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The Formation of Parts of the Human Immune System under the Influence of Factors of Industrial Ecology (Example of the Military Type of Technogenesis)

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ABSTRACT

Purpose of study: We conducted a study of the immune status of servicemen employed in chemical weapon storage and disposal enterprises. The paper presents the results of the analysis of the cellular and humoral immunity indicators taking into account the age of the servicemen and the distribution of the contingent. The paper also presents the results of the analysis of the NBT-test, which indicates the depletion of the immune status. The comparative analysis of the NBT-test showed higher than normal indicators in all age categories. The spontaneous NBT indicators show low levels in the age group of 18-29 years-2.2% of the subjects, the induced NBT indicators are below the norm in the age group of 18-29 years-2.2%, 30-39 years-4.5%. The servicemen have a pronounced change in the immunity indicators.

Methodology: Work at military enterprises is characterized by the impact of a number of chemical factors, in particular heavy metals, carbon monoxide, benzapyrene, on military personnel.

Result: Evaluation of the qualitative and quantitative characteristics of immunological indicators allows us to study the effect of individual indicators on the formation of the immune status in general. This position should be taken into account upon developing a set of preventive measures. Determination of the amount of immunoglobulins was carried out by the method of radial immunodiffusion. The parameters of cellular and humoral immunity were analyzed with the help of the nitro blue tetrazolium test (NBT-test). In the course of the study, the retired servicemen had a significantly increased leukocyte count (80.5% of the subjects), normal neutrophil count (85.4% of the subjects), T-lymphocytes (92.2% of the subjects), and B-lymphocytes (97.6% of the subjects).

Key words: Immune status, Military technogenesis, Carcinogenesis prevention, Highly toxic chemicals, Serviceman

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INTRODUCTION

The immune system is a host defense system comprising many biological structures and processes within an organism that protects against disease. To function properly, an immune system must detect a wide variety of agents, known as pathogens, from viruses to parasitic worms, and distinguish them from the organism's own healthy tissue. In many species, there are two major subsystems of the immune system: the innate immune system and the adaptive immune system. Both subsystems use humoral immunity and cell-mediated immunity to perform their functions. In humans, the blood–brain barrier, blood–cerebrospinal fluid barrier, and similar fluid–brain barriers separate the peripheral immune system from the neuroimmune system, which protects the brain.

Pathogens can rapidly evolve and adapt, and thereby avoid detection and neutralization by the immune system; however, multiple defense mechanisms have also evolved to recognize and neutralize pathogens. Even simple

unicellular organisms such as bacteria possess a rudimentary immune system in the form of enzymes that protect against bacteriophage infections. Other basic immune mechanisms evolved in ancient eukaryotes and remain in their modern descendants, such as plants and invertebrates. These mechanisms include phagocytosis, antimicrobial peptides called defensins, and the complement system. Jawed vertebrates, including humans, have even more sophisticated defense mechanisms, including the ability to adapt over time to recognize specific pathogens more efficiently. Adaptive (or acquired) immunity creates immunological memory after an initial response to a specific pathogen, leading to an enhanced response to subsequent encounters with that same pathogen. This process of acquired immunity is the basis of vaccination.

Disorders of the immune system can result in autoimmune diseases, inflammatory diseases and cancer. Immunodeficiency occurs when the immune system is less active than normal, resulting in recurring and life-threatening infections. In humans, immunodeficiency can either be the result of a genetic disease such as severe combined immunodeficiency, acquired conditions such as HIV/AIDS, or the use of immunosuppressive medication. In contrast, autoimmunity results from a hyperactive immune system attacking normal tissues as if they were foreign organisms. Common autoimmune diseases include Hashimoto's thyroiditis, rheumatoid arthritis, diabetes mellitus type 1, and systemic lupus erythematosus. Immunology covers the study of all aspects of the immune system. The central nervous and immune systems are particularly sensitive to various exogenous influences; their impaired functioning can lead to a decrease in the quality of life and the development of certain occupational diseases with significant social consequences [1,2]. In this regard, the study of the state of the human immune system as an indicator system of its stress resistance and its impact on the quality of human life of objects for storing and destroying highly toxic chemicals seems to be quite important [3,4]. Employees serving in high-risk facilities are affected by chemical factors not only in the workplace, but also in everyday life, thereby increasing the risk of causing pathological changes diseases [5,6,7].

The influence of pathogenic factors immediately affects the functioning of human immunity, since the immune system is a delicate mechanism, very susceptible and rapidly reacting to their effects [8-11]. The immune system under such influence changes the rhythm of its functioning, directing all forces to return the former status, otherwise the complex indicators do not return to normal; as a result, a pathological change appears in the body [12,13]. Constant monitoring of the state of the body's immune system is performed to identify tumor cells, assess benign and eliminate, at best, malignant ones. There is evidence that the presence of tumors is more common in weakened immunity [14,15,16].

We conducted a study of the immune status of servicemen employed in chemical weapon storage and disposal enterprises. Work at military enterprises is characterized by the impact of a number of chemical factors, in particular heavy metals, carbon monoxide, and benzapyrene, on military personnel. Objective of the study is to assess the impact of harmful production factors on the immune status of military personnel with the further development of preventive measures.

METHODS

The study involved servicemen employed in facilities for the storage and disposal of chemical weapons (381 people). A control group was also formed consisting of persons not related to military activities (169 people). The results were processed by statistical methods, taking into account the contingent and age. The following types of groups were formed: 1) by contingent: soldiers, active military servicemen, retired and former military servicemen; 2) by age: 18-29, 30-39, 40-49, 50-59, 60-69, and over 70 years old. To determine neutrophils and lymphocytes, it is necessary to prepare Romanovsky-Giemsa stained blood smears. The principle of the method, which helps detecting the activated granulocytes and monocytes, is based on the cytochemical detection of dark blue granules of diformazan, which are formed in the neutrophil cytoplasm as a result of the reduction of nitroblue tetrazolium (NBT). This chemical reaction is carried out due to the activation of phagocyte oxygen-dependent biocidal activity.

Progress of the study: 0.05 ml of capillary or venous blood are added to two agglutination

tubes preliminarily rinsed with a heparin solution (25 U/ml). Then, 0.025 ml of the buffer solution is added to one of them, and 0.025 ml of the zymosan suspension is added to the other. After this, 0.025 ml of a 0.15% NBT solution is introduced into the test tubes. The contents of the tubes are carefully mixed and incubated in a water bath at 37°C for 30 minutes, shaking every 10 minutes. After the incubation, the sediment is carefully removed and used for making smears on thoroughly washed and degreased mixture of Nikiforov slides. The smears are air dried, fixed with methanol for 10 minutes, dried again, stained with a 2% aqueous solution of methyl green for 20 minutes, washed in running water, dried and microscopized.

The figures indicate the degree of filling of the cytoplasm with granules of diformazan:

1. The area of the diformazan deposits does not exceed 1/3 of the area of the nucleus.
2. Blue-violet granules occupy from 1/3 to the entire area of the nucleus.
3. The area of diformazan deposits exceeds the nucleus area.

Normally, the amount of phagocytic activity of neutrophils (NPA) varies within the range of 0.1-0.15 in basal conditions and 0.5-15 with neutrophil stimulation. The immunoglobulin assay was conducted by the method of radial immunodiffusion. The principle of the method is based on the immunological phenomenon of precipitation. We also determined the level of circulating immune complexes in blood serum. The principle of the method is based on the change in the magnitude of the light scattering of the polyethylene glycol solution due to the precipitation of the CIC from serum.

RESULTS AND DISCUSSION

The analysis of the cellular and humoral immunity parameters subject to the characteristics of the groups studied made it possible to determine the direction and staging of the processes that affect the formation of the immunological status. As a result of the analysis, the distribution of indicators by contingent groups was revealed taking into account the normal, exceeding and decreasing levels of the normative indicator. The following trends are revealed:

1. Excess of white blood cell count in soldiers-26.5%, active servicemen-56.9%, retired and former servicemen-80.5%. Relatively low levels were revealed in the retired and former servicemen-2.4%.
2. A significant excess of the normative indicator of the neutrophil count was found in soldiers-27.7%, active servicemen-66.7%, and former servicemen-85.4%.
3. An excessive amount of T-lymphocytes in soldiers-78.3%, active servicemen-92.2%, retired and former servicemen-97.6%. Low levels were detected in soldiers (relative to the normal)-1.2%.
4. An excessive level of B-lymphocytes in soldiers-75.9%, active servicemen-92.2%, retired and former servicemen-97.6%. A low level was detected in soldiers-1.2%;
5. The level of IgA related to the indicator "not normal" was revealed in soldiers-1.2%, active servicemen-2%, former servicemen-4.9%.
6. An excessive level of IgM was found in soldiers-44.6%, active servicemen-31.4%, former servicemen-36.6%. Low levels in all groups of the contingent: 1.2% of soldiers, 5.9% of active servicemen.
7. A significant excess of IgG level was detected in soldiers-16.9%, active servicemen-9.8%. Low levels are detected in 15.7% of soldiers, 15.7% of active servicemen, and 43.9 of former servicemen.
8. Excess of indicators of the spontaneous NBT-test was detected in soldiers-72.3%, active servicemen-94.1%.

Figure 1 depicts the contamination of normal blood.

Distribution of the indicators by age

1. An excessive amount of neutrophils was found in servicemen aged 18-29 years-28.6%, 30-39 years-40.9%, 40-49 years-64%, 50-59 years-46.4%, 60-69 years-60%, and over 70 years old-100%.
2. High levels of T-lymphocytes were detected in the age groups of 18-29 years-76.9%, 30-39 years-77.3%, 40-49 years-80%, 50-59 years-53.6%, 60-69 years old-68%.
3. An excessive amount of B-lymphocytes was detected the age groups of 18-29 years-74.7%,

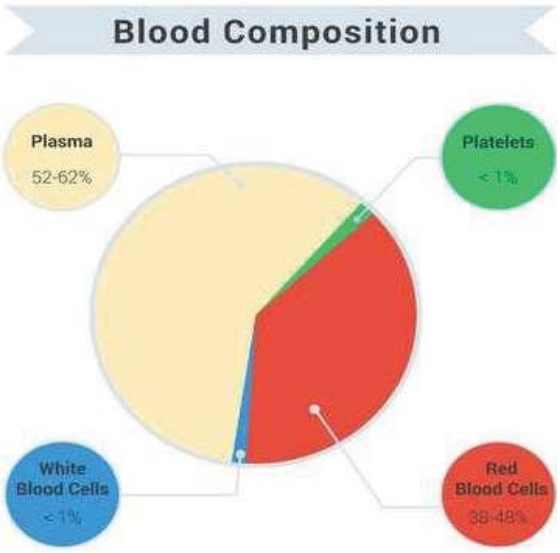

Figure 1: The ingredient of normal blood.

30-39 years-77.3%, 40-49 years-80%, 50-59 years-53.6%, 60-69 years old-68%. 1.1% of servicemen aged 18-29 years have a reduced number of B-lymphocytes.

4. "Not normal" IgA level was detected in age groups of 18-29 years-1.1%, 60-69 years-8%, over 70 years-7.7%.
5. Spontaneous NBT-test: High levels in the age groups of 18-29 years-70.3%, 30-39 years-77.3%, 40-49 years-80%, 50-59 years-57.1%, 60-69 years-68%, over 70 years-100%, low levels in the age group of 18-29 years-2.2%.
6. Induced NBT-test: High levels in the age groups of 18-29 years-38.5%, 30-39 years-54.5%, 40-49 years-64%, 50-59 years-60.7%, 60-69 years-68%, over 70 years-100%, low levels in the age groups of 18-29 years-2.2%, 30-39 years-4.5%.

The occupational factor can have a negative impact on the state of the immune system. As a result of the study of the indicators, there is a statistically significant level of occurrence of an increase in B-lymphocytes in the age categories of active and retired servicemen. Retired servicemen and those over the age of 60 have a significant difference in IgA from normal. High levels of IgG are observed in the contingent group among the soldiers and those in the age range of 18-29 years; the reverse dynamics is observed in the group of retired and former servicemen. The increased values of the NBT-test, which are typical for groups of active and retired servicemen, indicate the depressed state of the organism.

SUMMARY

1. The analysis of the cellular and humoral immunity parameters subject to the characteristics of the groups studied made it possible to determine the direction and staging of the processes that affect the formation of the immunological status.
2. The significantly high levels of occurrence of an excessive amount of B-lymphocytes were detected in groups of active servicemen (92.2%), and retired military personnel (97.6%) d. The "critical" age category is the age of 40-49 years (80%).
3. The values of the IgA level significantly differ from the normal in retired and former servicemen (4.9%), as well as those aged 60-69 years (8%) and over 70 years (7.7%).
4. The study of the level of IgG showed mainly low values, which were often observed in a group of retired and former military personnel (43.9%). High values were also observed in groups of soldiers (16.9%) and in the age group of 18-29 years (16.5%).
5. Excessive values of the NBT-test are typical for groups of active servicemen (72.5%-induced NBT, 94.1%-spontaneous NBT), and retired servicemen (97.6%-induced NBT, 95.1%-spontaneous NBT).

CONCLUSION

The influence of an occupational factor on the state of the immune system is proved. The servicemen show a pronounced change in their immunity indices. The decrease in the number of IgM, IgA may speak of a reduced resistance of the organism, a decrease in the primary immune response. This condition is compensated for by an excess of IgG, or by a secondary immune response. Similarly, the activation of the immune status is indicated by the significant activation of sNBT and iNBT. Taking into account the indicators of immunological status will allow developing preventive measures for the preservation of the health potential of servicemen.

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