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INFLUENCE OF WORKING CONDITIONS ON THE STATE OF HEALTH AND LABORATORY INDICATORS OF EMPLOYEES WHEN PERFORMING WELDING WORKS

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ABSTRACT. Currently, the profession of a welder is one of the most sought after in various industries. The purpose of the work is to analyze working conditions, health indicators and determine the significance of laboratory tests regulated as part of periodic medical examinations for the timely diagnosis of changes in the health status of electric and gas welders working and living on the territory of the Republic of Bashkortostan. A clinical and diagnostic examination of workers — electric and gas welders working at the enterprises of the republic was carried out. The influence of harmful production factors is considered: chemical, physical and the severity of the labor process. Diseases of the musculoskeletal and nervous systems, diseases of the circulatory system, respiratory organs, and sensorineural hearing loss with signs of noise exposure were identified. Reliable changes in laboratory parameters were diagnosed depending on the length of service and the duration of contact with production factors. It is necessary to carry out dispensary observation of this category of workers with the development and justification of individual medical and preventive measures.

KEY WORDS: working conditions; electric and gas welder; differential diagnosis.

ВЛИЯНИЕ УСЛОВИЙ ТРУДА НА СОСТОЯНИЕ ЗДОРОВЬЯ И ЛАБОРАТОРНЫЕ ПОКАЗАТЕЛИ РАБОТНИКОВ ПРИ ВЫПОЛНЕНИИ СВАРОЧНЫХ РАБОТ

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РЕЗЮМЕ. В настоящее время профессия сварщика является одной из самых востребованных в различных отраслях промышленности. Цель работы — проанализировать условия труда, показатели здоровья и определить значимость лабораторных исследований, регламентированных в рамках периодических медицинских осмотров для своевременной диагностики изменений в состоянии здоровья электрогазосварщиков, работающих и проживающих на территории Республики Башкортостан. Проведено клинико-диагностическое обследование работников-электрогазосварщиков, работающих на предприятиях республики. Рассмотрено влияние вредных производственных факторов: химического, физического и тяжести трудового процесса. Выявлены заболевания костно-мышечной и нервной систем, болезни системы кровообращения, органов дыхания и нейросенсорная тугоухость с признаками воздействия шума. Диагностированы достоверные изменения лабораторных показателей в зависимости от стажа работы и длительности контакта с производственными факторами. Необходимо проведение диспансерного наблюдения данной категории рабочих с разработкой и обоснованием индивидуальных медико-профилактических мероприятий.

КЛЮЧЕВЫЕ СЛОВА: условия труда; электрогазосварщик; дифференциальная диагностика.

INTRODUCTION

The Republic of Bashkortostan is one of the largest industrial regions of the Russian Federation. Almost all types of production activities require the involvement of specialists to perform electric and gas welding works — electric and gas welders.

The technological process of electric and gas welding refers to operations with harmful working conditions. Workplaces of electric and gas welders are one of the most unfavorable in terms of the risk of professional diseases [17, 26].

In the course of a labor activity, an electric and gas welder is exposed to a whole complex of dangerous and harmful production factors of physical and chemical nature: radiation, welding aerosol, sparks and splashes of metal and slag, industrial noise, etc. [9, 11, 19, 21].

Industrial aerosols traditionally occupy the leading place among unfavorable factors of the industrial environment for electric and gas welders. Welding aerosol has a combined effect on the body, since harmful substances damage the body by different mechanisms — from fibrogenic and general toxic to allergenic and carcinogenic ones. Thus, it contribute to the formation professional respiratory diseases [10, 30].

Hemogram is the most frequently used clinical blood test to assess the state of health and early diagnosis of changes [3, 15], due to the high lability and rapid reaction of the hematopoietic system to various effects of harmful industrial factors, especially those of chemical etiology. Some of the chemical substances contained in aerosols cause changes in hematopoiesis, others disrupt the synthesis of porphyrin and heme in hemoglobin, while others cause changes in hemoglobin composition and hemolysis [2, 12, 14, 18, 22, 27, 29].

AIM

To determine the significance of laboratory tests, regulated within the framework of perio-

dic medical checkups, for timely diagnostics of changes in the state of health of electric and gas welders working in the territory of the Republic of Bashkortostan.

MATERIALS AND METHODS

According to the Order of the Ministry of Health of the Russian Federation from 28.01.2021 No. 29n and Appendix to the Order of mandatory preliminary and periodic medical checkups of workers, provided by part four of article 213 of the Labor Code of the Russian Federation, a clinical and diagnostic examination of electric and gas welders (225 people) working at the enterprises of the Republic of Bashkortostan in the presence of aerosols of predominantly fibrogenic action (APFD), representing a complex mixture of multidirectional action, was carried out.

All examined workers were men aged from 47,16 to 48,34 years, with an average total length of service of 23,66±0,66 years.

Hematologic and biochemical methods of research were used in the survey, according to generally accepted methods [20]. The results of the studies were processed using the STATISTICA 6.0, a statistical analysis software package, mean values, Student's coefficient (t) and significance level (p) were determined. Age determinacy of health disorders was assessed using correlation coefficient (r) and non-parametric χ^2 criterion.

RESULTS AND DISCUSSION

According to the results of the special assessment of working conditions (SAWC) of electric and gas welders, the leading harmful and hazardous factor is a chemical one, represented by substances of the 1–4th class of hazard, which influence the organism in different ways. Welding aerosols constitute a complex mixture of mainly fibrogenic action (amorphous silicon dioxide in a mixture with manganese oxides in the form of condensation aerosol, digelesotrioxide, tungsten, aluminum and its compounds) and chemical substances of different nature, including manganese, zinc, chromium (VI), chromium (III), beryllium, nickel, chromium trifluoride, gases, which have an acute effect on the body. The work of an electric and gas welder is associated with the use of flammable and explosive materials. This occupational group of workers is characterized by a combination of priority factors of working environment and labor process: the chemical factor (class 3.1) noise (class 3.1) and severity of labor process (class 3.1) (Table 1).

The conducted analysis of incidence of general non-infectious morbidity allowed to establish that the first rank is occupied by diseases of the musculoskeletal system (MS). This pathology was detected in 51.56% of the surveyed. Next are diseases of the circulatory system, represented by hypertension and, they are detected in 28.2% of electric and gas welders. Diseases of the nervous system are represented by disorders of the vegetative nervous system — 24.89%. Neurosensory hearing loss and signs of noise exposure amounted to 21.33% of all examined persons.

Low detection rate of respiratory diseases is noteworthy — 1.33% of all the examined workers. Obviously, this is due to the fact that workers do not always provide a doctor with reliable information about their health status when undergoing periodic medical examinations in order to maintain admission to work in harmful and (or) hazardous working conditions. In addition, a lack of caution among specialists conducting these check-ups also contribute to the low detection [1, 4, 23, 28]. Laboratory tests

Table 1

Classification of working conditions for gas welders according to the degree of harmfulness and danger

Таблица 1

Классификация условий труда газосварщиков по степени вредности и опасности

Оценка факторов по критериям Р.2.2.2006-05 / Evaluation of factors according to criteria P.2.2.2006-05				Общая оценка условий труда / General assessment of working conditions
Вредный фактор / Harmful factor	Химический / Chemical	Физический / Physical	Тяжесть труда / Burden of labor	
Электрогазосварщики / Electric and gas welders	3.1	3.1	3.1	3.2

prescribed for medical checkups have an important diagnostic value and allow to give an initial assessment of a general condition, especially for workers exposed to harmful production factors.

Hematological studies have shown that all the examined workers exposed to welding aerosols have normel reference values of a general blood analysis (erythrocytes, hemoglobin, leukocytes and platelets). Except for the "allergenization index" (AI), the average value of which was 1.45±0.03.

Comparative analysis of changes in blood test showed that increased hemoglobin values (more than 160 g/l) were observed in 23.56% of men. Hematocrit changes were detected in 23.11% of the examined patients. Erythrocytosis is found in 16.00% of the examined, which indicates the activation of erythropoiesis. An increase in erythrocyte parameters (MCV) was found in 19.11% of workers and in 27.56% — hemoglobin content in individual erythrocyte (MCH). The findings revealed that a minority of individuals were found to have thrombocytosis. Eosinophilic granulocytes above 5% were diagnosed in 54.22% of electric and gas welders (Table 2).

The results of studies obtained in workers with different length of service are presented in Table 3. Thus, in the group of workers with 11–20 years of experience, the highest indices of erythrocytes, hemoglobin and hematocrit were found compared to similar indices of workers with 0 to 10 years of experience. In parallel with erythrocytosis and high hemoglobin levels, there was a tendency for erythrocyte indices to increase. Constant inhalation of chemical substances in production conditions probably contributes to the phenomena of hypoxia, which may explain the shifts in hematologic indices. Similar researches were conducted [16, 25].

In the available scientific literature there is a few contradictory works devoted to the effect of aerosols of mainly fibrogenic nature which influence on the erythrocytic growth of hematopoiesis of electric and gas welders as the length of work experience increases [11, 13].

To assess the reliability of the results obtained with regard to red blood parameters, we used the χ^2 criterion. Reliability was found for MCV χ^2=5.09 (p <0.001), MCH χ^2=8.84 (p <0.001).

The correlation between hematologic indices and the duration of contact with harmful industrial factors in the examined men was established (r=0.97–0.99). During the years of professional activity the number of workers with eosinophilia and allergy index increases, the correlation reaches high values (r=0.97–0.99). Increase in the number of eosinophilic granulocytes and gradual increase in their clinical frequency confirms the

Table 2

The frequency of deviations of hematological parameters in workers (%)

Таблица 2

Частота отклонений гематологических показателей у работников (%)

Направление отклонения показателей / Deflection direction indicators	**Электрогазосварщики (ср. общий стаж 47,75±0,59 / Electric and gas welders (average seniority 47,75±0,59) n=225**
Гемоглобин >160 г/л / Hemoglobin >l60 g/l	23,56
Эритроциты >5,5×10^{12}/л / Erythrocytes 10^{12}/l	16,00
Гематокрит >48% / Hematocrit >48%	23,11
MCV >95 фл	19,11
MCH >31 фл	27,56
Лейкоциты >9,0×10^9/л / Leukocytes >9,0×10^9/l	18,22
Эозинофилы >5% / Eosinophils >5%	54,22
Тромбоциты >320×10^9/л / Platelets >320×10^9/л	8,44
Индекс аллергизации >1,2 у.е. / Allergicization index >1,2 c.u.	69,33

allergizing effect of chemicals which are common in the working area of electric and gas welders. These chemicals provokes serious sensitization and possible autoimmune processes as well as clinical forms of pathologies. The increased index of allergy in workers also proves this fact. According to the results of biochemical studies of blood serum in electric and gas welders, the violation of carbohydrate and lipid metabolism was revealed depending on the length of service (Table 4).

Elevated glucose levels are observed among the workers with increasing length of service — from 4.00% at the beginning of work to 30.00% with more than 30 years of service. A high degree of functional relationship of this index with length of service was found (r=1.00). The number of workers with elevated cholesterol correlated with years of professional activity, the correlation reaches r=0.98. The detected disorders of lipid metabolism in the examined workers, most likely, are a consequence of chemical factor exposure, correspondingly, it has a significant impact on the development of atherogenic processes in electric and gas welders. According to some literature data, changes in biochemical parameters under exposure to harmful chemicals can be associated with increasing length of service [5–8, 16]. Increased parameters of carbohydrate and lipid metabolism in the examined workers can be considered as specific changes developing under the influence of harmful factors of production.

CONCLUSION

Thus, it has been established air pollution by chemical substances of the 1st–4th hazard classes is a harmful factor of the working environment and labor process in the work of an electric and gas welder.

The revealed shifts in the blood profile should be considered as an individual response to harmful external exposure. Processes occurring in the red sprout of hematopoiesis are directly related to the duration of exposure to production factors.

It is necessary to conduct dispensary observation of this category of workers with the

Table 3

The frequency of deviations of hematological parameters in workers depending on the length of service

Таблица 3

Частота отклонений гематологических показателей у работников в зависимости от стажа работы (%)

Направление отклонения показателей / Deflection direction indicators	**Электрогазосварщики / Electric and gas welders (n=225)**			
	0–10 лет / 0–10 years (n=25)	**11–20 лет / 11–20 years (n=67)**	**21–30 лет / 21–30 years (n=73)**	**более 30 лет / over 30 years (n=60)**
Гемоглобин >160 г/л / Hemoglobin >l60 g/l	20,00	28,36	26,05	16,67
Эритроциты >5,5×10^{12}/л / Erythrocytes >5,5×10^{12}/l	16,00	20,90	13,70	13,33
Гематокрит >48% / Hematocrit >48%	16,00	28,36	23,29	20,00
MCV >95 фл	4,00	14,93	23,29	25,00** χ^2=5,09 (p <0,001)
MCH >31 фл	4,00	22,39	34,25	35,00** χ^2=8,84 (p <0,001)
Лейкоциты >9,0×10^9/л / Leukocytes >9,0×10^9/l	8,00	22,39	17,81	18,33
Эозинофилы >5% / Eosinophils >5%	52,00	46,27	56,16	58,33
Тромбоциты >320×10^9/л / Platelets >320×10^9/л	4,00	8,96	6,85	10,00
Индекс аллергизации >1,2 у.е. / Allergicization index >1,2 c.u.	68,00	67,16	72,60	50,00* χ^2 = 2,31 (p <0,05)

* Достоверность различий с первым годом работы (p <0,05) / Significance of differences from the first year of operation (p <0,05).
** Достоверность различий с первым годом работы (p <0,001) / Significance of differences from the first year of operation (p <0,001).

Table 4

The frequency of deviations of biochemical parameters in electric and gas welders, depending on the length of service (%)

Таблица 4

Частота отклонений биохимических показателей у электрогазосварщиков в зависимости от стажа работы (%)

Направление отклонения показателей / Deflection directionin dicators	Электрогазосварщики / Electric and gas welders (n=225)			
	стаж 0–10 лет / experience 0–10 years (n=25)	стаж 11–20 лет / experience 11–20 years (n=67)	стаж 21–30 лет / experience 21–30 years (n=73)	Стаж более 30 лет / Experience over 30 years (n=60)
Глюкоза >6,1 ммоль/л / Glucose >6,1 ммоль/л	4,00	22,39	26,03	30,00* χ^2=6,87 (p <0,001)
Холестерин >5,2 ммоль/л / Cholesterol >5,2 ммоль/л	32,00	50,75	57,53	65,00* χ^2=7,77 (p <0,001)

* Достоверность различий с первым годом работы (p <0,001) / Significance of differences from the first year of operation (p <0,001).

development and justification of individual medical and preventive measures.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisi-tion, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

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