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## RISKS OF CARDIOVASCULAR DISEASES EVOLVEMENT AND OCCUPATIONAL STRESS

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*Our aim was to study how significant psychosocial factors are in occupational stress and cardiovascular diseases evolvement in workers employed at petrochemical production; we also intended to work out a set of preventive measures. Our hygienic and social-psychological research enabled us to detect factors causing stress evolvement in workers employed at petrochemical production. These factors included chemical impact, noise, unfavorable microclimate, labor hardness and labor intensity. High level of risk for their own lives and responsibility for safety of others, as well as work under time deficiency conditions with increased responsibility for the final results, were the most significant psychosocial factors for workers. In the course of questioning we detected that 74 % machine operators, 63 % tool men working with controllers and automatic devices, and 57 % repairmen mentioned having stress at work. Here 38 % workers gave a subjective estimation of their professional activity as having apparent "stress nature". The questioning revealed that 48 % workers with various occupations had increased parameters as per anxiety scale (HADS); 23 % workers had increased parameters as per depressions scale (HADS). Primary hypertension was the most widely spread nosologic form among chronic non-infectious diseases; it was found in 46.1 % operators and in 45.2 % repairmen dealing with processing stations repair. 30.1 % tool men working with controllers and automatic devices had average occupational causation of primary hypertension by production factors. We detected direct relation between hyperlipidemia and age and working period.*

*We created foundation for preventive measures and worked out a program aimed at increasing resistance to stress at corporate and individual level. It will provide significant social effect and later on economic one. To overcome social stress we need to create safe working conditions at workplaces and to increase labor motivation based on career development possibilities.*

**Key words:** workers employed at petrochemical production, machine operators, occupational stress, cardiovascular diseases, risk factors, resistance to stress, prevention.

Occupational stress evolvement or growth in its significance is a distinctive feature of contemporary society [13, 17, 21].

There was research conducted in 27 European Union countries in course of which psychological welfare and psychological distress of 12,594 workers was assessed. One third of all respondents claimed financial difficulties and absence of stability to be primary reasons for stress at a working place

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[24].

This problem is even more vital in Russia. It is due to contemporary social and economic situation which has such peculiarities as instability, decrease in production, low average income per capita of the population, increased labor intensity, absence of effective labor motivation, and, in a number of cases. unemployment [3, 12].

High neuro-emotional and information loads cause stress and overstress in workers' bodies; it results in exhaustion involvement, and if resources are not recovered sufficiently, then apparent overstrain occurs, occupational stress and health disorders evolve [13, 14, 23].

Efficient labor motivation loss by population, low wages, uncertainty in future, and fear to lose a job are among basic reasons for "social stress" involvement [3, 20, 28]. A number of authors state that more than 10% of working population live under constant social and occupational stress conditions [5, 8, 18].

Psychoemotional factors cause so called "stress diseases"; such diseases include various psychosomatic disorders, for example, neurotic disorders, circulatory systems diseases, pancreatic diabetes, ulcer is stomach and duodenum, and certain malignant neoplasms. The most frequent consequences of high neuro-emotional loads are primary hypertension and ischemic heart disease [9, 22, 25, 27].

As per INTERHEART research data (2005) a contribution made by psychosocial factors into myocardial infarction risk amounted to 32,5 % [19]. As per results of prospective stage included into Russian component of KORDINATA research, it was determined that depressive symptomatology deteriorated prognosis for patients with arterial hypertension and ischemic heart diseases, led to disability and increased public health care expenses [5, 6]. Contemporary scientific literature contains objective data which characterize occupational stress involvement in social workers, in law enforcement officers, and in operators [1, 2, 4, 17, 26]. Still we couldn't find any data on psychological state of workers employed at petrochemical

production; such workers had to work under adverse influence exerted by unfavorable factors of working environment and labor process, and it makes our research truly vital.

Petrochemical enterprises belong to hazardous industrial objects due to application of hazardous substances having 1-3 danger category, including explosion hazard and fire hazard; such industries often function under high temperature regimes, and it increases risks for incidents occurrence [7, 10, 11]. A lot of technogenic incidents which have occurred both in Russia and abroad in recent years prove it. These incidents had grave consequences, including deaths (China, 2005, 2007; Tobolsk, 2007; Buddyonovsk, 2008; Zabaykalye, 2010; Khabarovsk, 2011; Venezuela, 2012; Kirishi, 2012; Achinsk, 2014; Ufa, 2016).

Analysis of accident rate and incidents in petrochemical productions revealed that more than 70% of all incidents were caused by human factor. Primary reasons for incidents are of organizational character and happen due to safety standards violation, unsatisfactory labor organization, and insufficient attention paid to workers' training in safety standards sphere. Incorrect actions of even one worker can lead to a production incident, and in some cases it can endanger the existence of a whole enterprise. Therefore, issues of workers' reliability in providing safety at a petrochemical production are especially vital [7, 11].

**Our research goal was** to study how significant psychoemotional factors were for occupational stress and cardiovascular diseases involvement in workers employed at petrochemical production as well as to work out a set of preventive activities.

**Data and methods.** To assess occupational factors significance, we performed hygienic and social-psychological research which included anonymous questioning with the use of specially designed questionnaires and psychological testing (test method) with the use of Hospital Anxiety and Depression Scale – HADS (1983). When interpreting results, we allowed for total

anxiety and depression parameter with determining 3 value ranges, namely 1) 0–7 was normal (absence of authentically apparent anxiety and depression symptoms); 2) 8–10 meant subclinically apparent anxiety/depression; 3) 11 and higher were clinically apparent anxiety/depression.

Workers' health state was assessed as per data obtained during in-depth medical examinations with participation of a cardiologist and with the use of functional research techniques, including electrocardiography.

To assess lipid metabolism, we accomplished biochemical research which included determining crude cholesterol contents, high-density lipoproteins cholesterol contents, triglycerides contents, low-density lipoproteins cholesterol content, and atherogenicity index. To assess occupational risk, we determined relative risk (RR) and etiological fraction (EF) of working environment factors in cardiovascular diseases evolvement and degree of their causation [15].

1800 male workers with various occupations underwent in-depth medical examination; their age varied from 18 to 59, average age was equal to 40.2, overall working period on average was equal to 16.8 years. 430 workers took part in questioning.

Three groups comparable as per age and working period were formed depending on working conditions. The first basic group included machine operators ( $n = 936$ ), the second group were repairmen ( $n = 384$ ), the third group (control group) included tool men working with controllers and automatic devices (C&AD) ( $n = 480$ ).

**Results and discussion.** On a whole, working conditions of workers with basic occupations at petrochemical productions (machine operators and repairmen) as per P 2.2.2006-05 are mostly considered to be hazardous and correspond to 3.1-3.3 danger classes of working conditions; C&AD tool men work under allowable working conditions.

Workers employed at contemporary petrochemical production are influenced by

stress factors with various nature and intensity during their labor activities; such factors include working environment factors and labor process ones:

- adverse chemicals (labor conditions class 2.0–3.1);
- in-plant noise (labor conditions class 3.1–3.3);
- vibration (labor conditions class 2.0);
- unfavorable microclimate (labor conditions class 2.0–3.1);
- absence of scheduled breaks;
- labor intensity factors: intellectual, sensory and emotional loads.

Noise and labor intensity are prevailing factors for machine operators, noise and labor hardness together with chemicals prevail for repairmen.

We paid special attention to labor intensity assessment for workers belonging to different occupational groups.

Labor conditions class for machine operators dealing with processing stations corresponds to hazard class 3.1 as per labor intensity as they have to deal with explosion-hazardous and fire-hazardous production, they constantly face risk for their own life, they bear full responsibility for other people's safety and for final results, their errors matter a lot, and they have to work in three shifts, one shift being a night one. Labor conditions for repairmen and tool men dealing with C&AD belong to allowable class (table).

We questioned workers with various occupations, and our questioning results revealed that 74% machine operators, 63% tool men dealing with C&AD, and 57% repairmen claimed to have stress at work. Here 38% workers gave a subjective assessment of their everyday occupational activity as having apparent "stress nature". 69.9% respondents considered their work to be hazardous and dangerous, 62% mentioned intense in-plant noise,

25.7% spoke about fire hazard or explosion hazard, 18.0% complained on too high or too low temperature, 13.4% weren't happy to have to work in three shifts.

Table

## Parameters of labor intensity at working places at petrochemical productions

Intensity parameter	Machine operator dealing with processing stations	Tool man dealing with C&AD; repairman
Work content	Solving complicated tasks	Solving easy tasks as per instructions
Labor conditions class	3.1	2
Perception of signals (information) and their assessment	Perceptions of signals with following comparison between actual parameters values and their nominal values. Final assessment of actual parameters values	Perception of signals with the following correction of actions and operations
Labor conditions class	3.1	2
Degree of responsibility for the results of their activities. Significance of errors	Bears full responsibility for functional quality of an end product, work, and task. Errors cause damage to equipment, technological processes failure and may endanger lives of other people	Bears responsibility for functional quality of auxiliary work (tasks). Errors cause additional efforts of supervisors (team managers and foremen)
Labor conditions class	3.2	2
Degree of risks for own life	Probable	Probable
Labor conditions class	3.2	3.2
Degree of responsibility for others' safety	Possible	Possible
Labor conditions class	3.2	3.2
Shift work	Work in three shifts (one shift is a night one)	Work in two shifts (without a night one)
Labor conditions class	3.1	2
<b>Overall labor intensity assessment</b>	<b>3.1</b>	<b>2</b>

54% respondents were concerned over gas contamination. As for other dangerous production factors, they were mentioned by respondents in smaller number of cases. Only 12.1% respondents thought their working conditions were safe.

68% respondents were satisfied with labor organization at their production; 64%, with labor conditions; 92% thought they were fully provided with all the necessary protective clothing. We should note that less than two thirds of all respondents were satisfied with their wages and moral motivation and 55% workers complained they had no possibilities of their career development. And also more than a half workers didn't think everybody had

equal possibilities of career development. 74% respondents were satisfied with moral and psychological climate in their team and with interpersonal relations with their colleagues. 68% respondents mentioned their supervisor helping them in professional issues and they had quite normal interpersonal relations with him. As per our questioning results, 18% workers told they had conflicts with their colleagues. The most frequent reasons for conflicts included unsatisfactory labor and production organization, distribution of bonuses and extra pay, labor discipline. But despite such conflicts, only 9% workers told they wanted to change their team.

The performed questioning enabled us to reveal ranking in production issues which caused anxiety in workers employed at petrochemical production over 6 months: work under time deficiency conditions with increased responsibility for the final result (23.2%), and substantial changes in work processes (19.4%). Only 27.8% respondents didn't feel anxiety in their working conditions.

We should note that some workers could react with so called distress to stress occurrence at their working place and to lack of support from their relatives; this distress often involved excessive alcohol intake. As per questioning results, workers who didn't have emotional support from their relatives, often drank alcohol (more than 28.2% respondents). Only 9.1% workers had favorable psychological climate in their family. 16.0% drank beer, 12.3% chose wine and 6.9% admitted drinking strong spirits. We think that respondents due to quite understandable reasons were not always sincere when answering such questions, and therefore we assess the obtained data as being somewhat understated.

The results of testing as per HADS scale revealed that subclinical anxiety among machine operators occurred 2.4 times more frequently than among tool men dealing with C&AD (32.3 and 13.4 % correspondingly), subclinical depression occurred 3 times more frequently (17.5 and 5.8 % correspondingly). We should note that subclinical anxiety among repairmen was detected 1.9 times more frequently than among tool men dealing with C&AD (25.1 and 13.4 % correspondingly), and subclinical depression was detected 2.1 times more frequently (12.4 and 5.8 % correspondingly).

Clinical anxiety was diagnosed among machine operators in 7.9% cases; among repairmen, in 4.3% cases; among tool men dealing with C&AD, in 1.3%. Clinical depression was revealed only in the 1st and the 2nd group (1.7% and 0.9% cases correspondingly). There were no detected cases of clinical depression in the control group (figure).

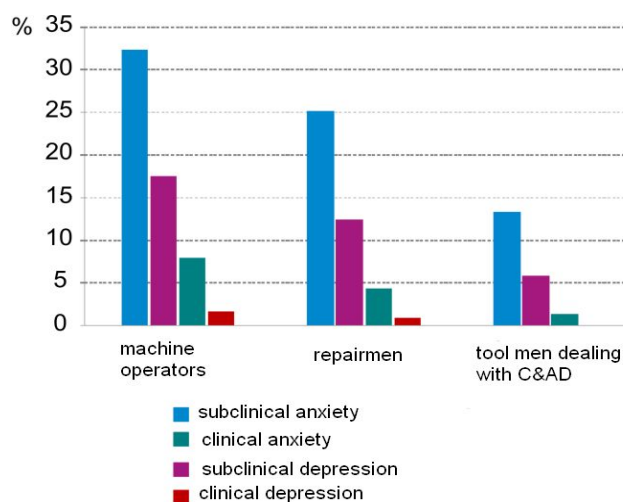


Figure. Frequency of psychosocial factors among workers from various occupational groups.

Circulatory system diseases mostly represented by primary hypertension, cerebrovascular diseases, and ischemic heart disease, prevailed in the structure of revealed chronic non-infectious diseases of workers employed at petrochemical productions.

The most widely spread nosologic form among cardiovascular diseases was primary hypertension which was detected in 46.1% machine operators, in 45.2% repairmen, and in 30.1% tool men dealing with C&AD. As we determined relative risk of etiologic fracture which working environment factors had in primary hypertension evolvement, we revealed average occupational causation of this disease among machine operators ( $RR = 1.53$  and  $EF = 35\%$ ) and repairmen ( $RR = 1.5$  and  $EF = 33\%$ ).

Authentic increase in primary hypertension frequency and cerebrovascular diseases frequency was detected among machine operators and repairmen after 6-10 years of work and 11-15 years of work in comparison with the same parameters among tool men dealing with C&AD ( $p < 0.05$ ).

We should note that arterial hypertension syndrome among workers with working period less than 10 years was mostly caused by vegetative-vascular dysfunction. Increased blood pressure in workers with longer working

period was caused by primary hypertension and atherosclerotic vessels damage.

Ischemic heart diseases was revealed in 4.3% workers; post-infarction atherosclerosis was diagnosed only among people older than 50 with their working period being longer than 15 years. ECG-symptoms among workers employed at petrochemical productions occurred in 22.1% of examined people and were mostly represented by myocardial hypertrophy in left ventricle, and excitability disorders as per supraventricular and ventricular extrasystoles types.

We detected direct moderate correlation between low-density lipoproteins cholesterol level ( $r = 0.58$ ), crude cholesterol level ( $r = 0.56$ ), atherogenicity coefficient ( $r = 0.34$ ) and triglycerides level ( $r = 0.3$ ) and working period among machine operators.

So, results of hygienic examinations on labor conditions assessment revealed that increased neuro-emotional loads caused by great responsibility for the results of professional activities and significance of errors, as well as high risk for own life and others' safety, were characteristic for all occupational groups also influenced by chemical and physical factors of their working environment. Machine operators had the most intensive labor with hazard class 3.1, repairmen's labor was considered allowable. Psychosocial factors of production and non-production nature cause occupational stress involvement mostly in machine operators.

The conducted research makes it advisable to work out a set of prevention activities aimed at optimization of working conditions for workers employed at petrochemical productions and at lowering stress factors. All prevention activities can be divided into three groups, namely primary, secondary, and tertiary ones. Here primary prevention focuses on preventing occupational stress at working place by eliminating or reducing influence exerted by initial causes and by increasing workers' psychological adaptation. Rational labor organization, production automation, creation of favorable psychological climate in a team, increase in workers' labor motivation and

change in its orientation, expansion of workers' possibilities to take part in decision making should become the primary trends in labor optimization and increase in resistance to stress for occupations with apparent emotional loads.

Secondary prevention is aimed at helping workers already having signs of psychological stress. It includes activities which can reduce influence of stress development in workers and which can either eliminate or decrease strain: relaxation skills training, positive thinking skills, informing workers on their exhaustion level and on possible consequences of stress, time management and conflict management structure. Increased physical activity and giving up bad habits are very important aspects of secondary prevention.

Tertiary prevention is rehabilitation and it is for workers whose health suffered from chronic occupational stress. Tertiary prevention goal is to prevent development of psychic and psychosomatic diseases in order to escape disability and untimely death. Tertiary prevention envisages providing workers with confidential consultations of a medical psychologist and psychotherapy.

#### **Conclusions:**

1. Basic risk factors for occupational stress involvement in workers employed at petrochemical productions are adverse chemicals impacts, in-plant noise, unfavorable microclimate and psychoemotional and physical loads. Labor conditions of workers from basic occupational groups were hazardous and corresponded to labor condition classes 3.1-3.3 according to P2.2.2006-05.

2. Most respondents were satisfied with labor organization and relations in a team. But still workers mentioned low labor motivation related to absence of career development possibilities and low wages.

3. Work under time deficiency with increased responsibility for the final results and social instability were the most significant psychosocial factors for workers employed at petrochemical productions.

4. Machine operators and repairmen had average occupational causation of primary hypertension by production factors. We

detected direct dependence of hyperlipidaemia on age and working period length.

5. The obtained results enabled us to give grounds for a set of prevention activities and to work out a program aimed at increasing resistance to stress in workers at corporate and individual level which will secure significant social and later on economic effect.

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