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The Influence of Carcinogenic Factors on Occupational Safety Employees of Industrial Enterprises

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ABSTRACT

Occupational cancer results from exposure to carcinogens in the workplace. Early detection of occupational cancer is difficult, mainly due to the latent period, which can be up to 20 years or more. For this reason, it is important to develop and improve methods for early detection of precancerous changes. Medical surveillance and prevention, as well as legislation, are needed to reduce the incidence and mortality of occupational cancer. In industrialized countries, occupation is causally associated with 2-8% of all cancers; however, among exposed workers, the proportion is higher. There are no reliable estimates of either the significance of occupational cancer or the extent of occupational exposure to carcinogens in developing countries. The relatively low incidence of occupational cancer in industrialized countries is the result of strict regulations on a few known carcinogens; exposure to other, not fully investigated agents is still permitted. Although several occupational cancers are listed as occupational diseases in many countries, very few cases are actually recognized and compensated. Many occupational carcinogens go undetected because they are associated with only a small increase in risk or because they have simply not been studied. Occupational cancer is largely a preventable disease.

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Introduction

The Ministry of Health proposes to expand the list of occupational diseases by adding oncological diseases to it. The current Russian list of occupational diseases practically does not take into account "occupational" cancer - unlike other countries, which, according to the department, does not correspond to the real state of affairs. According to Rospotrebnadzor, in 2022, 4.3 thousand cases of occupational diseases were recorded in 3.5 thousand people in the Russian Federation - almost two times less than in 2013 (the department has been keeping comparable statistics since then). If the updated list is adopted, the statistics of occupational diseases in the Russian Federation may become many times worse, payments by companies to the Social Fund will increase due to the need to insure new risks, and the social insurance system willtake on part of the burden of treating oncological diseases, which now falls on compulsory medical insurance. In the overall structure of oncological diseases, industrial carcinogens as the primary cause account for 4 to 40% (in developed countries from 2 to 8%).

Occupational cancer results from exposure to carcinogens in the workplace. Early detection of occupational cancer is difficult, mainly due to the latent period, which can be up to 20 years or more. For this reason, it is important to develop and improve methods for early detection of precancerous changes. Medical surveillance and prevention, as well as legislation, are needed to reduce the incidence and mortality of occupational cancer.

Strategies for the control of occupational exposure to chemical carcinogens are set out in the European Union Carcinogens Directive and in national legislation such as the UK Control of Substances Hazardous to Health Regulations. Although such legislative requirements should apply to all chemical carcinogens exposed in the workplace, it is argued that priority should be given to controlling those substances that contribute most to cancer. Examples of possible strategies to reduce exposure to two substances (diesel particulates and paint emissions) are discussed. It is concluded that there are no real technical difficulties in controlling exposure to chemical carcinogens; however, for many key substances we need to change attitudes about the potential risks and demonstrate to employers and employees how to reduce exposure.

Problem

The first clear evidence for cancer causation involved the occupational carcinogen soot as a cause of scrotal cancer in London chimney-fitters and was published in 1775, along with descriptions of appalling working conditions that included children climbing narrow chimneys that were still hot. Despite this evidence, messages about the need to prevent chimney fires were used to delay child labour legislation in the industry until 1840. An experimental model of soot carcinogenesis was first demonstrated in the 1920s, 150 years after the initial epidemiological observation. In subsequent years, a number of other occupational causes of cancer have been demonstrated through epidemiological studies (although the association with cancer was usually first noted by occupational physicians or workers). These include arsenic, asbestos, benzene, cadmium, chromium, nickel, and vinyl chloride. Such occupational carcinogens are of great public health importance because of the potential for prevention through regulation and improved industrial hygiene practices. In most cases, they are hazards that markedly increase the relative risk of a particular type or types of cancer. It is possible that other occupational carcinogens remain undetected because they are associated with only a small increase in risk or because they have simply not been studied.

Occupational Cancer - Key Facts:

- In industrialized countries, occupation is causally associated with 2-8% of all cancers; however, among exposed workers, the proportion is higher.
- There are no reliable estimates of either the burden of occupational cancer or the extent of exposure to carcinogens in the workplace in developing countries.
- The relatively low overall burden of occupational cancer in industrialized countries is the result of strict regulations on a few known carcinogens; exposure to other less well-studied agents, however, is still permitted.
- Although several occupational cancers are listed as occupational diseases in many countries, very few cases are actually recognized and compensated.
- Occupational cancer is largely a preventable disease.

In the past, occupational causes of cancer have received considerable attention in epidemiological studies. However, there has been much debate regarding the proportion of cancers that can be attributed to occupational exposure, with estimates ranging from 4 to 40%. The attributable risk of cancer is the total experience of developing cancer in a population that would not have occurred in the absence of effects attributable to the occupational exposure of concern.

Research into occupational cancer is difficult because there are no "complete" carcinogens; that is, occupational exposure increases the risk of developing cancer, but that future cancer development is by no means certain. Furthermore, it may take 20 to 30 years (and at least five years) between occupational exposure and subsequent cancer development; it may also take several more years for the cancer to become clinically detectable and result in death.

Several mathematical models of cancer causation have been proposed, but the model that is the simplest and most consistent with current biological knowledge is that of the Indian mathematician and epidemiologist Mulgavkar. This model proposes that a healthy stem cell occasionally mutates (initiation); if a particular stimulus promotes the proliferation of intermediate cells (promotion), then it becomes increasingly likely that at least one cell will undergo one or more further mutations, causing a malignant cancer (progression).

Thus, occupational exposure may increase the risk of developing cancer either by causing mutations in DNA or by various "epigenetic" mechanisms of promotion (not involving DNA damage), including increased cell proliferation. Most occupational carcinogens that have been discovered to date are mutagens and therefore cancer initiators. This explains the long "latency" period required for further mutations to occur; in many cases, the necessary further mutations may never occur and cancer may never develop.

In recent decades, a major problem has been the transfer of hazardous industries to the developing world. Such transfers have occurred partly because of strict carcinogen regulation and rising labor costs in the industrialized world, and partly because of low wages, unemployment, and the push for industrialization in developing countries. For example, Canada currently exports about half of its asbestos to the developing world, and a number of asbestos-based industries have been transferred to developing countries such as Brazil, India, Pakistan, and Indonesia. These problems are further exacerbated by the size of the informal sector, the large number of workers who have little support from trade unions and other labor organizations, worker insecurity, the absence of legal protection and/or poor enforcement of such protection, and diminished national control over resources.

As a result, it cannot be said that the problem of occupational cancer has been reduced in recent years, since in many cases exposure has simply been transferred from the industrial to the developing world. In some cases, overall occupational exposure has increased. However, the recent history of cancer prevention in occupational settings in industrialized countries has shown that it is possible to use substitutes for carcinogenic compounds in industrial processes without causing the collapse of industry, and similar successes would be possible in developing countries if adequate regulation and control of occupational carcinogens existed.

Occupational Carcinogens

Control of occupational carcinogens is based on a critical review of scientific studies in both humans and experimental systems. Several review programs are conducted in different countries to control occupational exposures that may be carcinogenic to humans. The criteria used in the different programs are not entirely consistent, sometimes resulting in differences in the control of agents in different countries. For example, 4,4-methylene-bis-2-chloroaniline (MOCA) was classified as an occupational carcinogen in Denmark in 1976 and in the Netherlands in 1988, but it was not until 1992 that the American Conference of Governmental Industrial Hygienists in the United States introduced the designation "possible human carcinogen".

The International Agency for Research on Cancer (IARC) has established, through its Monographs programme, a set of criteria for assessing evidence of carcinogenicity of specific agents. The IARC Monographs programme represents one of the most comprehensive efforts to systematically and consistently review cancer data, is highly regarded in the scientific community and serves as the basis for the information presented in this article. It also has an important influence on national and international work on occupational cancer.

- Evidence of cancer induction in humans is reviewed and is likely to play an important role in the identification of human carcinogens. Three types of epidemiologic studies contribute to the assessment of carcinogenicity in humans: cohort studies, control studies, and correlational (or ecological) studies. Case reports of cancer in humans may also be reviewed. Evidence relevant to carcinogenicity from human studies is classified into one of the following categories.

- **Sufficient Evidence of Carcinogenicity:** A causal relationship has been established between exposure to the agent, mixture, or exposure circumstance and cancer in humans. That is, in studies in which chance, bias, and confounding can be excluded with reasonable certainty, a positive relationship between exposure and cancer has been observed.

- **Limited Evidence of Carcinogenicity:** A positive association has been observed between exposure to the agent, mixture, or exposure circumstance and cancer for which a causal interpretation is considered plausible, but chance, bias, or confounding cannot be excluded with reasonable certainty.
- **Insufficient Evidence of Carcinogenicity:** the available studies are of insufficient quality, consistency, or statistical power to draw a conclusion about the presence or absence of a causal relationship, or there are no data on cancer in humans.
- **Evidence Indicating Lack of Carcinogenicity:** There are several adequate studies covering the full range of exposure levels known to occur in humans that are consistent in showing no positive association between exposure to the agent and the cancer of interest at any observed exposure level.
- Studies in which experimental animals (mostly rodents) are chronically exposed to potential carcinogens and examined for signs of cancer, and the degree of evidence of carcinogenicity is then classified into categories similar to those used for human data.
- Data on biological effects in humans and experimental animals that are of particular importance are reviewed. These may include toxicological, kinetic, and metabolic considerations, as well as evidence of DNA binding, maintenance of DNA lesions, or genetic damage in exposed individuals. Toxicological information such as cytotoxicity and regeneration, receptor binding, and hormonal and immunological effects, as well as structure-activity relationship data, are used in considering the potential mechanism of carcinogenic action of the agent.
- The body of evidence is considered as a whole to arrive at an overall assessment of the carcinogenicity to humans of an agent, mixture, or exposure circumstance.

Agents, mixtures and exposure conditions are evaluated under IARC monographs if there is evidence of human exposure and carcinogenicity data (either in humans or in experimental animals). Classification groups of monograph programs I ARS.

The agent, mixture or exposure circumstance is described according to the wording of one of the following categories:

Group 1	The agent (mixture) is carcinogenic to humans. The circumstances of exposure entail exposure that is carcinogenic to humans.
Group 2A	The agent (mixture) is probably carcinogenic to humans. The circumstances of exposure result in exposure that is probably carcinogenic to humans.
Group 2B	The agent (mixture) may be carcinogenic to humans. The circumstances of exposure entail exposure that may be carcinogenic to humans.
Group 3	The agent (mixture, exposure circumstance) is not classified with respect to its carcinogenicity to humans.
Group 4	The agent (mixture, exposure circumstance) is probably not carcinogenic to humans.

Currently, 22 substances (including groups of chemicals and their mixtures) are known to be occupational carcinogens (excluding pesticides and drugs that have been established as human carcinogens). Agents such as asbestos, gasoline, and heavy metals are currently widely used in many countries, while others are of mainly historical interest (e.g., mustard gas and 2- naphthylamine). Carcinogenic chemicals, group of chemicals or mixtures related to the occupational environment (excluding pesticides and drugs):

Group 1: Chemical Carcinogens to Humans

Carcinogens	Human target organs	Main area of application
4 – amino befinil (92-67-1)	Bladder	Rubber production
Arsenic and its compounds (7440 - 38 - 2) ***	Lungs, skin	Production of glass, metals, pesticides
Asbestos (1332 - 21 - 4)	Lungs, pleura, peritoneum	Production of insulating and filtering materials, textiles
Gasoline (71 - 43 - 2)	Hematopoietic system (Leukemia)	Production of solvents, fuels
Benzidine (92 - 87 - 5)	Bladder	Production of paints, laboratory reagents
Beryllium (7440-41-7) and its compounds	Lungs	Aerospace and metallurgy
Dichloromethyl (542 - 88 11		
)	Lungs	Production of chemical intermediate by-product
Technical chloromethyl methyl ether (107 - 30 - 2)	Lungs	Production of chemical intermediate by-product
Cadmium (7440-43-9) and its components	Lungs	Paint production
Chromium (VI) components	Nasal cavity, lungs	Electroplating, painting production
Coal tar (65996-93-2)	Skin, lungs, bladder	Production of building materials, electrodes
Coal tar (8007-45-2)	Skin, lungs	Fuel production
Ethylene oxide (75 - 21 - 8)	Hematopoietic system (Leukemia)	Production of chemical intermediate by-product sterilization
Mineral oils: unprocessed and lightly processed	Leather	Production of lubricants
2 - naphthylamine (91 - 59 -		
8)	Bladder	Dyeing production
Components of Nickel	Nasal cavity, lungs	Metallurgy, alloys
Shale oil (68308 - 34 - 9)	Leather	Production of lubricants and fuels
Soot	Skin, lungs	Production of dyes

Talc asbestos-forming compounds fiber	Lungs	Production of paper and paints
Vinyl chloride (75 - 01 - 4)	Liver, lungs, blood vessels	Production of plastics, monomers
Wood dust	Nasal cavity	Woodworking industry

In addition, 20 agents are classified as probably carcinogenic to humans (Group 2A). These include substances that are currently common in many countries, such as crystalline silica, formaldehyde and 1,3-butadiene.
Carcinogenic chemicals, groups of chemicals or mixtures related to the occupational environment, pesticides and drugs:

Group 2A: Probable Carcinogen to Humans

Carcinogens	Probable target organs in humans	Main industry of application
Acrylonitrile (107 - 13 - 1)	Lungs, prostate, lymphatic tissue	Production of plastics, rubber, textiles, monomers
Petrol based dyes		Production of paper, textile paints, paints
1,3 - butadione (106 - 99 -0)	Hematopoietic system (Leukemia, lymphoma)	Production of plastics, rubber, monomers
p - Chloro - o - luidine (95 - 69 - 2)	Bladder	Dyeing and textile production
Cresote (8001 - 58 - 9)	Leather	Wood impregnation
Diethyl sulfate (64 - 67 - 5)		Intermediate chemical production
Diethylcaryomethyl chloride (79 - 44 - 7)		Intermediate chemical production
Diethyl sulfate (77 - 78 - 1)		Intermediate chemical production
Ethylchloroiridine (106 - 89 - 8)		Production of plastics, synthetic resins, monomers
Ethylene dibromide (106 - 93 - 4)		Intermediate chemical production in fuel production
Formaldehyde (50 - 0 - 0)	Nasopharynx	Production of plastics, textiles, laboratory reagents
4,4' - methylene - two - 2 - chloraniline (MOCA) (101 - 14 - 4)	Bladder	Rubber industry
Tolychlorinate biphenyl (1336 - 36 - 3)	Liver, bile ducts, hematopoietic system	Production of electrical components
	(leukemia, lymphoma)	
Crystalline silicon (14808- 60-7)	Lungs	Mining, glass and paper production
Styrene oxide (96 - 09 - 3)		Plastics production, intermediate chemical production
Tetrachlorethylene (127 - 18 - 4)	Esophagus, lymphoma	Solvent production, dry cleaning
Triz (2,3-dibromopropyl phosphate) (126 - 72 - 7)		Production of plastics, textiles, flame retardants
Trichloroethylene (79 - 01 - 6)	Liver, hematopoietic system (lymphomas)	Metal production, solvents, dry cleaning
Vinyl bromide (593-60-02)		Production of plastics, textiles, monomers
Vinyl fluoride (75 - 02 - 5)		Intermediate chemical production

A large number of agents are classified as possibly carcinogenic, such as acetaldehyde, dichloromethane, and inorganic lead compounds. Evidence of carcinogenicity for most of these substances comes from animal studies.

The IARC monograph programme covers most of the known or suspected causes of cancer. However, there are several important groups of agents that have not been reviewed by IARC, most notably ionising radiation, electric fields and magnetic fields.

Industries and Professions

Current knowledge of the relationship between occupational exposure and cancer is far from complete. In fact, only 22 agents are known occupational carcinogens. For many experimental carcinogens, there is no clear evidence from human exposure studies. In many cases, there is ample evidence of increased risk associated with certain industries and occupations, although specific agents cannot be identified as the etiologic factor. The following tables list industries and occupations associated with increased carcinogenic risk, together with the corresponding cancer sites and known (or suspected) causative agents. Industries, occupations, and environmental factors posing a carcinogenic risk:

Industries	Profession/production	Cancer location/type	The established or causal agent
Agriculture, forestry and fisheries	Vineyard workers using arsenic insecticides Fishermen	Lungs, skin Skin, lips	Arsenic compounds Ultraviolet irradiation
Mining and quarrying	Arsenic mining Iron ore mining Asbestos mining Uranium mining Talc mining and crushing	Lungs, skin Lungs Lungs, mesothelioma of the pleura and peritoneum Lungs Lungs	Arsenic mixtures Radon decay products Asbestos Radon decay products Talc containing asbestiform fibers
Chemical	Production of 2 (chloromethyl) ether (BCME) and chloromethyl - methyl ether (CMME) (workers and users) Production of vinyl chloride Isopropyl alcohol production (strong acid process) Production of pigments of chromic acid salts Dye production and users Gold nitrogen production p-chloro-o- toluidine production	Lungs (small cell carcinoma) Angiosarcom a of the liver Paranasal sinuses Lungs, paranasal sinuses Urinary bladder Urinary bladder Urinary bladder	BCME, CMME Monomer vinyl chloride Not established Chromium compounds Benzidine, 2-naphthylamine, 4- aminobiphenyl Auramine and other aromatic amines used in the process of p-chlorotoluidine and its strongly acidic salts
Leather production	Footwear industry	Paranasal sinuses, leukemia	Leather dust, gasoline
Woodworking	Production of fittings and office furniture	Paranasal sinuses	Wood dust
Production of pesticides and herbicides	Production and packaging of arsenic insecticides	Lungs	Arsenic mixture
Rubber industry	Rubber production Calendering, vulcanization, tire production Rubber crumb and mixtures Synthetic latex products, vulcanization, calendering, regeneration, cable production, rubber film production	Leukemia, Bladder Leukemia Bladder Leuke mia	Gasoline, aromatic amines Gasoline Aromatic amines Gasoline
Asbestos production	Production of insulating materials (pipes, protective lining, textiles, fabrics, masks, asbestos cement products)	Lungs, mesothelioma of the pleura and peritoneum	Asbestos
Metallurgy	Aluminium production Copper smelting Chromate production, chromium mining Iron and steel smelting Nickel purification Etching Cadmium production and purification, nickel-cadmium batteries, cadmium alloy, electroplating, zinc smelting, soldering and PVC compounds Beryllium processing and purification, production of beryllium -containing products.	Lungs, bladder Lungs Lungs, paranasal sinuses Lungs Lungs, paranasal sinuses Larynx , lungs Lungs Lungs	Molycyclic aromatic hydrocarbons, tar Arsenic mixtures Chromium compounds Not identified Nickel mixtures Inorganic acid vapors containing sulfurous acid Cadmium and its compounds Beryllium and its compounds
Shipbuilding, motor building and production of railway equipment	Workers in ports, docks, engine-building and railway industries	Lungs, mesothelioma of the pleura and peritoneum	Asbestos
Gas industry	Coke plant workers Gas workers Gas boiler workers	Lungs Lungs, bladder, Scrotum Bladd er	Benzopyrene Coal roasting products, 2- naphthylamine Aromatic amines
Construction	Insulators Roofers, asphalt workers	Lungs, mesothelioma of the pleura and peritoneum Lungs	Asbestos Polycyclic aromatic hydrocarbons
Other	Medical personnel (9331) Painters (construction, automotive industry, etc.)	Skin, Leukemia Lungs	Ionizing radiation Not established

Industries, occupations and environmental factors associated with increased carcinogenicity but for which the risk assessment has not been definitively determined

Industries	Profession/Productio n	Cancer location/type	Established or possible causal agent
Agriculture, forestry and fisheries	Farmers Use of herbicides Use of insecticides	Lymphatic and hematopoietic systems (leukemia, lymphoma) Malignant lymphomas, soft tissue sarcomas Lungs, lymphoma	Not established Chlorophenoxy herbicides, chlorophenols (probably mixed with polychlorinated dibenzodioxins) Non-arsenic insecticides
Mining production	Zinc and lead mining Coal mining Metal production Asbestos business	Lungs Stomach Lungs Gastrointestin al tract	Radon decay products Coal dust Crystalline silica Asbestos
Food industry	Butchers	Lungs	Viruses, polycyclic aromatic hydrocarbons
Beverage production	Beer brewers	Upper respiratory and digestive systems	Beer consumption
Textile industry	Dyers of the Weaver	Urinary bladder, paranasal sinuses, mouth	Paints Dust from fibers and yarns
Tannery	Tanners and processors Footwear industry and shoe repair	Bladder, pancreas, lungs Paranasal sinuses, stomach, bladder	Leather dust, other chemicals, chrome Not established
Woodworkin g, papermaking and newspaper industry	Woodcutters and sawmill workers Paper mill workers Carpenters, joiners Woodworking workers Plywood and chipboard production	Nasal cavity Lymphopoietic tissue, lungs Nasal cavity, Hodgkin's lymphoma Lymphomas Nasopharynx, paranasal sinuses	Wood dust, chlorophenols, creosote Not establishedWood dust, solvents Not established Formaldehyde
Printing	Workers in rotogravure, bookbinding, printing and other industries	Lymphatic and hematopoietic systems, oral cavity, lungs, kidneys	Oil suspensions, solvents
Chemicals	1.3 Butadiene products Acrylonitrile production Vinylidene chloride production Isopropyl alcohol production (strong acid process) Polychloroprene production Dimethyl sulfate production Ethylene chlorohydrin production Ethylene oxide production Ethylene dibromide production Formaldehyde production Flame retardant and plasticizer use Benzene chloride production	Lymphatic and hematopoietic systems Lungs, large intestine Lungs Pharynx Lungs Lungs Lungs, lymphatic and hematopoietic systems Lymphatic and hematopoietic systems, stomach Digestive system Nasopharynx, paranasal sinuses Skin (melanoma) Lungs	1,3-Butadione Acrylonitrile Vinylidene chloride (mixed with acrylonitrile) Not established Chloroprene Dimethyl sulfate Epichlorohydrin Ethylene oxide Ethylene dibromide Formaldehyde Polychlorinated Buphenyls Benzene chloride
Herbicide production	Production of chlorophenoxy herbicide	Soft tissue sarcoma	Chlorophenoxy herbicides, chlorophenols (mixed with polychlorinated dibenzodioxins)
Oil industry	Oil refining	Skin, leukemia, brain	Gasoline, polycyclic aromatic hydrocarbon, unrefined and poorly refined mineral oils
Rubber production	Various professions in rubber production Styrone-butadione rubber production	Lymphoma, multiple myeloma, stomach, brain, lungs Lymphatic and hematopoietic systems	Gasoline, 4,4- methylene-two-chloroaniline, other not identified 1,3-Butadione
Production of ceramics, glass and firebricks	Ceramics manufacturing Glass workers (production of art glass and pressed products)	Lungs Lungs	Crystalline silicon Arsenic and other metallic oxides, silicon, polycyclic aromatic hydrocarbon
Asbestos production	Production of insulating materials (pipes, slabs, fabrics, clothing, masks, asbestos -cement products)	Pharynx, gastrointestinal tract	Asbestos

Metallurgy	Lead smelting, cadmium production and refining, nickel- cadmium batteries, cadmium paints, cadmium alloys, electroplating, zinc smelting, brazing and PVC compounds, iron and steel smelting	Respiratory and digestive systems, prostate Lungs	Lead mixtures Cadmium and its mixtures Crystalline silicon
Shipbuilding	Port and dock workers	Larynx, digestive system	Asbestos
Motor building	Production, distribution, repair	Lungs	Polycyclic aromatic hydrocarbon, welding fumes, exhaust gases
Electric power industry	Insulation Materials Manufacturing Roofers, Asphalt Workers	Leukemia, brain tumors Liver, bile ducts	Ultra-low frequency magnetic fields, polychlorinated biphenyls
Construction	Insulation Materials Manufacturing, Roofers, Asphalt Workers	Larynx, Digestive Tract Mouth, Pharynx, Larynx, Esophagus, Stomach	Asbestos Polycyclic aromatic hydrocarbon, coal tar, turpentine
Transport	Railroad workers, petrol station attendants, bus and truck drivers, excavator operators	Lungs, bladder Leukemia	Diesel Exhaust Gases Ultra Low Frequency Magnetic Fields
Other	Auto repair workers Chemists and other laboratory workers Embalmers and other medical personnel Orderlies Laundry and drycleaning workers Hairdressers Luminous dial makers	Leukemia and lymphoma Leukemia and lymphoma, pancreas Paranasal sinuses, nasopharynx Liver Lungs, esophagus, bladder Bladder leukemia and lymphoma Breast	Gasoline Not established (viruses, chemicals) Formaldehyde Hepatitis B virus Tri- and tetrachloroethylen e and carbon tetrachloride Hair dyes, aromatic amines Radon

The compilation and interpretation of such lists of chemical and physical agents, and the identification of their connections with specific professions and industries, is complicated by a number of factors:

- Information on production processes and the external environment is often insufficient and does not allow a full assessment of the importance of specific carcinogenic factors for various industries or professions
- Exposure to well-known carcinogens such as vinyl chloride and gasoline occurs at different intensities in different situations;
- Over time, changes occur in the external occupational carcinogenic environment, either because established carcinogenic agents are replaced by others or (more often) because new processes or materials are used
- Any list of occupational factors relates only to a small number of chemicals that have been studied for their carcinogenicity. All the above cases reflect the most obvious shortcomings of this type of classification, especially its generalizing nature for all possible cases, the presence of carcinogenic factors in an occupational situation does not necessarily mean that workers are exposed to them and vice versa, the absence of established carcinogens does not exclude the presence of still unknown factors of cancer occurrence.

Prevention of Carcinogenic Hazards in Production

The regulatory legal document defining the carcinogenic hazard to humans of chemical (excluding radioactive isotopes), physical and biological factors of the environment, as well as production processes, are the sanitary rules SP 2.2.3670-20 “Sanitary and Epidemiological Requirements for Working Conditions” in force since January 1, 2021. Their main goal is to establish mandatory requirements for ensuring safe working conditions for humans. Appendix 2 to SP 2.2.3670-20 specifies factors of the production environment and production processes that have carcinogenic properties.

In pursuance of SP 2.2.3670-20, legal entities and individual entrepreneurs are required to carry out industrial control over working conditions, develop and implement sanitary and anti-epidemic (preventive) measures, and ensure that factors of the production environment and the work process comply with hygienic standards. The nomenclature, scope, and frequency of industrial control measures over working conditions are determined in the industrial control program, taking into account the characteristics of production processes and technological equipment, the presence of harmful production factors, and the degree of their impact on the health of the worker and his or her living environment.

It is mandatory to include in the program information on the presence of factors in the production environment and work processes that have carcinogenic properties, the number of people in direct contact with these substances, and those employed in the relevant technological processes (total and women separately), indicating their professions.

In order to prevent the harmful effects of factors of the production environment and the work process on the health of the worker, it is mandatory to develop and implement preventive measures, including technological and technical measures, organizational, therapeutic and preventive nutrition, and the use of personal protective equipment. The main measure is to eliminate the possibility of human contact with carcinogenic factors in the production sphere.

It is extremely important when developing and implementing technological and technical measures to eliminate, prevent or reduce the danger at the source of formation and spread of industrial carcinogenic factors by changing the production process, using mechanization and automation of technological processes, remote and automatic control means, personal and collective protective equipment, etc. Organizational measures should ensure a reduction in the time of adverse impact of carcinogenic factors in the production environment on the worker.

The Possibility of Eliminating Carcinogenic Factors or Reducing the Harmful Impact on the Health of Production Workers

Where to start? How to protect workers from the harmful effects of carcinogens?

Questions that workers involved in developing occupational safety standards in manufacturing facilities often face.

It is important to understand that the main goal of carcinogenic control is to reduce the level of occupational cancer morbidity in production. First, you need to understand what risk factors are present specifically at your enterprise. Analysis of production for the presence of carcinogens. As a rule, it is necessary to start analyzing production for the presence of carcinogenic factors With detection supposed risks:

- Having carefully studied the WHO list of officially registered carcinogens, make sure that raw materials, auxiliary components, emissions during the production process, containers, and finished products do not contain them, having requested the relevant certificates from suppliers of raw materials and equipment.
- Or by conducting a laboratory analysis of all components of the production scheme, to identify which components contain CF.
- The most convenient way to check is to certify the production for the absence of carcinogens with the help of a specialized registered company that:
- Develop internal procedures for certification of products and services based on the requirements of the certification system
- Carry out certification of products and services:
- Accept applications, register them, make decisions on applications, conduct an examination of documents and analysis of production, make decisions on the possibility of issuing certificates of conformity, permission to use the conformity mark, decisions on refusal to issue a certificate of conformity, issue certificates of conformity;
- Issue certificates, keep records of them and report in the form adopted in the certification system;
- Carry out inspection control over certified products and services, confirm, suspend, and cancel the validity of the certificates of conformity issued by them;
- Interact with other participants in the certification system;
- Create conditions for conducting inspection control;
- Develop corrective actions for non-conformities in inspection control;

Thus, the manufacturing company receives not only a full analysis of the production, but also a certificate of compliance with the standard for the absence of carcinogens, if none are detected.

Elimination of Carcinogenic Factors

If carcinogens are detected in production, it is necessary to consider the possibility of eliminating or replacing components or processes containing carcinogenic factors.

Having assessed all factors of the production environment and work processes that have carcinogenic properties, it is necessary to take the following measures:

- Change in the production process;
- Refusal to carry out an operation characterized by the presence of harmful and hazardous production factors;
- Replacement of raw materials with less dangerous ones or those that do not contain carcinogenic components at all.

The main measure is to eliminate the possibility of human contact with carcinogenic factors in the production sphere. It is extremely important when developing and implementing technological and technical measures to eliminate, prevent or reduce the danger at the source of formation and spread of industrial carcinogenic factors by changing the production process, using mechanization and automation of technological processes, remote and automatic control means, means of individual and collective protection, etc.

Minimizing the Harmful Effects of Carcinogenic Factors

In cases where it is impossible to replace carcinogenic raw materials due to production needs, the following actions will help to minimize their impact on workers:

- Mechanization and automation of processes to minimize contact with carcinogens, retraining of workers as operators of production equipment with remote control;
- Means of control over the organization of the technological process, including remote and automatic ones;
- Measures to reduce the level of impact of factors of the production environment and the work process;
- The use of collective and individual protective equipment aimed at shielding and isolating workers, including properly selected PPE (personal protective equipment);
- The use of emergency shutdown systems for production processes to prevent adverse consequences;
- Selection and use of work equipment in order to reduce the impact of factors of the production environment and the work process, including the organization of proper ventilation in production facilities.
- Also, to reduce the effects of exposure to carcinogenic factors on workers, the following measures should be organized:
- Continuous training of employees in work standards at an enterprise with carcinogenic factors;
- Constant monitoring of employees to ensure they know the standards for working at an enterprise with carcinogenic factors;
- Organization of the work schedule in shifts, based on the standards of exposure to carcinogenic factors;
- Organization of therapeutic and prophylactic oncoprotective nutrition for all employees of the enterprise;
- Introduction of standards for medical examinations and admission of workers to workplaces;
- Control and recording of morbidity in production;

Workers at manufacturing enterprises who are regularly exposed to carcinogenic factors should be given the opportunity to rest in health resorts and should also be provided with special oncoprotective nutrition on a regular basis, which reduces the possibility of the consequences of exposure to carcinogenic factors, with recommendations for taking it outside of working hours.

Conclusion

Occupational cancer results from exposure to carcinogens in the workplace. Early detection of occupational cancer is difficult, mainly due to the latent period, which can be up to 20 years or more. For this reason, it is important to develop and improve methods for early detection of precancerous changes. Medical surveillance and prevention, as well as legislation, are needed to reduce the incidence and mortality of occupational cancer.

Occupational cancer is largely a preventable disease.

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