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PHYSICAL RISK FACTORS IN OCCUPATIONAL SENSORINEURAL HEARING DISORDERS

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We have studied the impact of harmful physical factors of production on the development of occupational sensorineural hearing loss (OSHL). A retrospective analysis of 537 cases of civil aviation flight personnel and car drivers of technological transport in the mining industry of Yakutia with the first diagnosis of OSHL was carried out. Among these two groups of workers, a comparative analysis of the severity of hearing loss and its dependence on age, length of service, and the level of excessive industrial noise was carried out. It was found that among flight personnel, OSHL is the only diagnosis of an occupational disease, develops after 24.69±7.05 years of work in this position. In car drivers, OSHL is combined with other diagnoses caused by exposure to local and/or general vibration, develops with a work experience of 26.02±6.69 years with a predominance of IInd degree of hearing loss. As a result, it was concluded that the typical pattern and prevalence of the Ist degree of OSHL is possible in the absence of the impact of other harmful physical factors of production, such as local and general vibration. When exposed, along with excessive noise of local and general vibration, the patterns of OSHL development are blurred, the clinical course is more severe, with a predominance of IInd and IIIrd degrees.

Keywords: occupational sensorineural hearing loss; occupational noise, occupational factor, degree of hearing loss.

Introduction. Hearing loss from exposure to occupational noise has recently become a common occupational disease. Occupational sensorineural hearing loss (OSHL; synonyms – perceptual hearing loss, sensorineural hearing loss) is a chronic disease of the hearing organ, characterized by bilateral impairment of the auditory function of a sound-perceiving nature, which develops under prolonged exposure to occupational noise exceeding the maximum permissible levels [1]. In the Russian Federation, the maximum permissible noise level at workplaces is established by the sanitary standards SN2.2.4 / 2.1.8.562-96 «Noise at workplaces, in residential, public buildings and on the territory of residential development» and is 80 dB. Currently, the incidence of OSHL is growing and affects mainly working-age workers [2]. Occupational risks play an important role in the complex of factors affecting health at working age: from 20 to 40% of all labor losses are caused by diseases directly or indirectly associated with unsatisfactory working conditions, among which noise occupies one of the leading places. Currently, as a rule, there is a combined effect of noise on the body of workers in combination with vibration (general and local), air pollution in the working area with harmful substances and aerosols, unfavorable microclimate, high severity and intensity of work and other harmful factors [2]. In Yakutia, those working in harmful and/or dangerous working conditions are mainly engaged in three economic activity's types – mineral extraction, transport and communications, production and distribution of electricity, gas and water. Recently, a lot of efforts have been made to minimize harmful production factors in the workplace. However, some technological processes have irreparable factors, such as unrecoverable engine noise in transport. All workers employed at work with harmful and/or hazardous working conditions annually undergo periodic medical examinations, with mandatory audiological examination. If an occupational disease is suspected, including sensorineural hearing loss, the employee is sent to the center of occupational pathology for examination of the connection of the disease with the profession, according to the results of which the employee is diagnosed with a chronic occupational disease.

Currently, the clinical picture of OSHL is well studied [3], therefore, many researchers are interested in the issues of epidemiology, the effectiveness of treatment and rehabilitation methods in OSHL [2]. Main methods in the diagnosis of OSHL are a thorough study of the patient's professional route, working conditions and audiological research methods. The purpose of this work is to analyze OSHL in civil aviation flight personnel and drivers of technological transport in the mining industry of Yakutia, depending on age, length of service in this position, the level of excessive noise and other physical factors.

Material and methods. As a result of the examination of the connection between the disease and the profession for the period from 2010 to 2019, at the Yakutsk Republican Center for Occupational Pathology 1181 patients were diagnosed for the first time with various diagnoses of a chronic occupational disease. For the analysis, we selected 537 civil aviation flight personnel and technological transport's drivers in the mining industry of Yakutia, who were first diagnosed with OSHL. From this number were formed two observation groups.

The first group consisted of 305 males working at the examination's time in the positions of «pilot», «co-pilot», «aircraft commander», «pilot-instructor», «navigator», «senior navigator», «navigator-in-

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structor», «onboard radio operator», «onboard mechanic», «onboard engineer», «aviation technician», «aviation mechanic», «senior onboard engineer», «onboard operator».

The second group consisted of 232 males working at the examination's time in the positions of «driver», «car driver», «driver for all brands of cars».

The age of the patients was identified using passport data. Work experience is calculated according to the entries in the work book. The median of the noise affecting the employee during the working life is taken as the level of excessive noise during his work in this position according to the sanitary and hygienic characteristics of the working conditions of each employee, approved by the Federal service for supervision of consumer rights protection and human welfare and additionally for Ist group – according to the protocol for calculating the equivalent noise level in flight approved by the labor protection department employer. Indicators of other physical factors are also taken from the sanitary and hygienic characteristics of working conditions.

In the retrospective analysis of the outpatient's card, all 537 participants underwent a standard examination by an audiologist-otorhinolaryngologist (using the «KaWe Combilight» otoscope, «KaWe», Germany). The auditory status was confirmed by an audiological study, including tuning fork tests (tuning fork C_{128}), impedance measurement (tympanometer and audiometer «AA222», «Interacoustics», Denmark), threshold tonal audiometry (tympanometer and audiometer «AA222», «Interacoustics», Denmark; audiometer «AC40», «Interacoustics», Denmark) on air conduction at frequencies 0.125, 0.25, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0 kHz and bone conduction at frequencies 0.25, 0.5, 1.0, 4.0, 6.0 kHz with a step of 5.0 dB [4]. The type of hearing loss was considered conductive – with an increase in air conduction thresholds on audiograms, sensorineural – with an increase in bone and air conduction thresholds on audiograms, mixed – with an increase in bone and air conduction thresholds with an interval exceeding 20.0 dB in total in $PTA_{0.5, 1.0, 2.0, 4.0}$ kHz. Hearing loss was considered symmetric when the difference in the hearing thresholds in the $PTA_{0.5, 1.0, 2.0, 4.0}$ kHz did not exceed 15.0 dB. Considering that we are studying the damaging effect of occupational noise, the degree of hearing loss was assessed by the thresholds of hearing worse than the hearing ear in the $PTA_{0.5, 1.0, 2.0, 4.0}$ kHz. When assessing the severity of the disease, were used two classifications: 1) the classification proposed by Ostapkovich V.E. for ICO 12.4.062-78 «Noise. Methods for determining human hearing loss», according to which 0 degree (signs of noise exposure to the hearing organ) – up to 10 dB (arithmetic mean 0.5, 1.0, 2.0 kHz) and 50±20 dB (4.0 kHz), Ist degree (sensorineural hearing loss with mild the degree of hearing loss) – 11-20 dB and 60±20 dB, IInd degree (sensorineural hearing loss with a moderate degree of hearing loss) – 21-30 dB and 65±20 dB, IIIrd degree (sensorineural hearing loss with a significant degree of hearing loss) – 31-45 dB and 70±20 dB [5]; 2) international classification, according to which the Ist degree corresponds to 26-40 dB in $PTA_{0.5, 1.0, 2.0, 4.0}$ kHz, IInd degree – 41-55 dB, IIIrd degree – 56-70 dB, IVth degree – 71-90 dB, deafness – > 90 dB.

sions of the expert commission showed that in Ist group OSHL is the only established diagnosis of an occupational disease, and in IInd group – in all cases (100%) OSHL was found in combination with other diseases, such as «vibration disease», «radiculopathy», «polyneuropathy» of varying severity and stage of the course.

Comparison of the degrees of hearing loss in two groups showed that during the initial diagnosis of OSHL, more severe hearing loss is observed in the second group (p<0.05): significantly less Ist degree (29.3% versus 63.9%), significantly more IInd degree (48.7% versus 25.9%) and IIIrd degree (22.0% versus 9.8%) (Fig. 1). Profound hearing loss (IVth degree) was observed in only one case, and is most likely of a casuistic nature.

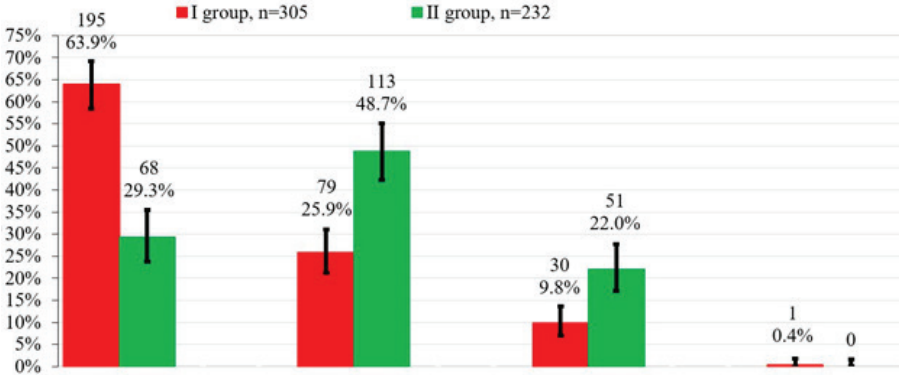

Figure 1. Comparison of degrees of hearing loss.

Statistical processing was performed using the software Biostatd (McGraw-Hill, Inc. Version 3.03), Sampling (kindly provided by V. Macaulau and M. Metspalu), and STATISTICA version 8.0 (StatSoft Inc, USA). Differences were considered statistically significant at p<0.05. The audiograms with a break were normalized by introducing the maximum values (120.0 dB) in places where the patient did not respond.

Each case contains a written informed voluntary consent of the patient to medical intervention, which provides for the anonymous use of the examination's results and treatment for scientific purposes.

Results. The analysis of the conclu-

Considering that noise is the only adequate stimulus to the auditory analyzer, we attempted to establish the cause of the observed difference in the severity of hearing loss in the second group. Comparison of age and length of service in this position showed that older (p<0.05) and more trained (p<0.05) patients work in the second group, while exceeding the maximum permissible level is more significant (p<0.05) in the first group (Table 1).

At the same time, correlation analysis shows that the relationship between age, work experience and the level of excess noise can be traced only in Ist group (Fig. 2, 3, 4).

Thus, in civil aviation flight personnel

Table1

Comparison of the two observation groups in terms of age, length of service, and excessive noise

Criterion	I group	II group	P
age	50.64±6.04	53.18±5.69	**0.000001**
experience	24.69±7.05	26.02±6.69	**0.028189**
excess noise	10.80±4.72	1.20±0.40	**0.000000**

Table2

Analysis of the presence of other physical factors

Physical factor	Working conditions class *	
	I group	II group
aerosols of predominantly fibrogenic action	1	2
noise	**3.1 – 3.3**	**3.1-3.2**
infrasound	1 – 2	1
ultrasound air	1	1
vibration general and local	1	**2 – 3.2**
non-ionizing radiation	1	1
ionizing radiation	1	1
microclimate	2	2
light environment	2	2
working posture (fixed or forced)	**3.1**	**2 – 3.2**

*1 – optimal, 2 – permissible, 3 (4 subclasses) – harmful, 4 – dangerous. Indicators exceeding the maximum permissible levels are highlighted in bold.

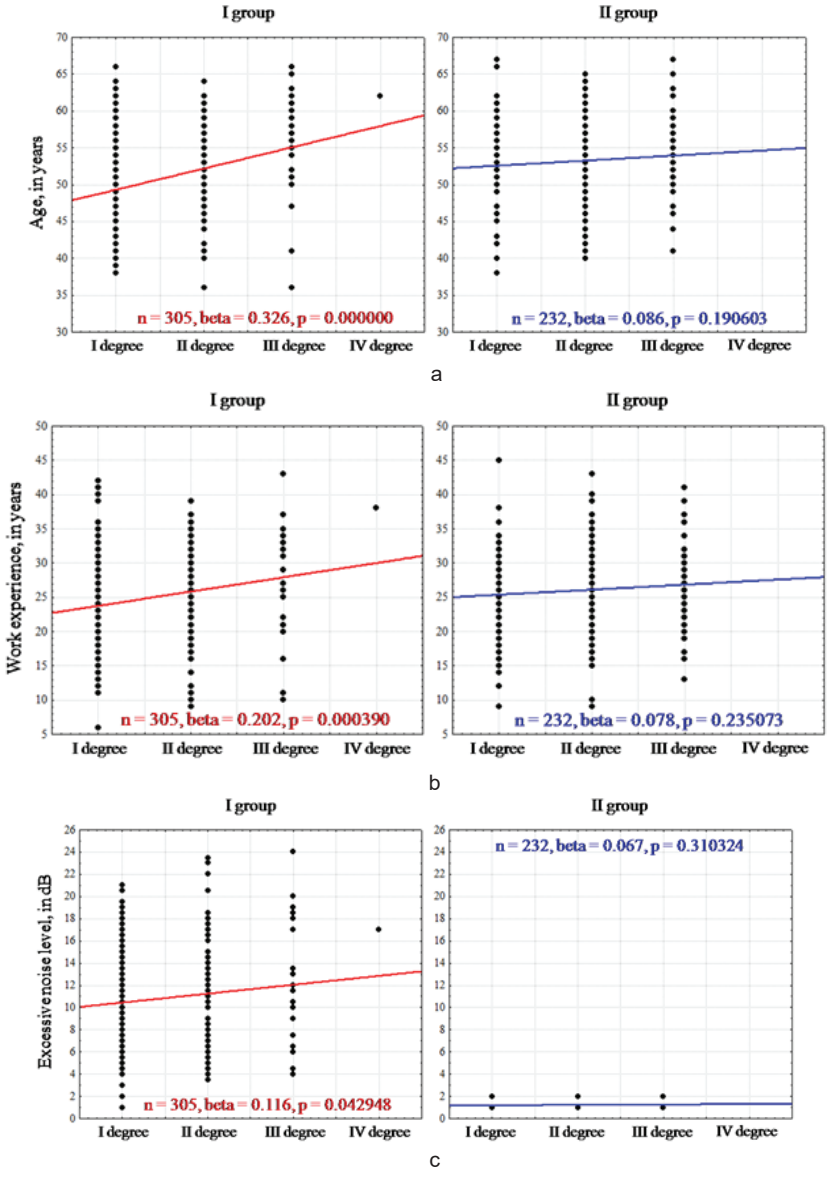

Figure 2. a) Correlation analysis of the dependence of the degree of hearing loss on age, b) Correlation analysis of the dependence of the degree of hearing loss on the length of service in this position, c) Correlation analysis of the dependence of the degree of hearing loss on the level of excess occupational noise.

(group I) the hearing loss is lighter and depends on age, experience and the level of excessive noise, and in car drivers (group II) the hearing loss is more severe, and does not depend on age, experience and level of excess noise. Since the results obtained do not fully explain the difference in the severity of hearing loss in observed groups, we additionally studied their working conditions and revealed the presence of other physical factors exceeding the maximum permissible levels in group II (Table 2).

Discussion. OSHL in all highly developed countries, including Russia, occupies one of the first places in the structure of all occupational diseases. Thus, in the all-Russian structure of occupational diseases, OSHL is about 16-17%. However, in some industries these figures reach 35-40% (weaving, forging and pressing production; aviation, automobile, mining, etc.). OSHL usually develops after a more or less long period (10-14 years) of work under conditions of industrial noise exposure. However, almost all researchers are unanimous in the opinion that increased sensitivity of the hearing organ to the adverse effects of noise, the additional effect of other factors of production (vibration, working posture, microclimate, neuro-emotional overstrain, etc.), and others play an important role in the development of OSHL risk factors (obesity, cardiovascular diseases, household noise, tobacco smoking, etc.) [6, 7, 8, 9].

The results of our study largely coincide with recent studies [10] and once again confirm that the severity of hearing loss with OSHL, obviously, depends on the potentiating effect of local vibration, general vibration, forced and/or fixed working posture. Hearing loss with OSHL in civil aviation flight personnel (group I) is lighter and depends on age, work experience and the level of excess noise, while the levels of local and general vibration are at the optimal level. For car drivers (group II), probably due to exceeding the maximum permissible level of local and general vibration at their workplaces, such patterns are blurred, and hearing loss becomes more severe. It should be noted that OSHL in car drivers (group II) is not the only diagnosis of an occupational disease, it was in all cases combined with other diseases, such as vibration disease or radiculopathy, caused by exposure to vibration and working posture. Perhaps the severity of hearing loss does not directly depend on the impact of these factors, but is a consequence of the disease «vibration disease» or «radiculopathy». These issues, as well as the genetic aspects of OSHL,

are the subject of more detailed study.

Conclusions. Typical flow and prevalence of Ist degree OSHL is possible in the absence of exposure to other harmful physical factors of production, such as local and general vibration. When exposed, along with excessive noise of local and general vibration, the patterns of OSHL development are blurred, the clinical course is more severe, with a predominance of II and III degrees.

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References

1. ГОСТ 12.4.062-78 ССБТ. Шум. Методы определения потерь слуха человека. - М.: Изд-во стандартов, 1979. – 6 с. [ICO 12.4.062-78 Noise. Methods for determining human hearing loss. M.: Izdatelstvo standartov, 1979. – P. 6. (in Russ.)].

2. ГОСТ Р ИСО 8253-1–2012. Методы аудиометрических испытаний. - М.: Стандартинформ, 2013. – 47 с. [8253-1-2012 Audiometric test methods. M.: Standartinform, 2013. – P. 47. (in Russ.)].

3. Аденинская Е.Е. Сравнительный анализ особенностей профессиональной нейросенсорной тугоухости у работников различных отраслей экономики / Е.Е. Аденинская, Ю.Ю. Горблянский, О.Г. Хоружая // Бюл. ВСНЦ СО РАМН. – 2013. - № 6(94). – С. 87. [Adeninskaya E.E. Comparative analysis of features professional employees sensorineural hearing loss in a variety of sectors / E.E. Adeninskaya, J.J. Gorblyansky, O.G. Khoruzhaya // Bulleten VSNS SO RAMN. – 2013. – Vol. 6(94). – P. 87. (in Russ.)].

4. Илькаева, Е.Н. Медико-социальная значимость потери слуха в трудоспособном возрасте и научное обоснование методов профилактики: автореф. дис. д-ра мед. наук (14.00.50) Екатерина Николаевна Илькаева; НИИ медицины труда РАМН. – М., 2009. – 44 с. [Ilkaeva E.N. Medical and social significance of hearing loss at working age and scientific substantiation of prevention methods: author's abstract of D. Sci. Dissertation (14.00.50) Ekaterina Nikolaevna Ilkaeva; Research Institute of Occupational Health. – Moscow, 2009. – P. 44. (in Russ.)].

5. Кругликова Н.В. Гигиенические аспекты профессиональной нейросенсорной тугоухости у лиц летного состава гражданской авиации / Н.В. Кругликова, В.Л. Ромейко, Г.П. Ивлева, О.И. Харитонова // Медицина труда. - 2015. - №4. - С. 163 [Kruglikova N.V. Hygienic aspects of occupational sensorineural hearing loss in the civil aviation aircrew members / N.V. Kruglikova, V.L. Romeyko, G.P. Ivleva, O.I. Kharitonova // Medicina truda. - 2015. - Vol. 4. - P. 163 (in Russ.)].

6. Национальное руководство по профпатологии / под ред. Н.Ф. Измерова - М.: ГЭОТАР Медиа, 2011. - 784 с. [National guidelines for occupational pathology / editor N.F. Izmerov - M.: GOETAR Media, 2011. – P. 784. (in Russ.)].

7. Панкова В.Б. Проблемы тугоухости у лиц летных профессий гражданской авиации России / В.Б. Панкова, А.Ю. Бушманов // Вестник оториноларингологии. - 2014. - №6. - С. 27. [Pankova V.B. The problems of hearing impairment in the flying staff of commercial aviation in Russia / V.B. Pankova, A.Y. Bushmanov // Vestnik otorinolaringologii. - 2014. - Vol. 6. - P. 27 (in Russ.)].

8. Тугоухость у пилотов гражданской авиации (диагностика, врачебно-летная экспертиза и профилактика профессионального заболевания органа слуха шумовой этиологии): метод, рекомендации для врачей гражданской авиации / отв. ред. Н.А. Разсолов - М.; 2004. - 95 с. [Hearing loss in civil aviation pilots (diagnostics, medical-flight examination and prevention of occupational diseases of the hearing organ of noise etiology): method, recommendations / exec. editor N.A. Razsolov - M.; 2004. – P. 95. (in Russ.)].

9. Харитонова О.И. Профессиональная нейросенсорная тугоухость у членов экипажей воздушных судов гражданской авиации / О.И. Харитонова, Е.Л. Потеряева, Н.В. Кругликова // Медицина труда и промышленная экология. - 2015. - №6. - С. 12. [Kharitonova O.I. Occupational neurosensory deafness in civil aviation pilots / O.I. Kharitonova, E.L. Poteriaeva, N.V. Kruglikova // Russian Journal of Occupational Health and Industrial Ecology. - 2015. - Vol. 6 - P. 12. (in Russ.)].

10. Arlinger S. Reference data for evaluation of occupationally noise-induced hearing loss / S. Arlinger, M. Johansson // Noise Health. - 2004. - Vol. 24:6. - P. 35-41