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ОСОБЕННОСТИ ИЗМЕНЕНИЙ АДРЕНАЛОВЫХ ГОРМОНАЛЬНЫХ ПОКАЗАТЕЛЕЙ У МОРЯКОВ В ТЕЧЕНИЕ РЕЙСА В РАЗЛИЧНЫЕ КЛИМАТИЧЕСКИЕ И ГЕОГРАФИЧЕСКИЕ РЕГИОНЫ

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Сложные условия трудовой деятельности моряков требуют высокой степени адаптацию регуляторных систем организма. В обеспечении адаптации одной из ведущих является эндокринная система (особенно гипофизарно-надпочечниковая ось).

Цель исследования: изучение изменений гормональных показателей у моряков в течение рейса в различные климатические и географические регионы.

Материалы и методы. Обследованы российские моряки в динамике рейса в различные климатогеографические регионы. У них определено содержание адренокортикотропного гормона (АКТГ) и кортизола четырехкратно (до рейса, вначале, в середине и в конце).

Результаты и их обсуждение. В начале рейса уровень АКТГ и кортизола увеличивается; к середине рейса АКТГ снижается, а кортизола — остается на тех же значениях; к концу рейса уровни обоих гормонов снижаются и достигают значений гораздо ниже, чем перед рейсом. Учитывая динамику гормональных уровней, в первой половине рейса происходит нормальное течение общего адаптационного процесса. Значительное снижение уровней АКТГ и кортизола во второй половине рейса может быть предвестником срыва адаптационного потенциала.

Ключевые слова: морская медицина, моряки, адренокортикотропный гормон, кортизол, условия труда

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THE FEATURES OF CHANGES IN ADRENAL HORMONAL INDICATORS THE SAILORS DURING THE VOYAGE IN VARIOUS CLIMATIC CONDITIONS AND GEOGRAPHICAL REGIONS

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The hard-working conditions of mariners require a high degree of adaptation of the regulatory systems of the organism. In ensuring adaptation, one of the leading ones is the endocrine system (especially the pituitary-adrenal axis.

The aim of the study is to investigate changes in hormonal parameters in mariners during a voyage to various climatic and geographical regions.

Materials and methods: Russian seamen were examined during the dynamics of the voyage to various climatogeographic regions. They have determined the levels of adrenocorticotropic hormone (ACTH) and cortisol four times (before the voyage, at the beginning, in the middle and at the end).

The results of the study and their discussion: at the beginning of the voyage, the level of ACTH and cortisol were increased; by the middle of the voyage, ACTH decreased but cortisol remained at the same values; by the end of the voyage, the levels of both hormones decreased and reached values much lower than before the voyage. Considering the dynamics of hormonal levels, the normal course of the general adaptation process occurs in the first half of the voyage. A significant decrease in ACTH and cortisol levels in the second half of the voyage may be a sign of breakdown of adaptive capacity.

Key words: marine medicine, mariners, adrenocorticotropic hormone, cortisol, labor environment

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Introduction. Various kinds of extreme environmental factors, affecting the body, trigger compensatory-adaptation mechanisms, which change metabolism and functional state of organs and tissues. Single or short-term influence of these factors, in most cases, does not lead to a stable restructuring of homeostasis regulation mechanisms, while long-term and repeated stress can induce pathology development [1, p. 1–124].

Initially, the nature of mariners' labor activity places high demands on the organism. Frequent changes of the place of navigation, combined with difficult working conditions have a negative impact on their health and working capacity [2, p. E512]. These negative changes are covered, first of all, by adaptation of regulatory systems of an organism. During voyages to different regions of the World Ocean the organism adapts to changing climatic and geographical conditions. Thanks to adaptation, stress of regulatory systems ensuring mariner's health and ability to work is compensated [3, p. A797]. The more contrasting the change of climatic conditions of navigation (it depends on the starting point, the distance of a voyage), the more pronounced changes will occur in the organism to adjust to new conditions of life activity [4, p. 343]. To ensure sufficient regulation of compensation mechanisms on environmental factors affecting the organism, one of the leading roles belongs to the endocrine system [5; 6, p. 449]. The degree of changing hormonal secretion determines the adequacy, the nature of adaptive shifts that ensure the constancy of the internal environment of the organism and its recovery [7, p. 187]. Physiological compensatory shifts, especially in the endocrine system, contribute to increasing its reserve capabilities [8, p. 613].

Based on the above, the aim of the study was to investigate the changes in hormonal indicators in mariners during a voyage in different climatic and geographical regions.

Materials and research methods. The subject of the study was a cargo voyage from November till December: Monfalcone (Italy) — St. Petersburg (Russia) — Nuevitas (Cuba) (table). We studied 35 male mariners of the Northern Shipping Company (Arkhangelsk) aged 25 to 30 years old who were not registered for any diseases and had no complaints at the time of examination. Fasting venous blood was taken from volunteers for determination of hormones from each subject 4 times at 8 o'clock local time. Blood serum after centrifugation was transported frozen to Arkhangelsk. Then, the content of adrenocorticotropic hormone (ACTH) and cortisol was determined under stationary laboratory conditions by radioimmune analysis (commercial kits "CIS", France).

Statistical processing of the results, evaluation of the distribution of indicators, comparative analysis of samples was carried out using the computer application package SPSS 13.0 for

Table

Blood sampling schedule for mariners during the voyage Monfalcone (Italy) — St. Petersburg (Russia) — Nuevitas (Cuba)

Таблица

График забора проб крови у моряков в течение рейса п. Монфальконе (Италия) — Санкт-Петербург (Россия) — п. Нуэвитас (Куба)

№	Steps of sampling	Dates of sampling
I	Before the voyage (Arkhangelsk, Russia)	01–02 November
II	The beginning of the voyage (Monfalcone, Italy)	06 November
III	The middle of the voyage (St. Petersburg, Russia)	20 November
IV	End of voyage (Nuevitas, Cuba)	13 December

Windows. In the majority of samples, the non-normal distribution was revealed. In this connection Wilcoxon criterion was used for comparative analysis. The critical level of significance (p) for testing statistical hypotheses was taken as 0.05. The significance level >0.05, but <0.1 was regarded as a trend of differences between the compared indices.

Results of the study. Analysis of the obtained data showed significant changes in the concentrations of the studied hormones of the crew in the dynamics of the voyage.

The average level of ACTH in the examined mariners changed statistically significant at all time points when blood sampling was performed (Fig. 1). A few days before the start of the voyage, when the crew was at their residence in Arkhangelsk (territory equated to the Far North), it was 63.0±2.7 pg/ml. Herewith the curve of individual values distribution tended to right-hand shift (As=0.47) with normal peak distribution (Es=–0.09). There was a statistically significant increase in mean ACTH levels (69.4±2.6 pg/ml; p=0.04) during the first days of sailing in the Mediterranean region. Frequency distribution of adrenocorticotropin levels during this period again showed significant right-handed asymmetry of the curve (As=0.82), with an island-shaped peak distribution (Es=–1.22).

After 2 weeks of the voyage, by the time of arrival in the Baltic from the Mediterranean there was a statistically significant decrease in mean ACTH level (53.0±4.2 pg/ml) compared to both the initial (pre-voyage) value (p=0.05) and the beginning of the voyage (p=0.001). When checking the distribution of ACTH values during this period, its centralization (As=0.22), with flatness of the peak (Es=–0.66) was noted.

Upon arrival at the final point of the voyage, making the transatlantic crossing to the Caribbean region, almost twofold statistically significant decrease in the mean ACTH level in blood was recorded in the examined crew of the vessel to 31.0±2.5 pg/ml, compared to all three preceding sampling points (p<0.001). The location of the distribution curve of individual values appeared close to the center (As=–0.38), but, at the same time, it was peaked (Es=–1.48).

As for cortisol, its dynamics in the examined mariners, as well as ACTH, showed statistically significant differences in the averages at almost all time points when blood sampling was performed (Fig. 2). Before the voyage, the mean cortisol level was 334.3±17.5 nmol/l. The frequency distribution of its individual levels during this period showed a symmetric curve (As=0.40), and the peak of the distribution was flat-topped (Es=–0.62). At the beginning of voyage, there was a tendency for higher mean cortisol levels (365.3±11.3 nmol/L), compared with the pre-voyage period (p=0.1). Frequency distribution of cortisol levels during this period already revealed a right-handed asymmetry of the curve (As=0.58) with a normal peak distribution (Es=0.22).

In the middle of the voyage the average cortisol level remained almost at the same level (378.8±13.8 nmol/L) as at departure. There were no statistically significant differences in comparison (p=0.54). At the same time, when comparing with the period of pre-trip training, there was already revealed not a tendency to higher values, but a statistically significant increase in such

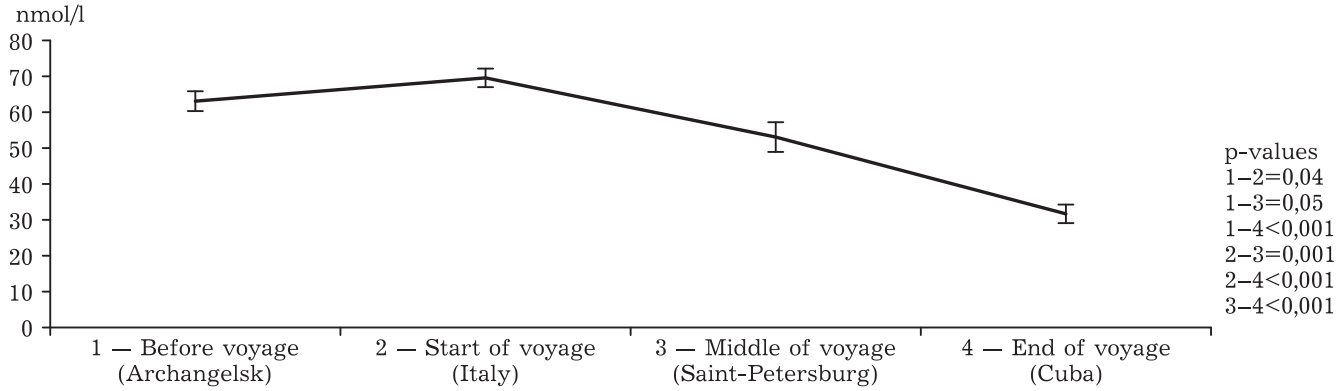

Fig. 1. ACTH changes (M±m, pg/ml) in mariners of the Northern Shipping Company (n=35) during the cargo voyage Italy — St. Petersburg — Cuba

Рис. 1. Изменения АКТГ (M±m, пг/мл) у моряков Северного морского пароходства (n=35) во время грузового рейса Италия — Санкт-Петербург — Куба

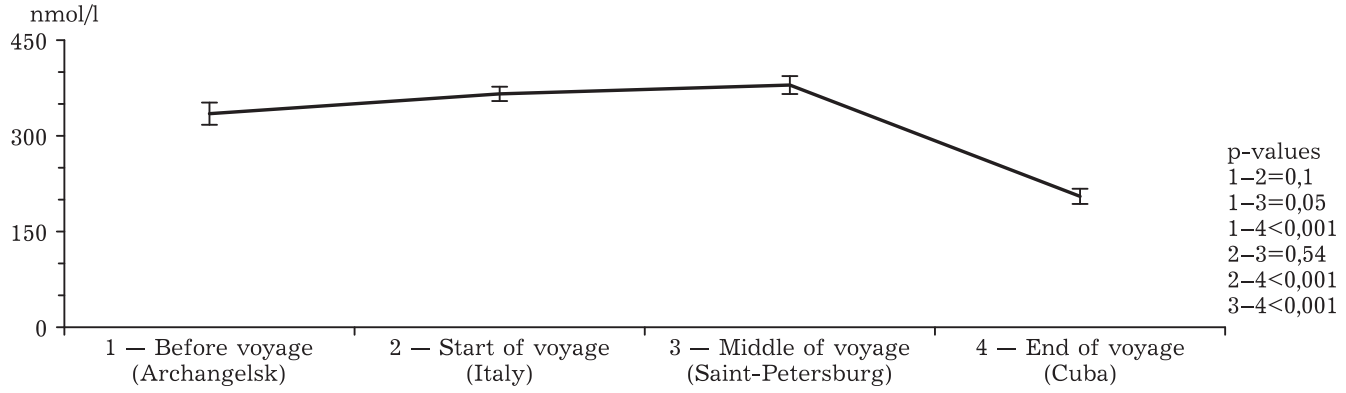

Fig. 2. Changes of cortisol (M±m, nmol/ml) in mariners of the Northern Shipping Company (n=35) during the cargo voyage Italy — St. Petersburg — Cuba

Рис. 2. Изменения кортизола (M±m, нмоль/мл) у моряков Северного морского пароходства (n=35) во время грузового рейса Италия — Санкт-Петербург — Куба

(p=0.05). Analysis of the frequency distribution of cortisol values during this period showed its shift to the right (As=0.84), with a normal peak distribution (Es=–0,36).

At the final stage of the study, upon arrival to the final point of the voyage, a significant, almost 1.5-fold decrease in the average blood cortisol level (204.3±12.2 nmol/l) was noted in the examined mariners. Significance level of differences in comparison with all three previous sampling points was the highest possible (p<0.001). The distribution curve of individual values on this one was located close to the center (As=–0.11) with a peak distribution close to normal (Es=0.28).

Discussion. Comparative analysis of blood content of hormones of pituitary-adrenal link of endocrine regulation (ACTH, cortisol) of the crew of the cargo ship of the Northern Shipping Company (Arkhangelsk) which made a month-and-a-half voyage from three different climatic-geographical territories (Mediterranean-Baltic-Caribbean) has revealed statistically significant changes of the studied hormones which are typical for adaptation to external conditions.

The study showed that during the first days after the start of the voyage the level of ACTH and cortisol increased. By the middle of the voyage (after 2 weeks) ACTH content gradually decreases, while cortisol remains at the same values. By the end of the voyage (after another 3 weeks) the levels of the studied hormones decrease and reach values much lower than before the voyage. The first half of such dynamics of the studied hormones indicate normal course of the general adaptation process [9, p. 59]. However, further decrease of ACTH and cortisol levels may be a harbinger of imbalance in regulatory systems (endocrine system, in particular), depletion of secretory function and indicate the beginning of the breakdown of adaptation potential [10, p. 355].

The results we obtained are consistent with the studies of functional state of endocrine system in mariners during a voyage, carried out by other authors. Thus, for example, when evaluating the hormonal indicators responsible for adaptation in mariners during transmeridian movement, these processes start already from the first days on the ship and are manifested by an increase in the functional activity of the pituitary-adrenal system. At the same time, inhibition of the potential power of stress-exercising mechanisms of protection of the organism often leads to delay or disruption of the adaptation process [11, p. 1023; 12, p. 1005; 13, p. 99].

Conclusion. Thus, the revealed changes of endocrine secretory function of pituitary-adrenal regulatory link in the mariners of the Northern Shipping Company during the voyage of three different climatic-geographical regions (Mediterranean-Baltic-Caribbean region) clearly marked the laws of the general adaptation process. Initially, during the first days of the voyage, there was an increase in blood levels of ACTH and cortisol, which are markers of the body's adaptation to changing environmental conditions. During the first half of the voyage there was a return to the initial levels, which also indicated the normal course of adaptation. However, further, with repeated changes of climatic-geographical environmental conditions (from the north transatlantic passage to the equatorial territories), combined with heavy conditions of maritime labor, the signs of adaptation potential dysfunction, manifested in further reduction of the studied adaptation hor-

mones, up to values statistically significantly lower in comparison with the pre-voyage period, began to be observed. Further development, procrastination can lead to disruption of interhormonal interactions, probable failure of the adaptation process and maintenance of homeostasis as a whole. This, in turn, requires the development of special measures to reduce the development of such deviations in order to increase the body's resistance and vitality to conditions of extreme influences, as well as to prevent the occurrence of pathological conditions. These measures should include:

— reasonable planning of business trips to "hot spots";

— Involvement of specialists after special training (physical, psychological, medical, using adaptogens if necessary, etc.);

— early diagnosis, including the use of laboratory methods, health disorders of persons exposed to occupational factors;

— upon completion of tasks in such conditions it is necessary to carry out a complex of medical and rehabilitation measures aimed at restoring the weakened functions of the body.

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