

Heart Rate Variability During “Alarm Stage” of Burnout Syndrome in Emergency Doctors

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The parameters of heart rate variations were examined in emergency care doctors that demonstrated the initial signs of defensive psychological burnout syndrome related to their professional activity. These parameters were compared within each of two groups with different individual typological features. The differences in the heart rate variability parameters were revealed between the examinees that were at the compensation or alarm stages of the burnout syndrome.

Key Words: *adaptation; heart rate variability; burnout syndrome; stress-coping behavior*

In 1974, Herbert Freudenberger coined the term “burnout syndrome” to describe a syndrome of frustration and extreme exhaustion in medical personnel of psychiatric clinics [11]. Later (in 1981) C. Maslach and S. Jackson refined the parameters of this syndrome and described its constituent features as emotional exhaustion, depersonalization, and underestimation of personal achievements [13]. Numerous studies support the notion that the burnout syndrome (BS) exemplifies a kind of psychological defense against the professional interpersonal relationship stress characteristic of so-called “helping professions” (doctors, teachers, psychologists, *etc.*) [4,5,9]. At present, BS is described as “a little examined state of emotional assessment of the personal stressful being, *i.e.* stress provoked by stress itself” [7]. The development of stress-induced BS is characterized by four consecutive stages: compensation (0), alarm (I), resistance (II), and exhaustion (III), which are similar to those of classical adaptation syndrome described by H. Selye although the formation and realization of these stages developed in different time scale. Actually, the alarm stage of BS can manifest itself at any stage of the classical adap-

tation syndrome; subjectively, it can be perceived as extreme mobilization that helps to cope with the sense of physical and/or psychic disturbance. In contrast to other types of the stress-coping activity (behavioral coping strategy), the alarm stage of BS is accompanied with dissatisfaction, emotional disorientation, and the desire to actively escape the alarm [3].

Among physiological indices of cardiac activity, HRV parameters are especially reliable in reflecting the degree of adaptive mobilization of various strata of the regulatory processes involved in the behavioral-emotional, cognitive, and psychosocial activities [1,6,8,10].

It is especially instructive to compare HRV in persons characterized by various types of favorite behavioral coping-strategies at the initial (alarm) stage of the developing BS considered as a form of psychological defense in doctors.

MATERIALS AND METHODS

The study included male and female volunteers ($n=84$) during their daily duty of the first-aid doctors at the emergency stations in Great Novgorod and Pskov. The age of examinees was 26-65 years and the length of their service was 3-26 years.

The following parameters were determined: BS stage (including the compensation stage 0), the preva-

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lent stress-coping strategy, and the major HRV parameters (geometrical, statistical, spectral, and integral).

BS stages were diagnosed according to V. V. Boiko [3].

The prevalent coping-strategy was established with E. Haim questionnaire [4]. All the examinees were subdivided into two groups of emotion-oriented and task-oriented persons.

To examine the peculiarities of HRV during the development of BS, the spectrum analysis of the heart rate was performed with a Kardiotekhnika 4000 AD hardware-software system (Inkart). ECG was recorded during the daily duties of the examinees.

HRV analysis was performed off-line yielding the following indices: Mo (mode), AMo (mode amplitude), SI (strain index), CI (centralization index), and ΔC (variational range) [2]. Additionally, the indices introduced by European and American Heart Associations in 1996 were also used: SDNN (standard deviation of all normal-to-normal *R-R* intervals), RMSSD (root mean square of successive differences of *R-R* intervals), NN50 (the number of pairs of successive normal-to-normal *R-R* intervals that differ by more than 50 ms), pNN50 (the proportion of NN50 divided by total number of normal-to-normal *R-R* intervals) and the following spectral parameters: high frequency wave power HF, which is formed by the respiratory waves in the range of 0.15-0.4 Hz; low frequency wave power LF related to slow waves in the range of 0.15-0.04 Hz; and index of activities of regula-

tory systems (IARS), and autonomic balance index (ABI=LF/HF) [12].

The data are presented as $m \pm SD$. The compared samples were analyzed for normalcy of distribution, and when it was established, the significance of the intergroup difference between the mean values was determined with one-way ANOVA test and Newman-Keuls test. Significance of the changes in a group was determined with Student's paired *t* test at $p < 0.05$.

RESULTS

Among the total number of examined doctors ($n=84$), 11 men and 14 women demonstrated no signs of BS corresponding to compensation stage 0. Other examinees were distributed as follows: 19 persons (8 men and 11 women) were at BS alarm stage (I) and 40 examinees were at BS stages II and III.

Table 1 shows HRV parameters of the examined doctors that demonstrated BS stage 0 or I. Stage I doctors predominantly comprised those persons that selected the task-oriented coping strategy. They had similar or similarly changed HRV parameters: increased SI, decreased *R-R* intervals, similar ABI, equal contribution of LF and HF into heart rate (HR) spectrum power, involvement of the suprasedgmental structures in HR control (according to VLF) and elevated CI (by up to 2 times). HRV parameters of the doctors with emotion-oriented coping strategy demonstrated signs of emotional stress: LF increased indicating activation

TABLE 1. HRV Indices of Emergency Care Doctors with Different Coping Strategies at BS Stages 0 and 1 ($M \pm SD$)

Index	Behavioral coping strategy			
	task-oriented		emotion-oriented	
	BS stage 0 ($n=10$)	BS stage 1 ($n=10$)	BS stage 0 ($n=15$)	BS stage 1 ($n=9$)
<i>R-R</i> , msec	962.0 \pm 26.1	911.0 \pm 32.2	950.0 \pm 44.6	876.0 \pm 45.3
SDNN, msec	83.8 \pm 5.3	64.0 \pm 4.5*	57.0 \pm 5.2+	71.0 \pm 6.7
RMSSD, msec	62.6 \pm 4.1	48.0 \pm 5.6*	41.0 \pm 5.8+	55.0 \pm 9.1
pNN50%	30.5 \pm 2.2	26.0 \pm 4.2	22.0 \pm 5.2	30.0 \pm 6.3
VLF, msec ²	2266 \pm 515	2933 \pm 295*	2413 \pm 227	1521 \pm 225+
LF, msec ²	1464 \pm 312	1446 \pm 187*	1659 \pm 270	1207 \pm 246+
HF, msec ²	1725 \pm 383	1110 \pm 301*	1521 \pm 522	648 \pm 177+
LF/HF	1.6 \pm 0.1	2.0 \pm 0.3	2.0 \pm 0.5	2.0 \pm 0.4
SI	61.4 \pm 4.6	98.0 \pm 3.7	92.0 \pm 4.0	124.0 \pm 5.0
CI	1.4 \pm 0.4	1.5 \pm 0.5	2.0 \pm 0.5	2.7 \pm 0.6
IARS, score	1-2	2-3	1-2	2-3

Note. $p < 0.05$ in comparison of BS stages 0 and 1 in *task-oriented and +emotion-oriented coping strategy.

of ergotropic influences on HR, SI was elevated, CI increased by more than 2-fold, ABI indicated sympathicotonia, and IARS counted 2-3 points.

These data suggest that BS stage I is characterized by stressed ANS assessed by SDNN and pNN50%, sympathicotonia and segmental control over HR with involvement of suprasegmental level according to LF, HF, VLF, CI, and ABI parameters. Satisfactory adaptation to stress is known to involve moderate activation of the control systems, which employs auxiliary functional reserves to adapt to the modified environment. The common feature of the persons with task-oriented and emotion-oriented coping strategies was elevation in LF and VLF, although the differences in mobilization of these reserves were especially pronounced in the emotion-oriented persons.

In zero-stage persons, the most characteristics HRV shifts were elevations in SI, CI, and LF. However, these changes were the most pronounced only in persons with emotion-oriented coping strategy, which attests to moderate involvement of the middle brain structures and hypothalamus with cooperative participation of the segmental structures into the adaptive processes in these persons. In contrast, the task-oriented zero-stage persons demonstrated less pronounced changes in HRV parameters: SI decreased, SDNN increased, LF and HF became equal, and CI surpassed 1. In this group, marked and self-sufficient involvement of only segmental structures into heart rate regulation was observed against the background of balanced central-peripheral relations.

Thus, initially adapted persons at BS stage 0 were characterized by vegetative balance, unstressed ANS, and moderate segmental control over HR. In contrast to stage I persons, these examinees achieve sufficient adaptation maintaining unstressed vegetative balance with involvement of suprasegmental control over HR

and sympathicotonia. It was accompanied with stress in the control systems outside the so-called "physiological optimum" that is self-sufficient to maintain the active balanced interaction with the environment. In our experimental paradigm, the reflex influences dominated over the metabolic ones.

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