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WEATHER DEPENDENCE OF PATIENTS WITH RESPIRATORY PATHOLOGY AT THE SOUTH OF PRIMORSKY KRAI

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Climato-physiological reactions can be considered as favorable or adequate one, when irregular reactions of functional systems initiate autoregulatory processes returning the system to optimal functioning. The weather dependence is an ability of an organism to respond to changes in particular weather parameter and a complex of weather factors (atmospheric pressure, temperature, wind, etc.). The climatic factors mainly exposure to the skin and the mucous membranes of the upper respiratory tract; the respiratory system changes induced by the contrasting climate can be the result of meteophysiological processes and meteopathic reactions. Disadaptation in patients with respiratory diseases occurs more often and is more severe than in healthy people. The aim of the current study is to define the weather dependence degree of external respiration function of patients with bronchopulmonary pathology in the south of Primorsky Krai, characterized by the monsoon climate with negative effect on human health.

Keywords: weather dependence, external respiration function, bronchopulmonary pathology.

Introduction

Chronic respiratory diseases are among the leading causes of morbidity and mortality worldwide [4]. The etiology of respiratory diseases is largely determined by the influence of weather conditions. Normally, physiological processes in human body as a whole adapt to weather changes. But the course of respiratory diseases is determined largely by weather: directly through an impact on the respiratory tract or indirectly through a change in the intensity and nature of immunometabolic processes [2, 3, 9, 11, 13, 14]. However, the mechanisms of weather influence have not been sufficiently studied. Literature review shows conflicting results related to both different research approaches and regional characteristics of heterogeneous weather conditions influencing human body. Therefore, the study of the nature of the response of patients with a respiratory disease to weather conditions is important problem.

The weather factors influence on external respiration function (ERF) by a direct action on the mucous membranes of the respiratory tract; the study of ERF is essential for the diagnosis of violations in lung ventilation as a response to the external stress [12].

Oxidative stress plays a key role in the pathogenesis of chronic lung diseases. Reactive oxygen

species can serve as triggers of inflammation process both directly and through the formation of lipid peroxidation (LPO) products. Oxidative stress has important consequences for the respiratory system and the body as a whole [1, 7, 10]. However, nowadays there is practically no information about the impact of weather on the parameters of lipid peroxidation and antioxidant protection in patients with respiratory pathology.

The aim of the current study is to identify the mechanism of formation of meteopathic reaction in patients with respiratory diseases under the influence of the monsoon climate at the Russian Far East, characterized by contrasting changes in meteorological parameters with specific response in patient with respiratory pathology.

Materials and Methods

The subjects examined during period from 2012 to 2017 were 146 residents of Vladivostok: chronic catarrhal non-obstructive bronchitis (CCNOB) was diagnosed in 29 subjects, controlled asthma – in 51 subjects, and uncontrolled asthma – in 39 subjects. The control group included 27 healthy volunteers.

The study of ERF was carried out by *spirometry* (12 parameters), characterizing the type of lung ventilation disorder, degree and reversibility of

bronchial obstruction; and by *body plethysmography* (8 parameters), describing static lung volumes and bronchial resistance.

The system “lipid peroxidation–antioxidant defense” (the LPO-AOD system) is analyzed to understand the process of cell energy provision, that acts as a key trigger mechanism in chemical modification of cell membranes. The LPO system includes two parameters (malonic dialdehyde – MDA, malonic dialdehyde / antioxidant activity – MDA/AOA); the AOD system integrates five parameters (antioxidant activity – AOA, superoxide dismutase – SOD, glutathione peroxidase – GP, glutathione reductase – GR and reduced glutathione – GSH).

The study involves weather data (2012–2017) provided by Primorsky Office for Hydrometeorology and Environmental Monitoring [8, 15]. Standard meteorological parameters: air temperature and humidity, dew point temperature, atmospheric pressure, wind speed and direction, precipitation, atmospheric phenomena, apparent temperature, are used. The concept of “weather complex” is introduced, showing simultaneous influence of 9 weather parameters.

To estimate how respiratory system depends on weather changes, analysis was carried out for: a) the ERF response on the examination day (actual weather complex) and weather complex on 1 and 2 days after the examination; b) the LPO–AOD response on weather complex 1 and 2 days before the examination. The metepathic reaction of a human body to climate is estimated in two stages: 1) direct influence on ERF; 2) indirect effect on the LPO–AOD system. Methods of the study at the first and second stages were different.

The study how weather conditions affect ERF was conducted based on the assessment of *inter-systemic* (P_{inter}) and *intra-systemic* relations (P_{intra}). P_{inter} described the intensity of response of the ERF system to the influence of weather complex by 3 points (on the examination day, 1 and 2 days **after** the examination). These data determine the respiratory organs sensitivity to changes in weather conditions at different level of respiratory diseases severity. The calculation of *direct* influence of weather conditions on ERF was conducted in two ways: 1) estimation of P_{inter} % according to diagnostic system of ERF (spirometry, body plethysmography) and depending on the severity of respiratory disease; 2) the assessment of P_{inter} % characterizing compensatory reaction of ERF to the influence of weather complex on the examination day, 1 and 2 days *after* the examination.

To calculate inter-systemic and intra-systemic relations, the module “Multiple correlation” (STA-

TISTICA8) is used. The pair correlations (r) with statistical significance $p < 0.05$ are summed and divided by the expected maximum sum of the correlation relations $R = 1.0$ to select percent of active relations from total sum of correlation relations.

Thus, the sum of r_{inter} evaluates the activity of the respiratory response (P_{inter}) of ERF on the effect of weather complex, and the sum of r_{intra} indicates the degree of functional strain (P_{intra}) of the particular ERF systems depending on severity of respiratory diseases and weather.

The response of the biochemical blood parameters to the weather impact is estimated by the *indirect* influence of weather conditions on the LPO-AOD system with time lag 1 and 2 days. The module “Multiple regression” in the program STATISTICA8 is used for calculating the “response” of subsystems and particular indicators of the LPO-AOD system (R_{regres}).

Results and Discussion

Differences of P_{intra} % represent changes in ventilatory lung capacity depending on the disease severity. Patients with CCNOB have minimal changes in ERF ($P_{intra} = 26–28\%$) compared to control group ($P_{intra} = 23–25\%$). A significant increment of P_{intra} (1.5–2 times) indicates the most marked violations of ventilatory lung capacity in asthma ($P_{intra} = 39–43\%$).

The activity of ERF response (P_{inter} %, $p < 0.05$) under the direct influence of weather complex differed depending on the severity of respiratory diseases. For instance, the total indices ΣP_{inter} (Body + Spir) in healthy subjects were 7.8% (on the examination day), 8.9% (on 1 day after the examination) and 9.5% (on 2 days **after** the examination). These data demonstrate high compensatory capacity of a healthy body. However, the weather on the examination day ($\Sigma P_{inter} = 7.8\%$) reduces the adaptive potential of the respiratory system even in healthy subjects, indicating negative influence of the monsoon climate.

The analysis of the total ΣP_{inter} in pathologies showed a clear dependence of the decrease in adaptive capabilities of ERF, depending on the severity of the respiratory diseases ($\Sigma P_{inter} = 1.1–5.7\%$). We assume that the influence of the monsoon climate causes a sharp decrease in the compensatory reaction (P_{inter}) in respiratory diseases characterized by a high intrasystem tension of ERF (P_{intra} in asthma).

The ERF in patients with respiratory diseases actively react to changes in weather 1 day **after** the examination, expressed mostly in patients with asthma ($\Sigma P_{inter} = 1.1\%$). Slight increase in weather sensitivity ($\Sigma P_{inter} = 5.5\%$) was observed in patients with CCNOB compared to the examination day ($\Sigma P_{inter} = 5.8\%$).

The analysis of ΣP_{inter} values 2 days after the examination shows that weather sensitivity in patients with CCNOB increases ($\Sigma P_{inter}=3.8\%$) compared to data of 1 day **after** the examination ($\Sigma P_{inter}=5.5\%$). Perhaps it is due to the continuous and active reaction of the respiratory organs to the external environment in this pathology. However, a completely different reaction is observed in patients with asthma, when total parameter (Body + Spir) ΣP_{inter} is low enough ($\Sigma P_{inter}=1.1\%$) one day **after** the examination, and rises to 2.7% two days **after** the examination, that can be explained by inertial character of respiratory system to weather change in asthma.

The *indirect* effect of weather on human body was analyzed by the response of the parameters of the LPO–AOD system (R_{regres}). This system is involved in the process of providing energy for cells and is the most important trigger for the chemical modification of cell membranes [16]. The dependent variable «y» was the component of the LPO–AOD system (prooxidant system – MDA, MDA/AOA; antioxidant system – AOA, SOD, GSH, GP, GR). The independent variable «x» was the weather parameter.

The study shows there is no pronounced response of peroxidation parameters to weather in healthy subjects and, accordingly, there is no need to induce compensatory antioxidant processes in them. The LPO–AOD system of patients with respiratory pathologies responded quite actively to changes in weather complex in 1 and 2 days before the examination ($R_{regres}=0.42–0.50$) compared to the actual weather complex ($R_{regres}=0.31–0.38$) (Figure). The high reaction causes peroxidative process and induces a fairly rapid response of the system to weather within 1 or 2 days. The integral criterion characterizing

the LPO–AOD balance (MDA/AOA) is the best to demonstrate the reaction of the human body to weather factors. The enzymes of the AOD system (GSH, GP and CO), which are involved to remove lipid hydroperoxides, hydrogen peroxide, and to reduce oxidized glutathione, have a significant importance for the response of this system. GP and GR as key factors of the maintaining the oxidative cell balance, play the most important role in the formation of the compensatory response to weather. The activation of the glutathione unit in AOD system is aimed at interrupting the chain reaction of lipid oxidation to inhibit stress-induced accumulation of LPO products.

The respiratory pathology is accompanied by the development of the systemic oxidative stress. One of the reasons is the disregulation of the AOD system as the result of polymorphism of gene encoding the AOD enzymes. The intensification of oxidative stress has important implications for the course of the respiratory diseases. They include increased neutrophil sequestration into the lungs, oxidative inactivation of antiproteases and surface-active agents, mucus hypersecretion, destruction / remodeling of extracellular matrix and apoptosis. The oxidative stress leads to direct or indirect damage of key cellular components, such as lipids, proteins and nucleic acids, and also inhibits DNA repair [5, 6, 17].

Conclusion

The impact of the monsoon climate on patients with the respiratory diseases induces the complex mechanism of the response of the human body and leads to the formation of meteopathic reactions that actively influence the most open ERF system and indirectly – LPO–AOD system.

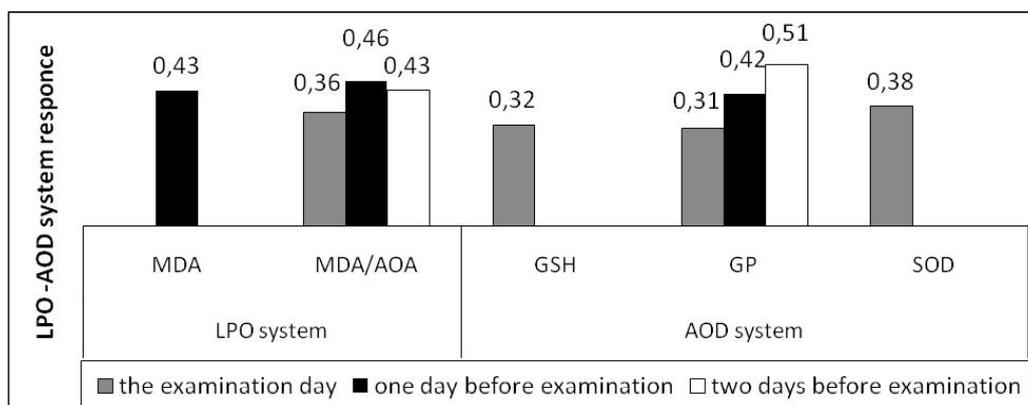


Figure. Response of the LPO-AOD system to the influence of weather complex (R_{regres})

The strain of the ERF system of patients living in the monsoon climate is intensified depending on the disease severity. At the same time the adaptive-compensatory reaction of ERF to the influence of weather complex decreases depending on the disease severity and, as a result, the pathogenic process of weather dependence and weather sensitivity is formed. The effect of climate on the metabolic parameters of blood makes a relatively equal contribution to the meteoropathic reaction of LPO-AOD system of glutathione-dependent antioxidant enzymes (actual weather complex, weather complex before 1 and 2 days). This process can be regarded as an increase in physiological strain by a change of the adaptive mechanisms at all stages of the development of weather dependence. The impact of the weather complex on human body acts on ERF primarily, while the response of metabolic parameters is manifested with a time lag of 1–2 days. Finally, the monsoon climate creates an additional load on both respiratory system and systems that ensure the peroxidation balance forming prerequisites for worsening of respiratory pathology.

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