

Heart Rate Variability as an Indicator of the Overall Functional State of Human Organism

Stoilova I.

Solar-Terrestrial Influences Institute, Bulgarian Academy of sciences, Sofia, Bulgaria, email.com.

The article provides an overview of the conducted research in recent years in our Institute to identify changes occurring in the cardiovascular system under different environmental conditions. The dynamics of R-R interval of ECG was used as the primary indicator of changes identified. Confirmed the importance and utility of this method in the study of the cardiovascular system under extreme conditions specific to our research. We monitored the dynamics of R-R interval in microgravity condition; during flights of varying prolongation; in press-chamber; during different sleep-stages in space flight and in the periods before and after flight. Variations in heart rate are readily available indicator that allows rapid assessment of health status in different extremal conditions.

Introduction

The main characteristic of human physiology is its homeostasis sustained by physiological regulatory mechanisms. Environmental changes do not influence strongly this homeostasis as human beings have been adapted during a longtime evolution to such changes including geophysical influences. But the human body still reacts with the physiological changes that are often early indicator of more serious pathological reactions to environmental change.

The examination of geophysical factors (geomagnetic and gravitational fields variations, anomaly atmosphere pressure, Sun storms, temperature etc.) by means of up-to-day techniques, reveal possibilities their impact on human physiology to be studied in details. On the other hand to know in detail physiology reactions of these different impacts is not only interesting but very useful for estimation and differentiation of normal and pathological physiological and/or psychological reactions.

The study of variations in R-R intervals of ECG is a readily available noninvasive method, which makes it possible to assess changes occurring in the cardiovascular system. Amount of R-R intervals, determined the frequency of cardiac activity (heart rate). The heart rate variability (HRV) integrates many mechanisms in- and outside of central nervous system, which influence and regulate the heart rate variability [1]. There are no doubt that heart rate varies in normal healthy subjects under conditions of rest, under high-load conditions and in pathology. The existence of spontaneous HRV was established long time ago but its importance and explanation is still an object of discussion. HRV is now defined as the fluctuations of the R-R intervals length around their average value [2]. The variations are source of information and gain a growing importance. Through various statistical and mathematical methods for analysis of biological signals significantly expands the possibility of extracting additional information hidden in the variations of R-R intervals.

The benefits of modification of heart rate variability are not well known, but recently increasing R-R intervals changes are associated with certain functional changes or pathological deviations [3]. Recently, space medicine specialists are trying to determine the importance of dynamics in R-R intervals in connection with the effects of geophysical and space factors. Researches carried out up to now, show that even small

changes in the geophysical factors may provoke significant departures from the normal values of some physiological parameters including in cardiac performance and general response of the central nervous system.

Various models of reproducing or removing of some geophysical influences are quite useful in this respect. The working environment in manned space stations during flights of different duration represents an example of almost entire removing of Earth gravitation. We registered the different psycho-physiological parameters including sleep of astronauts subjected to the influence of the extreme conditions of space flight on board the manned space station "Mir". We calculated R-R intervals changes. The R-R average values during quiet wake differed markedly in the frame of the period examined [4]. Results of physiological and psycho-physiological researches obtained in flight and compared with those collected from astronauts during the preparation period as well as during the post flight period, provide a basis to take into account the important role of the individual qualities of the astronauts and the role of good training period for the body's resistance [5]. The examination of heart activity regulation during space flight as well as during the preparation and the post-flight periods is one of the most important tasks of space biology and medicine in future[6].

We investigated too the environment in a decompressed press-chamber (PC), as a model of a partial geomagnetic field (GMF) elimination [7]. In this case the PC was used as a Faraday cage.

The total solar eclipse (TSE) is usually accompanied by sharp changes of the environmental factors. "Specific changes in Earth magnetosphere, ionosphere and atmosphere have been observed. The geomagnetic field and the electromagnetic wave propagation have shown variations. Wind velocity has increased and the temperature has decreased" [8]. Therefore the examination of the impact on living systems is absolutely reasonable. Having in view these considerations we performed observations and examination of the changes in some physiological human parameters and microbiological reactions during TSE in Bulgaria on 11 August 1999. The heart rate was also investigated. The average values of samples of consequent R-R intervals exhibited a trend to decrease on the day of TSE ($p < 0.06$). The R-R variation coefficient did not show statistically significant changes calculated over the whole group although a trend to increase was observed with some persons. [9]. The spectral

analysis of the R-R records of persons investigated was limited due to the quite short ECG registrations. Therefore only the initial (the low frequency) part of the spectrum could be studied and a trend to enlargement and increasing of the energy of this part of the spectrum was obvious. After TSE the energy of this part of the spectrum decreased.

We study also the impact of different stages of sleep and periods of wakefulness and immediately after awakening on heart dynamics. Expressed variations in the dynamics of the cardiac rhythm, described by the R-R time intervals function were established in particularity [5,10].

Results obtained confirm the necessity of systematically provided investigations of the influence of geophysical factors on human physiology. Investigation on specific influences of separate factors would be very useful in the future. These investigations will contribute to the clarification of some psychological and physiological reactions to sharp changes of geophysical factors not explained till now.

Now we continue to explore the influence of geophysical factors on activity of functional systems in healthy human beings and in pathology and hopefully with results to be useful for the prevention of harmful influence of these factors.

References

- [1] C.B. Martin 1978, *Semin. Perinat.*, 2, 131
- [2] P. Mansier., J. Clairambault, N. Charlotte, C. Medigue, Ch.Vermeiren, G. Lepape, F.Carre, H.Gounaropoulou, B.Swynghedauw, 1996, *Linear and non-linear analysis of heart rate variability.*, *Cardiovasc. Res.* 31, 371-379.
- [3] H. Tsuji, et all, 1994, *Circulation*, 90,878-883.
- [4] I. Stoilova,T.Yanev., 1998. *Analysis of heart rate variability during short-term space flight.* *Com.Rend. BAS*, v.50, 7-8.
- [5] I. Stoilova, T.Zdravev, T.Yanev and S. Zdraveva., 1997, *Heart rate variability in the preparation period for space flight. The IVth Nat..Conf. of the basic problems of Solar-Terrestrial influences.* Sofia, p. 88.
- [6] J.A.Drescher, A.Diedrich, O.Kotov, Y.A.Spatenko, 1996, *Heart Rate variability and Skin Microcirculation in Man during Orthostatic Stress in Microgravity In Research Program of the German-Russian Space Mission Mir-97* Ed.by P.R.Sahm. at all B.Schiewe, B.Fischer, M.H.Keller. 90-94
- [7] I. Stoilova, T.Zdravev, 2000, *Influence of the geomagnetic activity on the human functional systems*, *J. of the Balkan Geophys. Soc.*, vol.3, № 4, 73-76
- [8] I. Predeanu, (1980) In:“*Theoretical and Observational Problems Related to Solar Eclipses*”, eds’ Dr. Z.Monradian, Kluwer (1980) Ed. Acad. publ..
- [9] I.Stoilova, T.Zdravev, Sv. Dimitrova, S.Boyanova, T.Yanev , K.Tsekova, D.Todorova, 2002, *Impact of the total solar eclipse on 11 august 1999 on human beings and the response of microbiological cultures*, In *First Results of 1999 Total Eclips Observations*, Ed.D.N.Mishev and K.J.H.Philips, Acad. Publ. House, Sofia, 263-272
- [10] I. Stoilova, T.Zdravev, T.Yanev and S. Zdraveva., 1998, *Variations in geophysical factors – physiological aspects*, *Second National Geophys. Conf. Sofia*, 4, 128.