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Scientific-Methodical Approaches to The Formation of Risk Groups of Oncological Screening.

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ABSTRACT

Modern multidisciplinary screening examinations can both detect a tumor, and establish the diagnosis of a chronic disease changing further into cancer (pre-cancer stage). To study the state of the health of employees, we applied the social and hygienic method of investigation by questionnaire survey. The questionnaire included three parts: socio-demographic, medical-biological, and sanitary-hygienic. Each group of risk has been assessed: group 1 - cancer-specific symptoms presented; group 2 - cancer-alarming symptoms presented; group 3 - cancer-developing factors presented; group 4 - no symptoms or factors detected. The first group of risk of development of oncologic pathology of any organ has been identified in 49% of the surveyed. Localization such as "breast" and "prostate" are dominant. Processing of all risk groups of cancer pathology of each organ has provided integral evaluation giving a comprehensive description of the health of local population. The risk group 3 is of highest importance in the final structure of the risk groups - 48%. Based on the results of the regression analysis, the formation of a group of cancer risk is significantly influenced by age, general experience, professional experience, occupation, work in highly dust conditions, inhalation of hazardous substances, work related to the production of rubber. A mathematical model of malignancy risk prediction in employees of machinery production has been developed.
Keywords: machine-building production, oncological screening, risk group.

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INTRODUCTION

WHO guidelines define risk as "the expected frequency of undesirable effects arising from a given exposure to the pollutant". According to the Glossary of the American Environmental Protection Agency (US EPA), the risk is "the probability of injury, illness or death under certain circumstances". The carcinogenic risk is a probability of a significant increase in the incidence of tumors in people being exposed to certain carcinogenic factors in the household and / or in the production and correlated with the individual characteristics of lifestyles, endogenous factors, environmental pollution and some occupational hazards [1].

The screening, which includes a comprehensive programmed examination, is often used to detect cancer in any particular location. This approach ensures detection of a tumor, and establishment of the diagnosis of a chronic disease changing further into cancer [2, 9].

Positive screening results may indicate the presence of disease or a high probability of its development, and indicate the need to confirm these results. Certain production conditions may change the screening tasks, but, ultimately, medical screening should always be aimed at a comprehensive secondary prevention of the disease, i.e., identification of disease at a stage when it is possible to stop or slow its progression, or to achieve its regression [3, 10].

The screening is primarily required to the surveyed subjects themselves. foreign literature describes in details the evaluation criteria for screening tests being conducted both on- and off-site [4,6,7,8].

The paper presents the results of a questionnaire screening of the employees of machinery production.

Objective of this study is to examine the different factors of the production and non-production environment increasing the risk of cancer, as well as the application of scientific and methodological approaches in the formation of risk groups. To achieve this objective, the following tasks were solved: the selection of the study subjects, the questionnaire survey, the formation of cancer risk groups, and construction of a mathematical prediction model for cancer progress.

RESEARCH MATERIAL AND METHODS

The screening was conducted by a specially developed IARC questionnaire. The questionnaire included total 133 questions, including special ones for men and women. When drawing up a questionnaire, an attention was given to the production block (occupation, the presence of harmful factors, experience, etc.), medical and biological block (age, the degree of history burden, presence of chronic diseases, complaints) and social block (presence of harmful habits, diet, lifestyle). Each question and grading of answers had their own diagnostic feature and informational value. These coefficients served for the development of scores [5,6,7].

The IARC questionnaire ensures testing by 8 basic localizations: head and neck, gastrointestinal tract, respiratory system, skin, urinary system, reproductive organs, breast, and lymphatic system. In every system of the body some organs were chosen, for which the risk of cancer was also determined [6,7].

During testing, the cancer risk groups are formed, which are classified based on the identification of symptoms alarming against tumor pathology, and the factors that increase the risk of cancer.

As a result, total four risk groups have been formed:

- cancer-specific symptoms presented, examination by oncologist is urgently recommended;
- cancer-alarming symptoms presented, examination by oncologist is recommended;
- no evidence of disease at present time, but there are factors that significantly increase the
- probability of cancer development; no cancer-alarming symptoms or factors considerably increasing the probability of cancer development detected.

Further, the statistical processing of the results was conducted [5,6,7].

RESULTS

The first group of risk of development of oncologic pathology of any organ has been identified in 49% of the total number of surveyed individuals. In this risk group, the first risk groups are defined in 19% of the surveyed by two and more localizations (in certain cases - up to 6-9). The organs included in risk group 1 without any symptoms of cancer process, are the brain, the lower lip, pancreas, rectum, the organs of the urogenital system, the female reproductive system, except for the ovaries, the penis and the lymph system. No cancer-alarming signs were detected in group 2 in the organs such as the stomach, the skin, the cervix, and the ovaries. It was found that the environmental factors have impact on the development of cancer process in all organs and systems, with the exception of the pelvis and ureter, the prostate and the testis. No symptoms or risk factors of malignant transformation were revealed only in one organ - the testis, while the melanoma risk group 4 is absent in general.

Localizations such as "breast" (23%) and "prostate" (20%) have an extremely high probability of cancer development in the risk group 1. Further are the esophagus (16%), the lung (14%), and the larynx (11%).

The maximum number of symptoms alarming against the development of cancer was detected by the localization process in the pelvis and ureter (90%), and the brain (68%). Further are the rectum (43%), the thyroid (41%), the bladder (38%), and the esophagus (35%).

Environmental factors have a significant influence on the development of cancer diseases of the skin (skin cancer - 86%, and melanoma - 65%), uterine cervix (64%) and body (59%), stomach (54%), breast (50%) lung (46%), penis (40%), and esophagus (38%).

Processing of all risk groups of cancer pathology of each organ has provided integral evaluation giving a comprehensive description of the health of local population. Further analysis, taking into account age, experience, and occupational load, was carried in the integrated group of risk. The risk group 3 is of highest importance in the final structure of the risk groups - 48%. Further is the risk group 4 – 31%, risk group 1 – 13%, and risk group 2 – 8%.

In addition to determining the cancer risk groups based on personal data we have found the degree of impact of certain factors such as production, heredity, bad habits, poor diet on the development of cancer pathology. A significant problem is still the late detection of cancer.
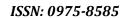
A production block was of particular interest during analysis, which included questions about the experience and the presence of harmful factors. 67% of all respondents mentioned about occupational hazard at their work. And 42% of them have more than 1 hazardous production factor. We also determined the experience load during work with occupational hazards. The greatest experience of work with occupational hazards is more than 25 years (26%), 22% of respondents have had exposure to harmful production factors for 10-14 years, 15% - up to 4 years and from 15 to 19 years, 11% of workers have contacted with harmful factors for 5-9 years and for 20 to 24 years.

We have determined the percentage distribution of integrated cancer risk groups within the age groups The group 1 is mainly represented by workers aged 50-59 years accounting for 60%, and age groups of 30-39 and 40-49 years account for 20% each. The second risk group consists of workers aged 50-59 years (100%). The third risk group consists of 37% of workers aged 40-49 years and 50-59 years, 16% of workers aged 30-39 years, and 11% of those over 60 years old. The risk group 4 consists of 33% of workers aged 40-49 years, and age groups of 20-29 and 30-39 years account for 25% each. 17% - 50-59 years old. Consequently, the cancer risk group includes people aged 40-49 and 50-59 years, and the preventive measures must be to the uttermost oriented to this contingent [5,6,7].

We have developed a mathematical model of malignancy risk prediction in employees of machinery production:

$y = 6.6 - 1.1x_1 + 3.1x_2 - 2.6x_3 + 0.1x_4 - 0.1x_5 - 0.1x_6 + 1x_7 + 1.7x_8 - 1x_9 + 0.6x_{10} + 1x_{11} - 4x_{12} - 0.7x_{13} - 0.4x_{14}$
where, y – risk group,

x_1 – age

x_2 – general experience

x_3 – occupational experience

x_4 – occupation

x_5 – chronic pathologies

x_6 – place of work

x_7 – smoking

x_8 – work in highly dust conditions

x_9 – inhalation of hazardous substances

x_{10} – contact with medicinal drugs

x_{11} – contact with colorants, nitrocompounds

x_{12} – work related with the production of rubber and rubber products

x_{13} – work with the use of electromagnetic radiation

x_{14} – other hazards not stated in the questionnaire

DISCUSSIONS

The first group of risk of development of oncologic pathology of any organ has been identified in 49% of the surveyed. Localizations such as "breast" (23%) and "prostate" (20%) are dominant in this risk group.

The maximum number of symptoms alarming against the development of cancer was detected by the localization process in the pelvis and ureter (90%), and the brain (68%) in the risk group 2. We have also determined symptomatically the high probability of occurrence of the colorectal, thyroid, bladder, and esophagus diseases.

In the risk group 3, the environmental factors have a significant influence on the development of cancer diseases of the skin (skin cancer - 87%, and melanoma - 65%), uterine cervix (65%) and body (59%), stomach (54%), and breast (50%).

The fourth risk group is represented by the lymphatic system (62%), prostate (60%), kidneys (84%), and pharynx (78%).

The final structure of the risk groups was as follows: the risk group 1 was determined in 13%, risk group 2 - in 8%, risk group 3 – in 48%, and risk group 4 – in 31%.

Upon determining the correlation between the risk group and the age, general experience and occupational experience, and presence of contact with hazardous production factors we revealed the following:

1. There is an inverse correlation between the score and the age (Gamma = -0.411765; Spearman = -0.451027; Kendall Tay = -0.348110 at $p < 0.05$). This indicates that the younger the person, the higher the total score is. The younger the person, the lower the risk of oncopathology is.
2. The same correlation was obtained between the total score and the presence of chronic diseases (Gamma = -0.424084; Spearman = 0.518416; Kendall Tay = -0.373710 at $p < 0.05$).
3. Correlation between the score and the general and occupational experience (Gamma = -0.333333 at $p < 0.05$). The greater the general and occupational experience, the higher the risk of oncopathology is.

Based on the results of the regression analysis, the formation of a group of cancer risk is significantly influenced by age, general experience, professional experience, occupation, work in highly dust conditions, inhalation of hazardous substances, work related to the production of rubber. Place of work, the presence of chronic diseases, and smoking have less influence.

The results of the screening test system of engineering workers, modeling of processes in the "health-environment" system, and the assessment of the degree of carcinogenic risk form the scientific and methodological basis for improving the primary prevention of malignant formations under the cancer-causing technologies and industries.

SUMMARY

1. Occupational activity in the machine-building production is associated with the development of a high level of carcinogenic risk.
2. Group of high carcinogenic risk, typical of oncological pathology of any organ, has been determined in 49% of the surveyed. We have revealed a significant domination of nosological forms of reproductive sphere (breast - 23%, prostate - 20%).
3. Based on screening results, we have also determined the high probability of occurrence of the colorectal, cerebral, thyroid, bladder, and esophagus diseases in the workers of carcinogenic industry.
4. We have revealed the following trends in the final structure of cancer risk groups: the risk group 1 was determined in 13%, risk group 2 - in 8%, risk group 3 – in 48%, and risk group 4 – in 31%.
5. With the use of nonparametric statistics, we have determined strong correlation between the carcinogenic risk groups and occupational experience, as well as with the burdened history.
6. With the use of discriminant analysis we have created a model that allows developing the control mechanisms for reducing the risk of carcinogenic hazard in terms of contact with carcinogenic substances and factors.

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