ESTIMATION OF ADAPTIVE CAPABILITIES OF A HUMAN ORGANISM BY MEANS OF BIORADIOLOCATION

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Abstract: The experiments for estimation of range of physical endurance of examinees were carried out. A professional skiers were taken as examinees. The possibility of usage of a multifrequency bioradar in such experiments was studied. Breathing and pulse signals were extracted from experimental data and the results of the signal processing are given. They represent two parts of the experiment: before starting physical activity and after finishing it. Method of tracing breathing and pulse rhythm curves is proposed for analysis of data colleted by bioradar during endurance test.

Introduction

Idea of "health" is a state of complete physical, psychical and social well-being rather than absence of illness or physical defects (World Health Organization). State of an organism is the result of his interaction with environment i.e. the result of adaptation to the environmental conditions [1]. So ability to maintain the homeostasis by means of adaptive mechanism is one of the most important parameters of a human state.

Physical activity is one of the external factors affecting the human state in everyday life. In that case endurance of cardiorespiratory system defines a capability of a whole human organism to suffer prolonged physical activity.

According to literature sources [2] it is possible only roughly estimate a duration of the recovery period after physical activity for trained and non-trained organism. Experimental data for trained people, which could be found in literature, do not contain any information about specific features of different type of sports that may effect on details of mechanism of human organism adaptation.

Hereby a detailed analysis of the specificity of the trained human reaction for physical activity is of interest.

At present variety of contact method for estimation of breathing and pulse frequencies is used to estimate human adaptation capabilities. These methods embarrass movements of the examinee while doing physical exercises. Additional time is also needed to prepare the experiment procedure. That is why contactless methods are more preferable in that case because they are free of the disadvantages of contact methods. As it was shown in [3] it is possible to carry on contactless monitoring of human breathing and pulse frequencies by means of short range radars. This method is called bioradiolocation.

Experiments

The multifrequency radar designed at the Remote Sensing Laboratory (Bauman Moscow State Technical University) was used in proceeding of experiments. 13 healthy examinees participate in the experiments. All of them were members of University ski select team at 17-22 years of age. The examinees were taking up this sport for more then 3 years, 10 of them had first grade other 3 had second grade at skis.

The experiment was divided into two stages.

During first stage monitoring of breathing and pulse parameters at steady state was carried out. It took from 3 to 5 minutes. For 5 examinees breathing and pulse frequencies went down during period of time from 20 to 90 s. from the beginning of the experiment. We presume that it was connected with heightened psycho-emotional agitation of an examinee.

During second stage monitoring of breathing and pulse parameters after doing some physical activity was carried out. Examinees were proposed to do bob exercises for 5 minutes with frequency 60 bobs per min (or another adequate physical activity). After that monitoring of breathing and pulse signals were carried out repeatedly. Duration of radar signal registration depend on the level of endurance of the examinee. It was determined by period of time when breathing and pulse frequencies reached level that corresponds to steady state.

Potential of bioradiolocation as method for estimation of a functional state of an organism was reviewed during experiments in which ski sportsmen participated. As is well known permanent doing ski sports influence on adaptation capabilities of organism by increasing endurance against hard exercise stress. Reaction of cardio respiratory system usually is considered while estimating examinee adaptation capabilities. The main attention in this case is paid to so called recovery time of breathing and pulse parameters after stopping doing any activities.

Changes in breathing pattern, which are caused by stress, are called stenoventilation tuning [4]. During this period of time organism compensates increasing oxygen demand by rising breathing frequency or making breath deeper. But these stenoventilation tuning have great individual differences (Gardner, 1977 and others). Specific features of respiratory system of a human depend on basal breathing pattern that should be considered while estimating adaptive capabilities of an organism. Nevertheless basal pattern and its tuning under the influence of different factors remain unchangeable for each man.

Results of experimental data processing

It is important to choose right method for visualization of information when processing bioradiolocation data as well as others experimental results. This method should give as much information about experimental data as possible. If the method is right one it decrease stress of the operator and reduce time which is needed for experimental data processing. This problem become quite relevant in case of prolonged realizations, when part of useful information could be misrepresent or even lost due to unsuitable method for experimental data processing.

At present analysis of breathing frequencies is not paid so mush attention as analysis of cardiac rhythm variation. It takes place because practitioners usually more interested in measuring volume parameters. That is why almost all diagnostic breathing apparatus give very little information about pattern of breathing.

So the task was to prove information capacities of breathing time parameters while estimation adaptation capabilities of a human organism. To do so it was necessary to choose the method of giving information, by which it is possible to track changing in a momentary breathing frequency at steady state and after doing physical activities. In case of analysis of signal records duration for more than several minutes the best way to represent results of the experiments might be graphic representation of the dynamic changing in parameters of breathing and pulse.

The example of experimental data processing, which were obtained during procedure of bioradiolocation, is given below. The examinee was male, 21 years old, first grade at skies.

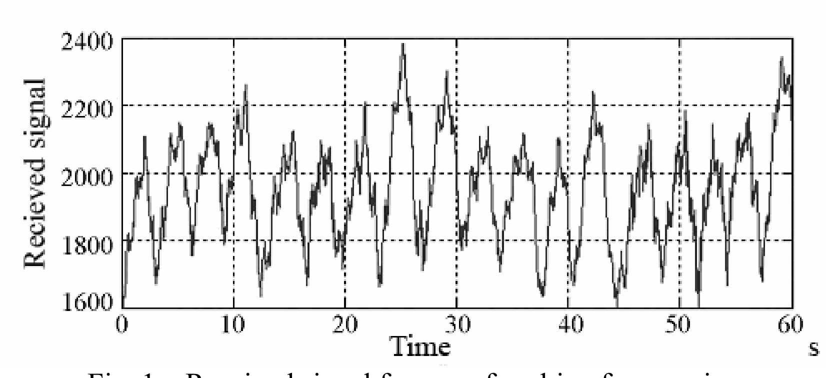

Fig. 1 – Received signal for one of probing frequencies.

Fig. 1 - 3 correspond to the first stage of the experiment (before doing any activities by an examinee). On fig. 2 radar signal reflected from the human thorax surface is given.

It is obvious that by this graphic representation of results it is possible to estimate mean time interval between breathing movement and time variation of inspiration – expiration period duration. But for finding out any pattern of this variation such graphic representation is not convenient.

From our point of view rhythmogram is the best method for representing of information when estimating dynamics of breathing frequency changing. It gives graphic information about variation of inspiration – expiration or pulse intervals in time. Rhythmogram of breathing and pulse signals for steady state are given on fig. 3 and 4.

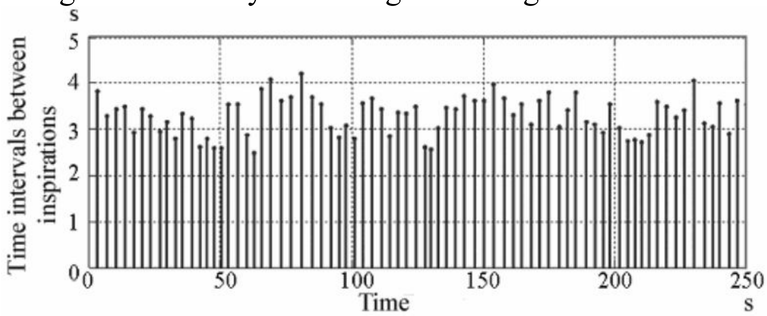

Fig. 2 – Rhythmogram of breathing signal

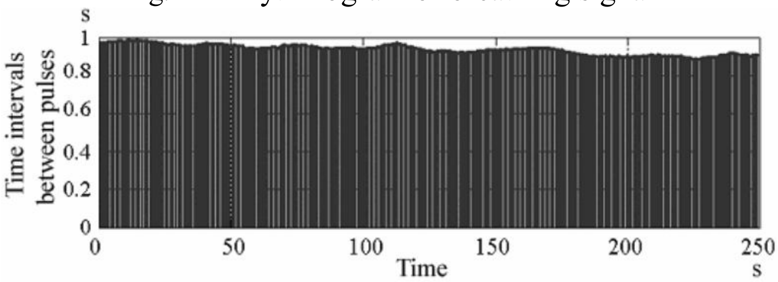

Fig. 3 – Rhythmogram of pulse signal

It can be seen from fig. 2 that breathing frequency at steady state is not constant. It has a significant time variation. During 3 minutes after start of the experiment pulse frequency descended. It could be caused by the fact that experiment was psychological stress for examinees. After some period of time (from 1 to 3 minutes) examinees became calmer.

Rhythmograms of breathing and pulse signals after doing physical activities by examinees are given below.

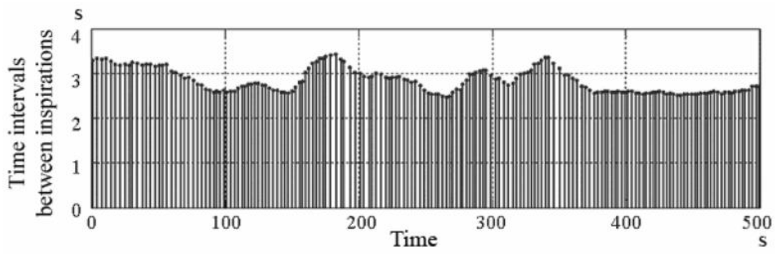

Fig. 4 – Rhythmogram of breathing signal

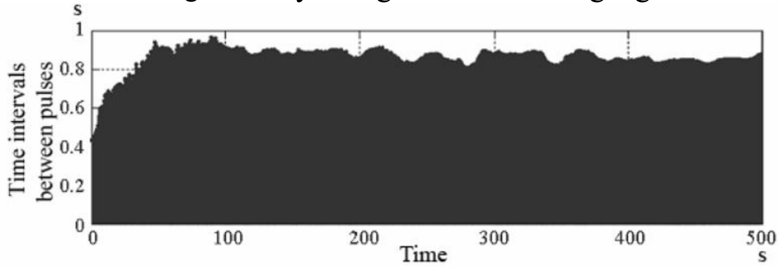

Fig. 5 – Rhythmogram of pulse signal

As can be seen from fig. 4 and 5 it took different time for breathing and pulse frequencies to reach the level of steady state during second stage of the experiment. Pulse rhythm stabilized in approximately 1 min after end of doing exercises. While breathing frequency early stabilized only in 100 s, but then again went down to the level, which corresponds to doing physical work of high intensity. And finally it stabilized only in more than 6 minutes after beginning of bioradiolocation monitoring. Thereby stationary value of breathing frequency in this case was not equal to the steady state value of this parameter (breathing frequency became higher). It is possible that the specific reaction of breathing system in return on physical stress is caused by prolonged ski training history. This sport supposes not short-term but long-lasting physical stress. Hence it can be made out, that parameters of cardiorespiratory system under doing sport exercises change due to specificity for organism fitness.

Conclusion

In view of foregoing it can be said that method of bioradiolocation might be used for estimation of adaptive capabilities of a human organism. It can be used for simultaneous contactless prolonged monitoring of breathing and pulse frequencies. Rhythmogram of breathing or pulse signal is preferable method for information visualization in this case. It makes it easy to track dynamics in changing of breathing and pulse frequencies and thus to estimate duration of recovery period after physical stress of examinees.

In prospect we think to look into possibility of estimation of a human reaction on another kind of stress by means of bioradar. We intend to use test with psycho-emotional stress and test with additional influence on ventilation by usage of breathing training devise.

References

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