STATE OF ORGANISM ADAPTATION IN THE CONDITIONS OF AIR POLLUTATNT'S IMPACT

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The aim of the work is investigation of the protective systems of the laboratory animals state. The impact of increased level of dust particles in the air on the state of cardiovascular, respiratory, nervous systems in 105 white rats, which inhaled coal dust in concentration up to 500 мг/м^3 for 4 months was estimate. First 2-3 weeks are evaluated as a stage of "urgent" adaptation. The "stable" adaptation occurred in a 2-3 months period. The maintenance of adequate minute volume of conditioning is provided by the increase of volume of an inhalation and lungs' capacity. A stage of disadaptation with development of sickly state of animals occurred on the 4-th month. Morphological examination showed the signs of remodeling of bronchi et lung tissue, dystrophia of cardiac cells. The restoration of indices after the experiment's termination did not occur. The cascade principle of functioning of the defense mechanisms was determined. The protective systems supplement and substitute one another. The disadaptative processes destroy the balance between the inflammatory damage and the regeneration of the bronchus and lungs. This may be the trigger mechanism which leads to chronic pathology process.

Introduction: The results of space ecological epidemiological monitoring, especially in large industrial centers, show an evident correlative dependence between the integral level of antropogen pollution of regions and wide distribution and mortality resulting from pulmonary and coronary diseases. Air dust particles even in a quantity close to standard level negatively influence health state of the population. Unfavourable factors of the environment penetrate an organism through pulmonary tract destroy, lung protective mechanism and lead to destruction functioning of lung and other organs and systems. Organism adaptation to unfavourable influence of environmental factors is carried out by means of interconnected action of protective adaptive systems. The necessity of adaptation of large contingents of people to the conditions of influence of harmful factors, stressful situations brings up a question of necessity of investigations of adaptation process and their management.

Adaptation is a developing process. As a result of this process an organism obtains stable response to a certain factor of the environment and gets possibility to live in the conditions earlier impossible or incompatible with life. Reaction to any fierce environmental impact and to any destruction of homeostasis through higher level regulation is ensured by the work of correlative systems: of specific reaction to irritator by means of functional systems formation and of nonspecific reaction to irritator by means of stress realizing adrenergic, hypophysis and adrenal systems.Two stages can be traced down in the development of adaptation reactions: stage of primary adaptation ("urgent" imperfect adaptation emerges directly after the beginning of irritator's action and is realised on the basis of ready physiological mechanisms) and stage of long-term adaptation (perfect long-stage adaptation emerges step by step an a result of long-term and repeated influence of environmental factors on organism) (6,7).

Under the conditions of influence of unfavourable factors an organism is in need of "long-term" adaptation formation. That can be ensured by interconnected systems, not by separate organs. Destruction of functioning of the components, can lead to failure of adaptation process and to the development of pathology.

The aim of the present experiment was to check up the hypothesis of correlation existence between adaptation systems of laboratory animals' organisms and development of remodeling of bronchi and pulmonary apparatus under the inhalative influence of coal dust in large concentrations and stress situations.

Inhalative impact of large dust concentrations call up bronchi -obstructive reaction, which leads to hypoxia and favours formations of functional systems responsible for elimination of oxygen shortage in an organism. It can be presented in a following way: functional system, formed under the conditions of harmful environmental factors' influence (high concentrations of coal dust and stress situations) by afferent link (mechano-, hemoreceptors ets.),central regulative link (centers of neuro-humoral regulation on various level CNS) and effectory link (pulmonary and coronary organs, skeleton muscles).

Methods: A model of chronic inflammation of dust ethiology in bronchial and lung system was created for the functional system operation evaluation. The investigation was carried out on 105 white rats weighting 170-200 gramms (3,8,9). The animals were exposed to dynamic coal dust inhalation procedures in 200 litre cameras for the period of 4 months, 5 days a week, 4-5 hours a day. Stressful state was aroused by means of bright light flashes and shaking the cameras with animals inside. 15 animals composed the control group. Ground finely dispersed coal dust was delivered to cameras through a special dozage device. Dispersed coal dust concentration constituted (100-500) mg/m^3. That dozage corresponds to the real industrial conditions in coal mines of West Donbas coal basin. Experimental animals' body mass, respiratory rate movements, heart rate was determined. Pathomorphological changes of bronchial lung tissue were studied. The state of nervous system was judged by the behavior of the animals, dynamics of changes of "behavioral" reactions : "Burrow" reflex (number of "peeping into" the holes of platform in 3 min.) and "open field" (number of crossed quadrats by 4 paws in 2 min.). The number of ECG intervals was determined. By means of QT interval the index of heart adaptation (IHA) to the conditions of the experiment was calculated:

$$\text{IHA} \quad \frac{QT(0)}{QT(5)}$$

IHA reflects the dependence of electrical impuls in heart muscle from the level of experiment of central nervous system (9).

The experiment was started after 1-month observation of the animals' behaviour, weight dynamics, general health state and separation of animals disease symptoms and evident aggressive reaction. Investigations were carried out prior to the experiments, during the experiment (1,2,3,4,month's), and also after the 1-st and the 3-rd months of rehabilitation period for the evaluation of long-term consequences of inhalatory impact of coal dust.

At the beginning of the experiment the animals of both experimental and control groups behaved the same, but after the 2 weeks of coal dust inhalation the experimental group animals showed excitement, anxiety, aggressiveness, heart rate and respiratory rate increased. Inhibition of "behavioral" reactions was noticed.

Table 1. The state of central nervous and respiratory systems of rats under the course inhalation of coal dust

Stage	Mass of a body gr	Behavioral tests		Respiratory rate (Mm)	Heart rate (Mm)
		Burrow reflex (Mm)	Open field (Mm)		
Primary state	217,9±4,9	3,9±0,4	11,9±1,0	80,5±1,2	405,1±9,8
2-3 weeks	235,3±5,0	2,0*±0,3	6,1*±0,8	138,4*±2,9	502,9*±18,5
2 months	283,2±7,6	2,3±0,4	6,3±1,0	133,5*±3,62	407,1±9,4
3 months	276,3*±8,4	1,1*±0,3	4,2*±1,0	131,9*±3,12	441,8±14,0
4 months	269,0±8,7	0,7*±0,2	3,8*±0,8	120,8*±3,56	437,0±10,8

(* $p<0,05$)

ECG numbers showed reduction of QT and RR intervals during the first two weeks of the experiment.

Table 2. ECG parameteres and adaptation indices of the heart in rats at the time of the experiment

Stage	Number	Intervals of an ECG (ms)				Heart rate (in 1 min)	Indixes of heart adaptation %
		PQ (Mm)	QRS (Mm)	QT (Mm)	RR(Mm)		
Primary state	16	44,8±0,7	14,9±0,3	71,6±0,3	148,1±3,6	405,1±9,8	19,2
2 weeks	15	44,0±0,7	14,2±0,3	59,7±1,1	119,3±4,4	502,9*±18,5	8,2*
1 months	14	44,2±0,9	14,7±0,3	67,8±0,9	146,1±3,5	410,7*±9,8	26,4*
2 months	14	45,6±0,7	14,6±0,4	65,0±0,7	147,4±3,4	407,1±9,4	24,5*
3 months	13	47,3±1,0	14,9±0,4	66,3±1,2	135,8±4,3	441,8±14,0	11,9*
4 months	12	47,8±1,1	15,1±0,3	66,3±0,9	137,33±,4	437,0±10,8	11,4*

(* p<0,05)

Results: The primary result of functional system mobilization lies in the fact that heart hyperfunction and hyperventilation of lungs are distinctly expressed, but still aren't enough for elimination of hypoxemia and combine with more or less evident manifestations of adinamia, euphoria. Growth of lung ventilation is attained as a result of rate increase, but not by means of breath depth.

Transition of the stage of urgent adaptation to the long-term stage requires repeated mobilisation of functional system and is characterised by increase in body mass of animals, "animation" of behavioral reactions, of the number of respiratory movements, decrease of heart rate, rehabilitation of ECG indices, maintenance of adequate minute volume of ventilation under a smaller respiratory rate is ensured by the enlargement of inhale volume and lung volume.

Stress and long time inhalation of coal dust create a situation known in physiology as a situation of "insurmountable difficulty" and leads to excessive tension of protective systems and destruction of adaptation processes, i.e. desadaptation. Thus, after 3 months of the experiment the inhibition of behavioral reactions was noticed, as well as increase of heart rate, development of disease symptoms, nonmotivation agression, decrease in body mass, change in fur colour etc.

Coordinative work of nervous and heart systems was desorganised. This was proved by the changes the index of heart adaptation (HAI).

Respiratory rate decreased. That can be explained by the destruction of respiratory center and increase of lung stretchability as a result of emphysema development and appearance of hyperventilation.

Destruction of adaptation mechanism was proved by the development of morphological changes of bronchial and lung apparatus.

The first animal group which consisted of 10 rats was excluded from the experiment after one week (urgent experiment). "Urgent" experiment led to moderate widening of respiratory bronchioli and alveoli. Mucousa of bronchi was swollen, proliferation of epithelium was clearly seen. Increase of vessels penetration, full-blooded microcircular course, development of swell was revealed by the electromicroscopic investigation. Swollen collagen tissues were seen in interalveolar septums. I-st type alveolocyte membranes formed projections. A large number of mitochondrii and osmiofilus plate-like bodies were found in the cytoplasm of II type alveolocyte (ill.. There were singular macrophags with light foam cytoplasm, large quantity of phagosoms and lysosoms in between alveoli. After a month of animals dust inhalation, termination 1-st group animals' (urgent experiment) pathological changes practically disappeared. 2-nd group animals were exposed to chronic inhalation impact over the period of 4 months (chronic experiment). Marked emphysema was found upon termination. Mucosa of bronchi was swollen, hyperemian with atrophy parts. Sticky slime was found in

bronchi. Bronchial walls were thick on the cut as a result of swell and sclerosis, there was thinness of parts of bronchial walls. Respiratory bronchioli and alveoli were distinctively widened. The pericapillar, intersticial, subendothelial, subepithelial edema, swell, descvamation of epithelium and boldening of bazal membrane were found on a considerable interval in the interalveolar septums by the electromicroscopic investigation. Interalveolar septums were thickened. There was a small amount of neutrophils, monocytes, plasmatic cells in lung interstition. There were a lot of descvamative alveolar epithelium, macrophages, osmiofilus plate-like bodies and tubular mielin, liquid between alveoli. Macrophages contained a large number of dust particles. Macrophages congestion filling the in between alveoli space, alveolar ways and respiratory bronchioli were noticed. Macrophages had dystrophy changes in the center of their congestion, but on the peripheri stayed functionally active. 2-nd type alveolocytes dystrophy was evident. Numerous fybroblasts and collagen tissues, which in some parts grew through the capillar walls and through their gaps were revealed. Pneumoconiotic granulems on various stages of development were observed. After 1 month of the experiment termination 2-nd group animals preserved boldening of bazal membrane. The membrane was unevenly thickened. Growth of grannular tissue, atrophy of muscular bronchial tissue was observed in membranose bronchi. Destruction of 2-nd type alveolocytes was revealed, as well as fibrosis of alveolar walls and diffuse pnevmosclerosis. Thus, remodeling of bronchial and lung tissue on cellular, tissue and organ level occured during the experiment (1,2,4,5).

Discussion: the functioning of adaptation mechanisms seems to be based on ability to supplement each other; thus formation of “urgent and emergency” stage of adaptation (IHA lowers from 19,2 to 8.2, p 0,05) occurs in the first 2 weeks of the experiment; certain inhibition of CNS, reduction of respiratory rate from 158,9 2,8 to 138,4 2,9 in 1 min., seems to restrict the access of pollutants into lungs, but is followed by intensification of work of cardiovascular system (heart rate increases from 405,1 9,8 to 502,9 18,5 in 1 min., p 0,05). The following 3-d and 4-th weeks of the experiment are characterised by the stabilization of work of nervous, respiratory and cardiovascular systems (IHA made 26,4, p 0,05), that is appear as transition from “urgent” stage of adaptation to stable “long-term” stage. However stress and continuous inhalation of coal dust led to over tension of protectiry systems and destruction of adaptation processes. Thus, after 3 month of the experiment the index of heart adaptation made 11,9 (p 0,05), animals were losing weight, stable inhibition of “behavioral” reactions was noticed, as well as heart rate increase to 441,8 18,5 in 1 min. Appearance of symptoms in animals corresponded to morphological symptoms of remodeling of bronchial and lung system.

Observation of animals continued for 3 months after the termination of coal dust inhalation procedure. There was no rehabilitation of adaptation processes. Disease symptoms which led to animals death developed.

Conclusions: Thus, influence of unfavourable invironmental factors, stressful situations leads to instantaneous activation of functional system. This system is responsible for adaptation but doesn’t provide perfect adaptation. Destruction of adaptation mechanisms of cardio-vascular, nervous and respiratory systems limits possibility of organism reparation and requires application of early complex rehabilitation therapy.

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