Ensuring safety during the work with mercury and its inorganic salts

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Abstract. The paper presents a food product intended for the nutrition of those working with mercury and its inorganic compounds. Efficiency consists in the ability to neutralize mercury compounds, convert them to an inert form, have a neutralizing effect and cleanse the body. The composition of the product includes ingredients that reduce the processes of intoxication with mercury and its inorganic compounds, as well as reduce the main symptoms and stages of mercury poisoning (chronic mercury poisoning with constant exposure to metal vapors or its compounds). Cereal bar is proposed for feeding workers working with mercury and its inorganic compounds, which includes the following ingredients: oat bran, raisins, dates, crushed peanuts, bee honey, coarse wheat fibre, rice flour, strawberries, sea cabbage, beetroot, sesame, coriander, apple, dried rosehip, butter, chlorella powder and coconut shavings. Invention provides the preparation of cereal bars intended to feed workers working with mercury and its inorganic compounds, which accelerate the removal of mercury compounds and its inorganic compounds from the body.

1. Introduction

In case of healthful and dietary meals under harmful working conditions, Russian legislation provides for various measures to protect workers whose activities are associated with conditions that negatively affect their health. Healthful and dietary meals is the release of certain foods and vitamins intended for people working in harmful and dangerous conditions, which help minimize the effects of harmful substances on humans and contribute to the speedy removal of toxins and other toxic substances from the body. Depending on the type of work performed, Healthful and dietary meals consist of: dairy products; hot meals on special diets; vitamin complexes or products enriched with vitamins and minerals. The need to provide additional free meals for workers is indicated in art.222 of the Labor Code of the Russian Federation. It is part of a set of labor protection measures for workers in harmful and hazardous industries [1].

Currently, working conditions are divided into several classes. Such a separation directly depends on the presence of risk factors for life and the degree of danger to which workers are exposed:
The first class (optimal working conditions) is the most “harmless” class. It is assumed that in this case, nothing threatens human health, so he works at the limit of his physical abilities.

The second class (permissible working conditions) - in this case, employers provide the employee with a break during which he regains his strength. It is believed that nothing will happen to the health of the worker and his descendants in the near or distant future [2].

2. Relevance

The third class (harmful working conditions) - work in negative conditions for humans. The worker’s well-being is affected by various negative factors, which are also divided into four degrees, depending on the measure of influence on the human body.

The fourth class (hazardous working conditions) - working conditions which the government considers to be extreme. A person's life is exposed to deadly risks, and serious occupational diseases may develop, which can take a severe form. For example, professions such as miner, radiologist, oncologist, and others are considered dangerous to health [3].

Nutrition for the treatment and prevention of diseases associated with physiological nutritional standards. The main food and biologically active components necessary for the human body and associated with metabolic disorders due to harmful factors should be provided to employees of enterprises with adverse working conditions. Prevention of diseases associated with professional activities is an important state and medical task. To solve it, various hygienic, sanitary-technical and biomedical measures are carried out, which are aimed at preventing a number of diseases that arise due to exposure to harmful substances in the workplace. The nutrition of a preventive nature is based on the following principles:

- the use of antidote food components corresponding to harmful factors, as well as their action;
- accelerating the metabolism and elimination of toxic substances with a slowdown in their absorption in the gastrointestinal tract;
- increasing the overall resistance and functional ability of severely affected organs;
- compensation of increased costs that relate to biologically active substances due to the detoxification of toxic elements and the effects of negative components.

Healthful and dietary products are received by: Employees of manufacturing enterprises, as well as those performing construction, installation and repair work. Employees of organizations involved in cleaning and preparing equipment before repair or preservation in workshops. Persons who have received a disability due to an occupational disease. Employees who were previously on medical nutrition and for some time transferred to another place of employment due to the primary manifestations of occupational diseases for up to one year. Women working in production on maternity leave – until the end of it. Female employees of organizations that have children, who have not reached the age of one and a half years, if their work is associated with harmful factors, are entitled to a preventive nutrition until the child is one and a half years old [4,5].

3. Problem Statement

Under industrial conditions, mercury poisoning is becoming more common. Mercury poisoning is most often observed in workers whose activities are related to mining or using it in the manufacture of measuring instruments, x-ray tubes, mercury medicines, etc. Mercury is a substance of the first hazard class (GOST 12.1.005-88), which tends to evaporate at room temperature and enter the human body by inhalation. Mercury exists in several forms: liquid metal, steam, and solid metal (at temperatures below 30 degrees). Inhalation of mercury vapor to the lungs leads to its accumulation in the blood, where it remains unchanged for a certain time. Gradually, mercury forms compounds with blood proteins that are partially excreted in the urine, biological secrets, and through the intestines [6].

A significant amount of mercury is deposited in the parenchyma organs, the brain (here the highest concentration of this substance is observed). An almost exclusive accumulation of metal is observed in the basal nuclei, the midbrain region. Due to the ability of mercury to circulate in the cerebrospinal
fluid, the vascular plexuses and the cerebral cortex itself are irritated. Mercury can enter the human body:

- at the all stages of mining, cleaning, production and use of this metal (especially in case of safety violations, air conditioning failures, insufficient cleaning - mercury poisoning at work);
- at power plants;
- in the production of pesticides including mercury, X-ray tubes, thermometers and other devices;
- in medical institutions, first-aid posts, rooms where devices with mercury are used;
- at home (mercury poisoning with broken thermometers).

Three methods for the penetration of mercury are considered:

1. Aspirating way (poisoning by mercury vapor) - the most dangerous way.
2. Orally (by mouth) with dirty hands or when contaminated seafood is consumed. Because fish and shellfish tend to accumulate mercury.
3. Transcutaneous (through the skin).

Most often, mercury enters the body by aspiration, reacts with proteins, and in the form of complexes of albuminates travels through the bloodstream. After oxidative reactions, the metal transforms into mercury dichromate, and at the end of the chemical reaction into mercury chrome albuminate. Over time, part of the mercury is excreted by the kidneys, liver and through saliva. And the remaining amount is deposited in the parenchyma, lungs and bones [7].

Chronic mercury intoxication develops slowly, several years after the onset of contact with mercury. There are several consecutive stages of pathology (Kussmaul, 1861).

1. Irritable weakness syndrome - emotional instability, increased fatigue, memory impairment, sleep formula disorders - insomnia, sleep inversion. Typical for this stage is the tremor of the fingers of outstretched hands, first transient, with an increase in amplitude and duration. The excitability of the autonomic nervous system increases (pulse lability, blood pressure, disturbance of the oculo-cardiac reflex, bright red dermatography). The early symptoms of intoxication include mercury stomatitis, gingivitis with the formation of a blue-black border on the gums, hair loss, and brittle nails. Intoxication, which has a latent course, can worsen with acute infection or various other stressful effects on the body. Symptoms are reversible with timely treatment.

2. The symptom of mercury erythrom is the occurrence of severe excitement, anxiety in the presence of strangers, and the inability to perform normal work, a vaso-vegetative reaction (facial flushing, sweating, and palpitations). At this stage, the tremor intensifies, becomes constant, and spreads to the lower extremities, in a state of excitement it looks like hyperkinesia. Timely active treatment reduces symptoms.

3. Mercury encephalopathy with symptoms of intense headache and insomnia. Large amplitude tremors of the upper and lower extremities, head, chorea-like hyperkinesia, dynamic ataxia, chanted speech, nystagmus, hyperreflexia with pathological reflexes are observed. In some cases, polyneuropathy occurs with a predominant lesion of the ulnar nerve. Treatment includes the evacuation of the victim from the contaminated area and spa treatment with healthful and dietary meals [8].

4. Results

It is known that the effect of metallic mercury vapor (which may mainly be due to the development of occupational intoxication with mercury) is significantly different from the action of its salts. In case of poisoning with mercury salts (mercuric chloride, mercury nitrate, calomel, explosive mercury) in the clinical picture, usually the most pronounced changes are in the excretory organs – the kidneys and liver.

Inhalation of air, which contains mercury vapor in a total concentration of 0.25 mg/m3, leads to the accumulation of metal in the lung tissues and this is due to its specific effect on the human body. At higher concentrations, mercury can be absorbed through the skin. Chronic or acute poisoning develops
depending on the duration of mercury intake and its quantity. Micromercury poisoning is referred to a separate category [9].

The first symptoms of acute poisoning are noted a couple of hours after direct contact with the metal: headache; general weakness; metallic taste; pain when trying to swallow something; lack of appetite; nausea; vomiting; swelling and bleeding of the gums; salivation. A little later occurs: mucus diarrhea with blood and severe pain in the abdomen; shortness of breath and cough - the addition of inflammation of the lung tissue, severe chills, chest pain, catarrh of the respiratory tract; also characterized by hyperemia with an increase in temperature to 38-40 degrees; the presence of mercury in the urine (determined by examination) [10].

If any situation, that carries the risk of exceeding the permissible concentration of mercury in the air, develops you need to invite a special accredited laboratory and take measurements (standard - not more than 0.0003 mg/m³). The maximum permissible concentration of mercury in the air of working premises is 0.01 mg/m³.

5. Conclusion
For complex treatment, they resort to prescribing of Nootropics that improve blood supply to the brain, and also improve metabolic processes in neurons.

Table 1. The composition of the cereal product for nutrition people working with mercury and its inorganic compounds.

| Ingredients                | Weight, g | Composition, g | Energy value, kcal |
|----------------------------|-----------|----------------|-------------------|
|                            |           | proteins       | fats              | carbohydrates |                 |
| oat bran                   | 100       | 17.3           | 7.0               | 66.2         | 246             |
| wheat fiber. large         | 60        | 9.6            | 14.1              | 2.28         | 111.8           |
| rice flour                 | 50        | 4.7            | 1.2               | 37.7         | 184             |
| sesame seeds crushed       | 25        | 4.9            | 12.2              | 3.1          | 141.3           |
| peanuts                    | 35        | 9.2            | 15.8              | 3.5          | 193.2           |
| chlorella powder           | 15        | 9.2            | 1.2               | 1.035        | 51.45           |
| coconut flakes             | 30        | 15.6           | 175.5             | 16.8         | 177.6           |
| dried dates                | 50        | 1.3            | 0.3               | 34.6         | 146             |
| raisins                    | 50        | 1.5            | 0.2               | 39.6         | 149.5           |
| ground beets               | 50        | 0.8            | 0.1               | 4.4          | 21              |
| dried rosehip fruit        | 50        | 0.8            | 0.4               | 11.2         | 54.5            |
| dried seaweed              | 50        | 3.8            | 0.8               | 12.5         | 103.8           |
| strawberry                 | 165       | 1.3            | 0.7               | 12.4         | 67.6            |
| apple                      | 100       | 0.3            | 0.2               | 13.8         | 52              |
| butter                     | 70        | 0              | 69.9              | 0            | 629.4           |
| honey                      | 70        | 0.6            | 0                 | 56.2         | 229.6           |
| cilantro                   | 30        | 0.9            | 0                 | 16.4         | 65              |
| TOTAL                      | 100       | 8.18           | 29.96             | 33.17        | 262.37          |
| Total                      | 100       | 8.18           | 29.96             | 33.17        | 262.37          |
| Total                      | 30        | 2.45           | 8.99              | 9.95         | 78.7            |

According to the order No. 46n of the Ministry of Health and Social Development of the Russian Federation dated February 16, 2009 (Appendix No. 2, registered with the Ministry of Justice on April 20, 2009, No. 13796), the Nutrition Institute of the Russian Academy of Medical Sciences proposed a
healthful and dietary meal No. 5 intended for people who work with mercury and its inorganic compounds. The diet should contain complete animal proteins, vegetable oils, omega 3 fatty acids. The diet is enriched with 4 mg of vitamin B1 and 150 mg of vitamin C.

The authors of the work proposed a cereal bar for feeding people who work with mercury and its inorganic compounds, for which a Russian Federation patent No. 2 649 882 was obtained (published on April 5, 2018, bull. No. 10). The table 1 shows the ingredient composition and energy values of this product [11,12].

The proposed food product is enriched with ingredients that can reduce the processes of mercury intoxication, reduce the main symptoms and stages of mercury poisoning, and also effectively adsorb heavy metals, converting them to an inert form and remove them from the body. The process of preparing a cereal product consists in preparing a mixture of oat bran, wheat fiber, rice flour, sesame seeds, peanuts, dried dates and raisins. Then add chopped beets, dried rosehips fruit and seaweed, chlorella powder, cilantro. Next, strawberry fruit puree, coconut flakes, butter and honey are entered. After that, all dry and liquid components are thoroughly mixed. The resulting mass is distributed in a baking dish, kept for 15-20 minutes and baked in the oven at a temperature of 180° for 15-20 minutes. After that, the obtained cereal cake is cooled and cut into bars weighing 30g [13].

6. Conclusion

Thus, the composition of this product includes proteins, dietary and fruit fibers, as well as vitamins of groups B and C, which are able to block the flow of mercury into the human body. A food product can be an additional source of necessary food components and provide a lack of energy value in the nutrition of individuals when working with mercury and its inorganic compounds [14-20].

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