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Influence of Industrial Factors on Cytomorphological Indicators of Phagocytic Cells

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Abstract

AIM: The article has researched cell morphological changes of phagocytic system's cell of experimented animals by influence of cool-rock dust physical loading basis.

METHODS: The phagocytic activity in combined operation of destructive changes in the cells and the lowering of vital capacity was investigated. Immunological methods are identification of the phagocytic activity of acute myeloid leukemia (AML) described in methodical recommendations. For studying of bronchial aspirates, the bone marrow were got by washing 1.0 saline solution. Centrifugation was performed within 10 min at 2000 rpm per min, swabs made from the precipitate, and dried in an oven at a temperature of –37° Peripheral blood was obtained from a rat tail vein. The swabs were fixed in a mixture of Nikiforov – within 30 min and stained with hematoxylin and eosin with the microscope 100 cells were counted.

RESULTS: The taken results let consider the structure-functional condition of the phagocytal system's cell in operation of unfavorable and industrial factors. It was noticed an accumulation of maximum amount of dust particles and the of destructed alveolar macrophages AML on average in 2 times. During the study of rats' red bone marrow (RBM), there was an increased yield of neutrophil leukocytes 31%, and the activity of phagocytic cells, their number was 11.6 ± 0.9%, which is in 4.8 times higher than the control values. Phagocytic index increased by 54% and the maximum number of dust particles in the cell in 2 times.

CONCLUSION: Experimental animals with intratracheal administration of coal-rock dust have pronounced changes in phagocytic activity in AML, RBM, and physical activity as compared with the control group.

Introduction

The World Health Organization and the International Labor Organization noted that if the working conditions are not improved, the governments of the countries concerned will have to face serious and costly problems associated with the increase in the number of occupational diseases and injuries of industrial character. At present, 160 million of new cases of diseases related to professional activities annually are registered in the world. Maintaining the health of the working population, as the economic foundations of society is the most important task of occupational medicine required in the modern conditions of management, new scientific approaches and solutions. Preserving workers' health must be multidisciplinary preventive services capable to identify and control the risk of injury to health under the impact of unfavorable factors of production.

Mining occupying a leading position in the economy of our Republic stays as the industry with harmful, difficult, and dangerous conditions. The results of numerous studies on the health of workers employed in underground mining operations indicate, that at present highly developed industry, despite the automation and mechanization of production, miners are exposed to the complex of harmful environment factors, the contents of which significantly exceed the maximum permissible concentration and maximum permitted levels. At the same time, several problems of occupational medicine in the coal industry are poorly studied and require further development. Given the current economic situation, the transition to private ownership of the state, at the present stage is not enough address the issues of occupational health, particularly in the coal industry. Remain poorly studied issues such as the assessment of the health of workers in the coal industry in the region in terms of individual professional and vocational caused disease. Of particular interest is the problem of disability-related occupational diseases. Research on the status of this issue in the coal industry is extremely law.

Among occupational diseases leading place take the dust pathology of bronchus pulmonary system, as in contact with industrial aerosols operate large numbers of workers in the coal and mining industry. The study of lung defense system is one of the challenges of modern pulmonology. Components of this system, the lungs are located throughout the respiratory tract, and important among these are macrophages and neutrophils. Their number, especially in the alveoli is increased when various kinds of stimulations. However, the role of macrophages and neutrophils in the lung defense mechanisms has not yet to be fully disclosed on. It is manifested not only in phagocytosis and in the participation of these cells in many metabolic processes.

Ulcerative immune protection in the lungs is represented by physical barriers and complex humoral and cellular mechanisms. Pulmonary alveolar macrophages acting as a first tier of cells coming into close contact with the particles, which are deposited in the deep airways play a key role in the kinetics of elimination, delay, and translocation of poorly soluble particles primarily because that prevent their penetration into the internal environment of the lungs and thereby contributing to the displacement of the zone of operation of airway mucociliary transport and further, through the pharynx – digestive tract. This role of the alveolar phagocytosis installed because of many experiments and are carried in modern mathematical models of the delay of dust in the lungs and tracheobronchial lymph nodes. Thus, large particles inhaled with the air flow are deposited in the nasopharynx and tonsils. Smaller particles, which have penetrated further into the airways, are deposited on their surface covered ciliated epithelium, where they fall at the mucosal layer and light output from the riser mucus movable cilia mucociliary transport system. If smaller particles, such as bacteria or viruses, nevertheless penetrate into the alveolar space, where they react with the soluble components and the leukocytes contained in the mucosal layer. Mucosal lining layer completely lung epithelium and is a viscoelastic gel of complex composition, containing about 200 different proteins, including antimicrobial proteins (lysozyme, lactoferrin and defensins), cytokines, and antioxidant proteins. The soluble components of the mucosal layer play a crucial role in non-specific immune defenses of the lungs. Hence, lysozyme hydrolyzes the peptidoglycan cell walls of bacteria, lactoferrin binds iron, thus depriving the bacteria necessary for their livelihoods trace element, immunoglobulin A and G, complement proteins and surfactant proteins are additional opsonized germs [1].

In addition to the soluble components in the mucosal layer are immune cells that are normally presented mainly by alveolar macrophages. Lymphocytes and neutrophils are present in much smaller quantities. As is known, leukocytes express a variety of receptors that provide non-specific immune recognition components of microbial lipopolysaccharides, proteoglycans, Flagellin *et al*. united by the general concept pathogen associated molecular patterns.

Under the modern conditions of production of the coal, workers exposed to aerosols of disintegration. Therefore, the study of the effects of dust is important. Experimental works had been done early by Bazelyuk [2], [3] noted that the effect of coal dust without physical activity (PA) causes functional changes of alveolar macrophages and neutrophils until fibrotic changes in the lung.

In the experiment, the issues of participation of cellular defense mechanisms of lung alveolar macrophages acute myeloid leukemia (AML), the red bone marrow (RBM) and peripheral blood (PB) under the influence of coal-rock dust (CRD), and PA not identified. The aim of the work was to evaluate the complexes of systems of phagocytic cell defense mechanisms of AML, RBM, and PB under the activity of CRD and PA in the experimental conditions.

Materials and Methods

The research on mongrel rats – males (weighing 160–180 g) were conducted. A total is of 30 animals. The first group – control, the second – where 50 mg of CRD (silicon dioxide content of 10–15%) were administered by a single intratracheal way. The size of dust particles was 1–2 mm in saline solution of 0.8 mm, in the control group – a purely physiological solution under light and ethereal anesthesia. The third group is CRD and PA. The PA dosage created on the horizontal treadmill at a speed of 20 m/min, according to the literature [4] correspond to the average activity of 2 h 5 times a week. Duration of the experience is 1 month, on the biological material bronchoalveolar lavage (BAL), RBM, and PB. We studied the phagocytic activity, phagocytic index, and the maximum number of dust particles in neutrophil leukocytes (NL) and AM. It was paid attention to the cells with obvious morphological signs of destruction and the number of visible dust particles phagocytosed neutrophils, macrophages, and monocytes. The evaluation of the significance of the results was carried out by the criterion Otyudenta at a constant level of significance $p < 0.05$.

Results

When monthly in tracheal seed of CRD, the bronchial washings of lungs were dull-gray. At the animals in Group 2 were indicated an increase in bronchial washings of phagocytic index in NL in 2 times, in AML in 70% and increasing of phagocytosis activity in 2.1 times compared with the control group (Table 1), that indicates that high gripping function of coniophage. When PB studying, it was found increased phagocytic activity of NL in 2.8 times, the maximum number of dust particles by 30% and destructed NL in 2 times (Table 2).

The action of CRD and PA in 1 month – the third group of animals observed worsening of adverse effects in AML, with increased total amount of NL and reduced the number of AML, it increases the functional activity of the cells, which results in increased phagocytosis activity of NL in 3 times and in reducing the activity of phagocytosis of AML in 30%, increase in phagocytic index of NL in 60%, and AML reduction in 50%. Number of dust particles in the cell in the NL was increased maximally by 2.2 times, and MA is reduced by 30%. It is increasing the total percentage of destructive AM in 3 times ($p < 0.01$) as compared with the control group. When RBM study, we have found a decrease of the total number of monocytes by 45%, the increase in phagocytic of NL in 2 times. Simultaneously, it was increased the overall percentage of destructive NL and monocytes (respectively, in 2.2 and 2 times). When studying RB, there were increased content of dystrophic changes of NL in 2 times, and the number of lymphocytes decreased in 50%.

Discussion

When compared experimental animals poisoned with only one CRD – group 2, with animals in Group 3 with poisoned CRD and PA, it is more noticed significant changes in intracellular metabolism. From AML, it is noticed improvement of yield NL, phagocytic activity, phagocytic index an average of 3 times, and also the increase in the maximum number of dust particles per cell. From AML, it was found phagocyte's activity decreasing in 2.7 times, phagocytic index, and maximum number of dust particles per cell of 2.6 times. Destructive changes in AML increased by 40%, lymphocytes decreased in 5.8%. The RBM observed similar changes as in AML, but they are less pronounced in relation to the phagocytic activity. Destructive changes of NL and monocytes increase sharply (70% 2-fold), respectively [5], [6], [7]. Sharply, increasing the destructive red blood cells by 93%. The PB decreased phagocytic activity of the NL in 2.2 times, phagocytic index and the maximum amount

Table 1: The structural composition and functional indicators of phagocytosis of AML and RBM in rats with experimental exposure to coal – rock dust, and physical activity for 1 month (M ± m) %

The object of research	Neutrophils	Macrophages	Lymphocytes	Red blood cells	The object of research	Neutrophils	Macrophages	Lymphocytes	Red blood cells	The object of research	Neutrophils	Macrophages	Lymphocytes
The control group													
BAL	5.0 ± 1.1	2.0 ± 0.2	1.2 ± 0.4	1.8 ± 0.6	1.2 ± 0.4	81.2 ± 3.6	15.4 ± 1.5	4.6 ± 0.6	10.4 ± 1.1	6.6 ± 1.1	1.4 ± 06	4.0 ± 1.9	-
RBM	37.4 ± 2.1	2.4 ± 0.6	1.1 ± 0.2	2.0 ± 0.4	4.0 ± 0.4	16.0 ± 2.6	2.4 ± 1.1	1.3 ± 0.4	2.0 ± 0.6	2.8 ± 0.4	17.0 ± 2.8	16.6 ± 2.4	6.2 ± 2.4
The experimental group CRD for 1 month													
BAL	3.0 ± 3.2*	1.8 ± 1.9	0.6 ± 0.6*	2.0 ± 1.5	1.2 ± 1.2	73.3 ± 6.9	32.8 ± 4.5*	7.8 ± 0.7*	21.0 ± 1.6*	14.2 ± 1.9*	1.2 ± 04	5.3 ± 2.5	-
RBM	49.0 ± 3.2*	11.6 ± 0.9*	1.7 ± 0.2*	4.0 ± 0.8*	5.3 ± 0.7	15.0 ± 2.6	3.2 ± 0.7	1.5 ± 0.25	3.0 ± 0.7	3.0 ± 0.8	13.7 ± 2.3	8.8 ± 2.3*	7.0 ± 2.3
The experimental group CRD and PA for 1 month													
BAL	9.0 ± 1.3*0	6.0 ± 0.6*0	2.0 ± 0.2*	4.0 ± 0.6*0	1.0 ± 0.2	58.0 ± 3.9*0	12.0 ± 1.7*0	3.0 ± 0.2*0	8.0 ± 0.40	20 ± 1.1*0	7.0 ± 2.8	3.0 ± 0.9	-
RBM	35.0 ± 1.70	5.0 ± 0.6*0	1.3 ± 0.20	2.0 ± 0.40	9.0 ± 1.3*0	11.0 ± 0.9*0	2.0 ± 0.4*	1.0 ± 0.10	1.0 ± 0.1*0	6 ± 0.8*0	19 ± 1.3	17 ±	6.0 ± 0.6

*Reliable change sas compared with the control group ($p < 0.05$), *0Reliable change sas compared with CRD and CRD – PA, ($p < 0.01$).

Table 2: The structural composition and functional indicators of phagocytosis in the peripheral blood of rats with experimental exposure to coal – rock, dust, and physical activity for 1 month (M ± m) %

The object of research	Neutrophils	Monocytes	Eosinophils	Lymphocytes	The cellular composition (neutrophils)				
					The total cells	The functional activity of phagocytic cells	Phagocytic index	The maximum number of dust particles in the cell	The total percentage of destructive cells
The control group	32.4 ± 2.8	5.8 ± 1.3	1.2 ± 0.35	61.4 ± 3.8	96.8 ± 0.9	9.2 ± 1.5	1.6 ± 0.19	2.8 ± 0.20	3.2 ± 0.85
The experimental group CRD for 1 month	37.5 ± 5.3	5.3 ± 0.53	4.8 ± 2.4	53.0 ± 3.8	93.7 ± 1.76	26.5 ± 4.2*	1.8 ± 0.14	3.6 ± 0.35*	6.3 ± 1.76*
The experimental group CRD and PA for 1 month	47.0 ± 1.7*	6.0 ± 1.7	6.0 ± 2.1	41 ± 2.5*^{0}	90.0 ± 1,3	12.0 ± 0.9*^{0}	1.0 ± 0.2*^{0}	2.0 ± 0.6*^{0}	10.8 ± 1.3*^{0}

*Reliable changes as compared with the control group ($p < 0.05$), *^{0}Reliable changes as compared with CRD and CRD - PA ($p < 0.01$).

of dust by 80%, the overall percentage of destructive NL increased by 60%.

Thus, in single intratracheal administration of CRD and PA in a dose of 50 mg for 1 month at the experimental animals from cytomorphologic indexes, we found in AML, RBM, and PB an increasing in the relative content of alveolar neutropenia, macrophages, and monocytes, as well as the activity of phagocytic cells, phagocytic the index, and the maximum number of dust particles. The destructive processes in the cell appeared by homogenization of cytoplasm, thickness of core, and loss of microvilli on their surface. It is known that the development begins and ends with neutrophils in the bone marrow, and the machine oxygen dependent of cytotoxicity comprising the production of free radical hydroxy metabolite actually is keeping its functions with starting wand – nuclear form [8], [9]. Decrease in the phagocytic capacity of RBM and PB cells may be due to oxidative stress at the level of many systems of the body in contact with animals fibro genic dust. Segmented neutropenia of RBM, morphologically identical to NL blood, but bone marrow reserve of mature neutrophils significantly exceeds the number of peripheral [10], [11]. Many bone marrow granulocytes in spite of the completeness of morphological, functional status is not achieved in the blood.

Conclusions

1. Experimental animals with intratracheal administration of CRD have pronounced changes in phagocytic activity in AML, RBM, and PA as compared with the control group
2. Installed metabolic changes in AML, RBM, and PA in experimental animals under the influence of CRD and PA, exactly the reduction in the phagocytic activity of coniophage and increasing their destruction, represent a significant reduction in the effective capacity of granulocytes, monocytes, and red blood cells, which is extremely unfavorable in terms of combined dust and PA.

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