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*Mercury – influence on biochemical processes
of the human organism*

Heavy metals are too well-known environmental pollutants, very dangerous to human health and even life. Being one of the most toxic pollutants, they are wide-spread in the environment because of their popular industrial usage. Mercury, besides cadmium and lead, is a heavy metal being of great danger for human health. Exposure to mercury can cause immune, sensory, neurological, motor and behavioural dysfunctions. It is a strongly toxic metal of the biggest influence on the central and peripheral nervous system. Mercury is a liquid metal that easily evaporates and falls apart into small balls, which significantly increases its evaporating surface. It is widely used in electro-technical industry (rectifiers, fluorescent and quartz lamps), in thermometers and barometers production, scientific-research apparatus production, in explosive materials technology (mercury fulminate) and in chemical and pharmaceutical industry (11). Mercury in nature occurs in three forms: as organic, inorganic and metallic mercury (14). Metallic mercury as well as its organic and inorganic compounds are very strong poisons (1).

Main danger for people is occupational exposition and environmental pollutions. Occupational exposure occurs in work places where metallic form of mercury or its salts are used: in mining and distillation of cinnabar ore (mercury sulphide), when producing chlorium and lye by electrolytic methods, when producing metal alloys, dyes, fungicides, when producing and using mercury apparatus. Hence exposed are workers of laboratories, dentist's offices and photographic laboratories (9, 15). In the environment mercury occurs as a result of atmospheric emissions, passing into soils and water when paper producing; gold separating, oil products and coal burn and some pesticides using (1).

Metallic mercury is poorly absorbed by skin (0.1%) and to a higher extent by the alimentary canal (2%). The main way of its penetration is the respiratory system (80%) (1). That is why consumption of metallic mercury from thermometer does not induce any toxic effects, and it is excreted with faeces in the same form (13). Mercury vapours indeed show significant toxicity. By the respiratory system mercury vapours get into the circulatory system, where in the erythrocytes the biggest part of mercury is oxidized into bivalent cation (9) by enzymatic system catalase – H_2O_2 (13), and the remaining part of elementary mercury gets into the brain (1). Inorganic mercury compounds are accumulated in kidneys (90%), liver and in the central nervous system (8).

Organic mercury compounds are particularly dangerous for human, because they cause serious central nervous system damage, and their results are irreversible (5, 17). They are absorbed by the alimentary tract mucous membrane and with blood they are distributed into all tissues. They are accumulated mainly in brain tissue, kidneys, liver, muscles and bones (9). Organic mercury compounds half-life in kidneys amounts to 70 days, for the most of inorganic salts it is about 40 days and for mercury vapours – 60 days (1, 13). In comparison, half-life of mercury compounds in the brain is stated for 27 years (8). Mercury and its compounds, similarly as in the case of cadmium and lead, show big affinity to sulfhydryl groups and thanks to that they are easily bound to transporting proteins

but also they negatively influence numerous cell processes, because they bind to enzymes (1). Binding to proteins of cell membranes mercury leads to cell death (9).

In acute mercury poisonings symptoms like metallic taste, thirsty, strong stomach aches, vomiting, diarrhoea, and anuria occur. Mercury vapours inhalation leads to sialorrhoea, metallic taste, acute bronchitis, bronchiolitis, pneumonia, kidneys and central nervous system damage. The symptoms of organic mercury compounds poisoning are mainly: durable and irreversible central nervous system damage, tachycardia, headaches and even acute respiratory failure leading to death (1). In chronic poisonings the main symptoms are headaches and vertigo, disorders of sleep, concentration and memorizing, mercury neurosis (moodiness states from aggression to depression) and escalating with time hands shaking (12).

Mercury is thought to be a nephrotoxic metal (9). Based on numerous researches it was stated that mercury could cause damage in kidneys through two mechanisms. One of them puts on important antioxidant enzymes (SOD, CAT, GPx) (8) activity lowering by mercury. It results in increased production of free oxygen radicals and peroxides (7), which cause cell damage (9). The second mechanism is based on the thesis of immunotoxic action of mercury (11, 14) involving the production of antibodies against antigens of glomerule basilemma (immunoglobulins of IgG class) and accumulation of immunocomplexes, which together in consequence leads to glomerulonephritis on autoimmunological bases (pseudomembranous glomerulitis) (1, 9). Immunomodulating properties of mercury (18) are also shown in its ability to lymphokines stimulation and activating action on human T lymphocytes and thymocytes in *in vitro* studies (1). Mercury also influences the cardiovascular system causing myocardium contractility reduction (16). That metal, thanks to strong affinity to –SH groups, inhibits Na⁺K⁺ATP-ase and Ca²⁺ATP-ase activity (10) – enzymes playing important roles in proper heart functioning. The presence of Hg⁺ cations disturbs correct intra- and extra-cellular calcium distribution, which is directly connected with functional disturbances while contraction, diastole or both of those phases during heart working (4). Moreover, mercury and its compounds are allergy-inducing factors. Contact dermatitis occurs mainly in health service workers (dentists, dental technicians and nurses) (6). Allergenic action of organic mercury linkages is also very important. The example can be metriolat (thiomersal), which because of its bactericidal properties is widely used as a disinfectant for conservation of cosmetics, medicines, vaccines and fluids for keeping contact lens (1).

Mercury can bind to elements of nucleolar chromatin and with DNA, which can lead to genetic regulation disorders (9). Similarly as in case of lead International Agency for Researches on Cancer (IARC) has classified mercury and its compounds as carcinogenic agents of group 2B (possible human cancerogenic factors) (11). Epidemiological studies showed more frequent occurrence of lungs cancer in workers exposed to Hg than in general population. Furthermore, studies carried on among people exposed to organic mercury compounds showed more often deaths because of liver and oesophagalgia tumors (3, 11).

Negative effects caused by mercury compounds can be inhibited by selenium (2). It was observed that the presence of selenium in intoxicated rat diets decreased toxic symptoms of mercury poisoning. It can occur by competition of those elements in binding to some protein and amino acids or by protective action of selenium on oxidation disturbances in cells (13).

Mainly kidneys excrete mercury soon after its absorption but slowly and for a long time. That metal is also excreted by salivary glands. They are irritated causing sialorrhoea that is one of the early symptoms of mercury poisoning. That element is also present in sweat (13).

The symbol of mercury danger became tragedy in bay in Japan on Kiu-Sziu Island. Plastic factory poured out its sewage into bay water. There some bacteria methylated mercury and it got into fish organisms. In 1953 in the fishing village on the bay the first child with mercury-caused brain damage was born. In the following years the amount of newborn children with mental retardation increased, and adults had strange disease, the characteristic symptoms of which were sight, hearing and motion

disorders. In 1959 it was stated that the origin of that disease was mercury poisoning (1, 8). Mercury pollutions limitation is one of the factors decreasing the risk of occurrence of these metal poisonings.

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SUMMARY

Heavy metals are too well-known environmental pollutants of particularly serious health hazard to human health because of the effects of their actions are not immediate, but they show up after many years. Due to their wide usage in many industrial branches they are present everywhere in the air, water and soil. Food contaminant by heavy elements is hard to avoid and it is a result of environmental contamination by dusts, industrial gases, sewage, waste and coal burning processes. The content of heavy metals in the environment is quite diverse and their harmful action depends on the type of element, the chemical form of their occurrence and the state of organism's nutrition. One of the very toxic and also very frequently used heavy metal is mercury. Exposure to mercury can cause immune, sensory, neurological, motor and behavioral dysfunctions.

Rtęć – wpływ na procesy biochemiczne organizmu ludzkiego

Metale ciężkie należą do tych zanieczyszczeń środowiska, które są szczególnie groźne dla zdrowia człowieka, ponieważ skutki ich działania nie są natychmiastowe, a ujawniają się po wielu latach, nawet pokoleniach i nie są w pełni poznane. Zanieczyszczenie żywności pierwiastkami ciężkimi jest trudne do uniknięcia i jest odzwierciedleniem skażenia powietrza, wody, gleby przez pyły, gazy przemysłowe, ścieki, odpady, a także procesy spalania węgla. Zawartość metali ciężkich w środowisku jest dość zróżnicowana, a działanie ich zależy od dawki pobranej, rodzaju pierwiastka, postaci chemicznej, w jakiej występują oraz stanu odżywienia organizmu. Jednym z bardziej toksycznych, a jednak szeroko stosowanych metali ciężkich jest rtęć. Narażenie na ten metal, jak również na jego organiczne i nieorganiczne związki może powodować zaburzenia i choroby immunologiczne, neurologiczne, motoryczne oraz behawioralne. Najsilniejszy szkodliwy wpływ rtęci dotyczy ośrodkowego układu nerwowego. Powoduje ona również uszkodzenia nerek, nadciśnienie, deformuje kości, powoduje zmiany nowotworowe.