state of the organism of sportsmen during The European Championship, Poland, 25-29 January 2017.**

#### **Introduction**

**Functional state of the organism - is an integral characteristic of the state of health, reflecting the level of activity, functional reserves and adaptive capacity, which can be used for sports strain, illness, injury, pregnancy ...**

Diagnostics of the functional state of the organism (FSO) has a leading role in the assessment of sports condition. It is imperative for the doctor, the coach and the athlete to have objective information about the level FSO in each period of the annual training and competition cycle, but especially right before the start of competition or on any day of multi-day competitions.

The results of functional diagnostics serve the basis to a coach to make the list of participants for the competition and to optimize the training loads of the sportsmen. The diagnostic information allows the doctors to improve FSO, using different means of rehabilitation of the athlete.

FSO diagnostics has been widely practiced in clinical and sports medicine for a long time using various medical equipment. Moreover, diagnostics FSO is sports is based on the analysis of indicators of cardiopulmonary system under the influence of intensive (often the maximum) physical exercises. Such diagnostics is carried out 2 times a year during the in-depth medical examinations in Russia.

However, this diagnostics has many disadvantages:

1. Not objective, depends on the motivation of the athlete.
2. It's conducted in major medical centers (away from training camps and competitions).
3. There is no clear conclusion about the level of FSO (only 3 kinds of reports: not satisfactory, satisfactory and good).
4. Doesn't identify the causes of deterioration of FSO.
5. Doesn't recommend a coach, doctor and the athlete to improve FSO.
6. Disrupts the usual preparations for the competition.
7. Doesn't carry out after or during illness or injury.
8. Each sport has it's own stress test.

9. It's held at the beginning and at the end of a sports season, but not in the competitive period.
10. Limitation of age (15-40 years).

Given the above, we believe that the ideal diagnostics FSO of athletes must meet the following criteria:

1. Objective, independent from the motivation of the athlete.
2. Athlete should be without additional exercise (not interfere with the plans of training during training camps and competitions).
3. Universal (for any sport) and takes a short time.
4. Integrated (system, multifunction).
5. Reflects the adaptive capacity of the organism (functional reserve).
6. Reflects the dynamics of the FSO.
7. The large variability of conclusions about the level of the FSO.
8. Detects violations of separate physiological functions.
9. Evaluates the effectiveness of rehabilitation measures.
10. Not contraindicated in diseases or injuries.
11. Has no age restrictions (children, adults, the elderly).

### **Materials and methods**

During The European Championship in biathlon (Poland, 25-29 January 2017) we applied the new universal technology diagnostics FSO of athletes, which is called **«Diagnostics FSO of athletes at rest»**. This technology is based on the analysis of simple and integral functional parameters of the hardware-software complex **«Integral Monitoring System «Symona 111»**, which is composed of 8 measuring modules, connected by a computer program:

1. Cardioplethysmograph,
2. Electrocardiograph,
3. Pulsoximeter,
4. Non-invasive blood pressure,
5. Body temperature (2 channels),
6. Electroencephalograph,
7. Gas breathing (CO<sub>2</sub> + O<sub>2</sub>),
8. Breathing mechanics.

The complex is designed for non-invasive measurements of various physiological parameters of central and peripheral hemodynamics, respiratory function, delivery and consumption of oxygen, metabolism, body temperature, activity of the central and vegetative nervous system. Simultaneously it displays information about the size of more than 100 simple and integral indicators. «Symona 111» is used in clinical practice (cardiology, pulmonology, functional diagnostics, anesthesiology, intensive care), and in sports medicine.

**The most important feature of the computer program is comparison of the measured values of each indicator from its normal value to a perfectly healthy man.** The magnitude of the normal value of any indicator depends on the age, sex, height, weight and body temperature.

We analyze the values and trends of both simple and integral indicators in practical diagnostics FSO of patients and athletes. We examine only integral indicators in this work:

**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 500 - 700. 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 slayers - 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. Reflects the total sum of the variance (%) from the norm 10 "simple"

indicators of the cardio-pulmonary system. The normal rate is  $0 \pm 100$  for a healthy person, but not for the athlete. Fully recovered athletes in a calm state always have IB above 100, and for elite athletes IB can reach 300-700. If a good recovered professional athlete (after the day of rest) demonstrates significantly dropped IB and it rates less than 100, it is a sign of overtraining. A drop of IB after training or competition reflects the physiological value of the transferred physical exertion. A negative IB value after exercises speaks about the redundancy of the transferred load and bad athlete fitness.

**CR - Cardiac Reserve** (conventional unit). It characterizes the existing reserves of the heart. Reflects the relationship between time parameters of the cardiac cycle. The normal rate is 4 to 6 for a healthy person, but not for the athlete. CR can reach up to 11 for well-rested and recovered elite athletes in a calm state. After exercises it is reduced and spent on the recovery of the body. CR is not reduced below 4.5 for well trained athletes at rest and after exercises or competition. The higher is the CR the greater is the endurance. The lower is the CR the worse is the FSO, the lower is the level of fitness.

**AR - Adaptive Reserve** (conventional unit). It characterizes the level of reserves of the body to perform physical and mental work. Reflects the interaction of IB and CR. 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 1200-1500. 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.

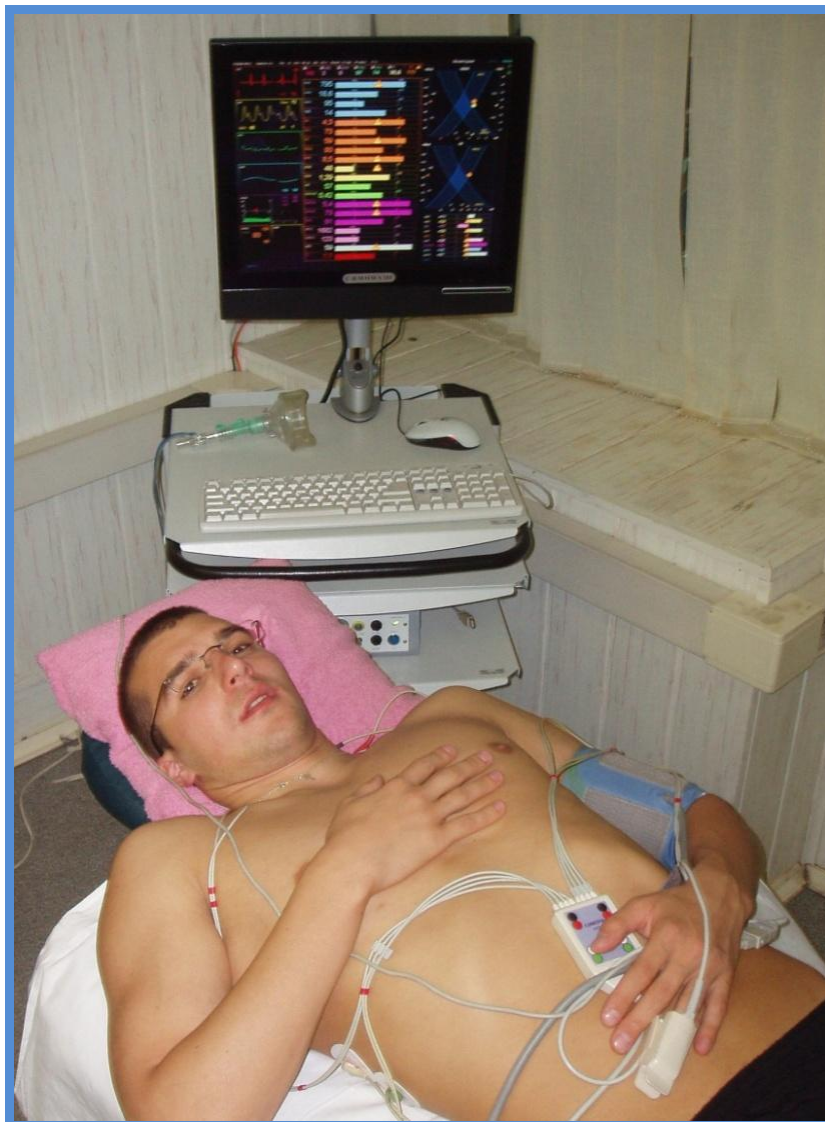
In this paper we provide medical information about 4 members of the men's team of Russia in biathlon participating in **The European Championship 2017**, January 27 (10 km Sprint) and January 28 (12,5 km Pursuit).

Working in the national team of Russia in biathlon, we usually analyze a variety of individual indicators FSO of athletes. And in this public work, not to disclose personal data, we divided the 4 athletes in 2 groups (2 people each). The only criterion for this separation was the results of reusable diagnostics FSO in January 2017, against the background of the competition in the World Cup and the IBU Cup.

**Group 1** has 2 athletes consistently having very high FSO (close to personal highs). We designated them No. 1 and No. 2. They finished 2nd and 17th in Sprint race, and 1st and 2nd in Pursuit - (total average place in both races is 5.5).

**Group 2** has 2 athletes with high level value FSO, typical for members of the national team of the Russian Federation, but not approaching personal highs in January 2017. We designated them No. 3 and No. 4. They finished 18th and 24th in Sprint race, and 16th and 20th in Pursuit – (total average place in both races is 19.5).

The examination of the athletes was performed in the morning after a night's sleep before breakfast and lasted no more than 10 minutes. The athlete was in the horizontal supine position in a quiet relaxed state.



We present a comparative table of 2 groups of the athletes with integral indicators FSO. The diagnostics were conducted in the morning of January 26.

<b>Integral indicator</b>	<b>Group 1 №1 и №2</b>	<b>Group 2 №3 и №4</b>	<b>Average value of norm</b>
<b>DO<sub>2</sub>I Oxygen Delivery Index</b>	<b>677</b>	<b>601</b>	<b>600</b>
<b>IB Integral Balance Deviation</b>	<b>+337</b>	<b>+257</b>	<b>0</b>
<b>CR Cardiac Reserve</b>	<b>9,29</b>	<b>7,98</b>	<b>5,00</b>
<b>AR Adaptive Reserve</b>	<b>1271</b>	<b>1004</b>	<b>500</b>

After a very successful performance of one of the athletes of the Group 1 in the first two starts (January 25, Men 20 km Individual, 1st place and January 27, Men 10 km Sprint, 2nd place), the coaching staff planned to cancel his participation in Pursuit on January 28, to provide a day of a rest to recover before the Mixed Relay on January 29. But diagnostics FSO of the athletes at rest in the morning of the start in Pursuit (January 28) showed complete recovery FSO for such a contestant. He was declared in Pursuit and was first in it, and the next day he was first in Mixed Relay.

### **Discussion**

Functional reorganization occurs in the body of the athlete under the influence of many years of training and competitive loads. First of all, it is visible in the restructuring of the muscular-articular apparatus. But the primary factor limiting muscle is a functional condition of the cardio-pulmonary system (CLS).

Both immediate and long-term changes in CLS occur under the influence of physical activity. All these changes are ultimately aimed at optimal achieving of entire body with energy.

**Long-term changes in the CLS of athletes have been known for a long time. They are well diagnosed at rest using different measuring medical devices and are expressed in increased Heart Chambers, Myocardial Contractility, Blood Volume, improved Pulmonary Oxygenation of the blood and Oxygen Delivery function of the blood, reducing Heart Rate, Vascular Resistance, and change many other parameters. The higher these numbers differ from the norm of the ordinary person, the better FSO.** This is their fundamental difference from the laboratory biochemical parameters. A rested elite athlete and ordinary healthy human have biochemistry exactly the same.

**The increased functional indicators of the internal organs which provide a metabolic rate of the athletes are very unstable. After training or competitions, as well as the loss of sports condition for any reason (illness, injury, overtraining, poor nutrition, poor sleep, etc.) these indicators are falling, approaching the normal average person, or can even fall below normal.**

**Functional indicators of CLS returned to usual high values of the athlete when FSO is restored. The sooner there is a complete recovery of the functional indicators and the greater their magnitude, the higher is the level of fitness.**

### **Insights**

1. Members of the men's team of Russia in biathlon, winning prizes in EURO - 2017, consistently demonstrated a very high level FSO during a month prior to and during the competition.
2. **«Diagnostics FSO of athletes at rest»** carried out using hardware-software complex **«Integral Monitoring System «Symona 111»**, allows you quickly and objectively to assess FSO of athletes in a quiet relaxed state.
3. Such integral indicators as Oxygen Delivery Index, Integral Balance Deviation, Cardiac Reserve and Adaptive Reserve objectively reflect FSO of athletes. The values of these indicators correlate with the sports results.

4. This universal technology allows:

- readiness assessment to maximum sports results on the eve of competition,
- the ranking of the athletes during the competition and training camp,
- an assessment of the level of the sports condition, selection to the national team,
- the optimization of individual plans of training and competition,
- rapid and early diagnosis of overtraining,
- the evaluation of the training loads (insufficiency, redundancy),
- the diagnosis of disorders of specific physiological functions,
- the evaluation of the effectiveness of various rehabilitation measures.

**Medical Group for Team of Russia in biathlon.**

**03 February 2017**

Read more articles about physiological basics of this technology in Russian/English at <http://symona.ru/sport/>