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Evaluation of Toxicological Threat to Health Caused by Some Carcinogenic Factors in the Working Environment of an Industrial Plant

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Abstract

This study was carried out in a car factory at workplaces in various states of activity. The measurements of substances enlisted as carcinogenic found at workplaces in some departments in 1995-1997 was carried out as well as the evaluation of microclimatic conditions and the evaluation of sick absenteism in the whole factory. Analysis of results revealed that microclimates in the rooms in the studied departments did not exceed permissible hygienic standards, except for some workplaces in the suspension springs department and the tool room. The analysis of exposure to particular/specific factors in 1995-1997 enlisted among carcinogenic substances did not reveal any toxicological health hazard. Sick absenteism in the whole factory and studied departments in the analyzed period varied. The prevailing group of diseases were diseases of the respiratory system. Morbidity from cancer was low.

Keywords: working environment, carcinogenic factors.

Introduction

Working environments may pose a substantial threat to maitaining intra-systemic homeostasis due to unfavourable effects of different harmful factors participating in the production process. Complex character of exposure prevails in all types of toxicological threats caused by working environments. Type, dynamics and the mechanism of inducing toxicological interactions determines the power and character of the effects of exposure. During the process of work an employee is exposed to a variety of physical and chemical factors. Physical factors of the working environment are formed by microclimate in halls, noise, lighting, pollution. Interaction of different toxic substances may take place among the working population exposed to various chemical substances and some chemical substances under specific conditions may induce cancer, especially when two types of factors: carcinogens and promotors coexist with them. Carcinogenic changes may be revealed many years after exposure to toxic substances and latency phase may be very long.

Mechanisms of developing cancer induced by chemical compounds have not been fully explained, but it has been proven that these processes are long and complicated. It is considered that at least 3 basic stages: initiation, promotion and progression should be present so that exposure to chemical compounds may result in the development of cancer.

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The increase in the morbidity and mortality from cancer in the population with occupational exposure to carcinogenic chemicals is related to the carcinogenic properties of these substances and the time of exposure. Epidemiological studies suggest the decrease in death in exposed population when the time of exposure and the concentration of carcinogens in the working environment decreases [3, 4, 9, 11, 16].

The aim of this study is the evaluation of exposure of employees in some departments of a car factory to carcinogenic factors and the analysis of sickness absenteism in studied departments in relation to total absenteism.

Materials and Methods

The study was carried out in a car factory at workplaces at different levels of activity. Concentration of substances enlisted as carcinogenic compounds found in chosen departments in 1995-1997 was measured and the evaluation of microclimatic conditions was carried out.

Measurements were taken in the following workplaces: department of standardized machine elements, department of machinery maintenance and transport, battery room, tool-room, foundry, assembly line and suspension spring department.

Microclimatic factors were measured using microclimate meter MM-01.

Concentration of sulphuric acid was measured with the aspirator As-50 using the turbidimetric method according to PN-91/Z-04056/02.

Concentration of benzene at workplaces was measured using aspirator A-l and nitration method according to PN-73/Z- 04033/03.

Concentration of chromium was measured using the atomic spectrophotometry according to PN--79/Z-04126/02.

Concentration of formaldehyde was measured using colorimetric method using PN-76/Z-04045/02.

Concentration of cadmium at workplaces was measured using atom-absorption spectrophotometry according to PN-85/Z-0410203.

Concentration of nickel was measured using atom-absorption spectrophotometry according to PN-85/Z--04124/02.

Evaluation of sickness absenteism of all employees and chosen departments was carried out using medical files.

Results

Results of measurements of microclimatic conditions obtained from a studied factory are presented in Table 1.

In the studied departments of standarized machine elements, tool-room, foundry, and suspension springs the values of temperature, humidity, and air circulation were within hygienic standards. The effective temperature that

Table 1. Microclimatic conditions in the rooms of particular departments of the car factory in 1996.

Department (workplace)	Operating temperature (°C)	Air humidity (%)	Speed of air movement/ circulation (m/s)	Effective temperature (°TE)
1. Standardized machine elements				
Hardening workshop				
1. measurement at the furnace line	30	50.3	0.61	26.0
2. Tool-room				
1. Hardening workshop – measurement taken during taking out large items from the furnace after hardening	43.6	46.8	0.25-0.32	33.9
2. Forge – measurement taken during taking out items from the furnace and forging	31.4	48.7	0.66	24.8
3. Foundry				
1. Melting	28.2	47.3	0.54	22.7
2. Hand moulding workshop	31.3	39.9	0.62	24.8
3. Core workshop				
I Shalco Automatic machine	29.9	39.1	0.61	24.0
II Roperwerk Automatic machine	29.5	48.6	0.41	24.0
III Furnace Level (taking out from the furnace)	32.8	44.5	0.36	26.2
4. Suspension springs				
1. New suspension springs				
I Reeling/coiling	35.3	29.85	0.56	27.7
II Heat treatment seat	33.2	27.9	0.51	24.0
III Hardening leaves of a spring (workplace)	36.8	54.6	1.17	51.6
2. Hoesch assembly line				
I Furnace for heating leaves	33.9	30.03	0.35	26.0
II Hardening workshop aves	26.55	28.2	0.415	19.5
III Leaves rolling seat	23.9	31.2	0.58	19.6
IV Seat for rolling the eye	29.7	33.7	0.60	24.0

Table 2. Rates of sick absenteism in the car factory and studied departments in the years 1995-96-97.

The years	Rates of sick absenteesm						
	Whole car factory	Standardized machine elements	Assembly line	Foundry	Tool-room	Suspension springs	Whell department
1995	3.45	2.46	3.24	4.28	2.52	3.94	3.51
1996	5.14	4.45	5.18	7.38	4.32	5.42	4.95
1997	5.12	4.02	6.94	5.84	5.13	–	4.88

is the result/measure of subjective thermic perception represented by the above-mentioned parameters was within the range of thermal comfort, except from temporary changes in the department of suspension springs and the tool-room.

Concentration of sulphuric acid in 1995 in the studied departments did not exceed accepted standards. In 1996 and 1997 the highest permissible concentration was exceeded in the Department of machinery maintenance and the battery room that were 1.22 mg/m^3 in 1996 and 1.662 mg/m^3 in 1997 at the suitable/proper value NDS-1.0 mg/m^3. The values of concentration of benzene in the studied departments did not reveal any exceedance of accepted standards; however, the standard NDS /10 mg/m^3 was once exceeded in the assembly line department at the acceptance workplace and it was 18.4 mg/m^3.

The analysis of exposure to chromium and cadmium as well as nickel and formaldehyde at workplaces did not reveal any exceedance of accepted standards.

The picture of sick absenteism is presented in Tab. 2 and Fig. 1. The lowest rates of total absenteism in the factory were observed in 1995, much higher in 1997 and the highest in 1996. The highest rates of sick absenteism in 1995 and 1996 were revealed in the foundry, and in 1997 in the assembly line department.

The lowest rates of sick absenteism in 1995 and 1997 were recorded in the department of standardized machine elements, and in 1996 in the tool-room.

The picture of sick absenteism in the years 1995 -1996 taking into consideration contributing diseases is presented in Tables 3 and 4.

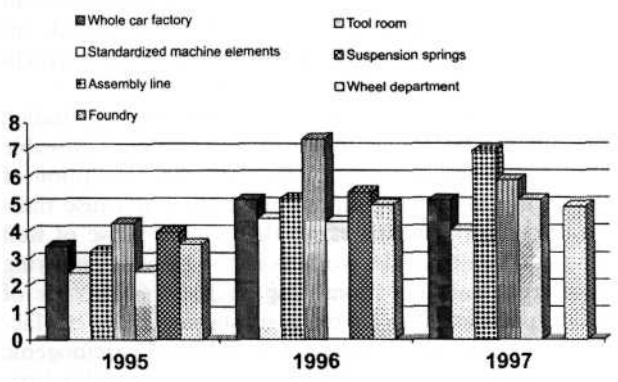

Fig. 1. Sick absenteism in the car factory and its studied departments in the years 1995-1997.

In the studied period the prevailing group of diseases in the whole factory were diseases of the respiratory system. In 1995 in second place were accidents, traumas, and non-occupational poisonings. In 1996 in third place were accidents, traumas, and occupational poisonings. In the studied departments the diseases of the respiratory tract were prevailing in 1995-1996, except the department of standardized machine elements in which accidents, traumas and non-occupational poisonings were first place in 1995. In the studied material on morbidity and morbidity rates for cancer the most common were cancer of the respiratory system, uterus and nipple, digestive system including liver and stomach. No skin cancer was observed. In 1995 the lowest absenteism rate for cancer was observed in the department of standardized machine elements, and the highest in the tool-room and wheel department. Although absenteism for cancer in the factory was low.

Discussion

The health of the working population depends on many factors. Disturbing the balance between outer environmental conditions and the natural environment in the body may result in disturbances in the work of the body systems, and sometimes even in the disease. Nowadays occupational health hazards posed by the working environment are a very important problem. It is estimated that in recent years in Poland a number of workers employed in working conditions that are hazardous to health was about 1.3 -1.5 mln [2, 8, 10, 13, 14, 15]. Long lasting exposure to some chemical substances may induce uncontrolled growth of cells resulting in cancer. These harmful changes may reveal after many years from the time of first exposure to these substances and the period of latency may be from 4 to 40 years. The problem of chemical environmental carcinogens is not limited only to exposure to particular chemical substances in the human environment. It is so complex that instead of the evaluation of the risk due to exposure to particular substances it would be better to evaluate the risk resulting from a cumulative effect of many various factors.

Many chemical substances reveal genetic toxicity causing different types of damage to the genetic material in procariotic and eucariotic organisms, including the human body. Transformation of normal cells into cancerous cells may be induced by a variety of highly differentiated chemical and physical factors [4, 9, 12, 17].

One of the most difficult problems in the evaluation

Table 3. Diseases prevailing for absenteism in the car factory and its studied departments in 1995.

No	Name of disease	Foundry	Assembly line	Tool room	Standardized machine elements	Wheel department	Suspension springs	Whole car factory
1	Diseases of the respiratory system including severe diseases of the respiratory system	0.92 0.69	0.65 0.44	1.68 1.59	0.48 0.30	1.07 0.38	0.99 0.58	0.87 0.69
2	Cardiovascular diseases. including hypertension	0.65 0.31	0.55 0.27	0.84 0.53	0.55 0.39	0.26 0.18	0.56 0.37	0.57 0.29
3	Diseases of the digestive system including ulcer	0.59 0.28	0.25 0.12	0.96 0.59	0.33 0.25	0.33 0.18	0.22 0.11	0.40 0.19
4	Accidents, traumas and occupational poisoning	0.24	0.14	0.49	0.17	0.34	0.11	0.59
5	Accidents, traumas non-occupational poisoning	0.81	0.44	1.20	0.77	0.76	0.66	0.85
6	Cancer	0.02	0.03	0.05	0.01	0.05	–	0.03

Table 4. Diseases prevailing for absenteism in the car factory and its studied departments in 1996.

No	Name of disease	Foundry	Assembly line	Tool room	Standardized machine elements	Wheel department	Suspension springs	Whole car factory
1	Diseases of the respiratory system including severe diseases of the respiratory system	1.70 0.91	1.82 1.13	1.05 0.60	–	–	–	1.42 1.14
2	Cardiovascular diseases. including hypertension	1.06 0.52	1.13 0.45	0.77 0.32	–	–	–	0.30 0.11
3	Diseases of the digestive system including ulcer	0.40 0.28	0.35 0.20	0.56 0.24	–	–	–	0.33 0.17
4	Accidents, traumas and occupational poisoning	1.10	0.83	0.37	–	–	–	0.59
5	Accidents, traumas non-occupational poisoning	0.68	0.56	0.31	–	–	–	0.34

of risk in occupational toxicology is determining the results of the adverse effect of many carcinogenic substances. Some metals (cadmium, chromium, nickel), and organic solvents (including benzene and many others) are often mentioned among many other carcinogenic chemical substances found in the working environment. Me Michael et al. examined 6000 men employed in a rubber factory for 9 years. Workers exposed to benzene developed leukemia 7 times more often than non-exposed workers. Older workers age 40-64 developed leukemia 3 times more often than younger workers [5, 6]. Krol et al. studied the exposure of workers in a non-ferrous metal plant in the area of Gorny Slask (Upper Silesia) to metals (nickel, chromium, arsen) and revealed several new cases of disease due to exposure to nickel in a population of 10,000 [3].

A great threat to health is cadmium, a heavy metal, because of its cumulative effects. Cumulation of cadmium may be harmful to body metabolism and may result in biochemical and structural changes [11]. Miarzynska M. carried out a study on workers of electrochemical plant who were exposed to cadmium in concentrations exceeding NDS and found chronic rhinitis in 20 out of 73 studied patients and atrophic changes in 5 patients [7].

Physical factors found in the workplace play a considerable role in the evaluation of environmental conditions. Health hazards due to chemical compounds increase in changing climatic conditions and a hot microclimate is found to be especially unfavourable.

The evaluation of microclimatic conditions in studied departments did not reveal the exceedance of permissible standards in the last years. However, the perception of heat in the effective temperature scale may cause thermal discomfort and influence the general sense of well being and health of the workers in the suspension spring department and tool-room. The analysis of exposure of studied population to chemical substances in this car factory in relation to the exposure to enlisted carcinogenic substances in the studied period did not reveal a toxicological threat. The obtained values for the concentration of benzene, chromium, cadmium nickel and

formaldehyde at specific/particular workplaces of the studied department are within permissible hygienic standards, but the exposure to sulphuric acid only once exceeded the highest permissible concentration at the workplace battery room in the department of machinery maintenance.

Morbidity for cancer among the population of the car factory was low in the analyzed period of time. Szeszenia-Dabrowska N. et al. analyzed morbidity for malignant cancer that was recognized as an occupational disease in Poland in 1971-1994. There were 1118 cases of occupational cancer in this period, of which 1042 (93.2%) were diagnosed in men. A considerable increase in occupational cancer, mainly among men, was observed after 1987 [16].

The problem of occupational carcinogenesis, its prevention, diagnosis and recognizing the occupational origin of cancer was started in the 80s. Taking into consideration the development of heavy industry, mining and many other branches of industry that introduce/induce the spread of carcinogenic factors in the workplace it seems necessary to develop a system of finding and diagnosing malignant cancer of occupational origin by determining the causative factor and the evaluation of exposure.

An analysis of absenteism contributes to optimizing the working environment despite the fact that hygienic standards were not exceeded. After analyzing of absenteism in the car factory it was found that the rates of absenteism vary. The highest values were revealed in the foundry and the lowest in the standardized machine elements department. The prevailing cause of sick absenteism in the analyzed period were diseases of the respiratory system.

The work itself and working environment influence the health of working population to a high degree. Creating healthy and proper working conditions is a very important form of prophylaxis. To prevent occupational cancer it is very important to make workers consciously follow safety regulations at the workplace and have regular checkups. The most effective function of occupational medicine is controlling the effect of environmental mutagenes by cytogenetic tests that enable us to obtain results well correlated with the frequency of occurence of cancer the among the working population.

Conclusions

1. Microclimate in the rooms/halls in the studied de partments of the car factory did not differ from hygienic standards except for some workplaces at the suspension spring department and tool room.

2. The evaluation of exposure of the studied working population to certain risk factors enlisted among carcinogenous substances revealed no toxicological health haz ard in 1995-1997.

3. In the analyzed period sickness absenteism in the whole factory and studied departments varied.

4. The prevailing group of diseases in the car factory were diseases of the respiratory system.

5. Morbidity rate for cancer among the working population of the factory was iow during the analyzed period.

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