

Impact of Mercury on Human Health

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Abstract:

Mercury exist naturally and it is an environmental contaminant that exposed humans, this contact is more general than anticipated. In the amount of atmospheric mercury, discharge of treated mercury can result to an advanced upsurge that enters the atmospheric-soil-water distribution cycles. The poisoning by mercury is the outcome of introduction to mercury or mercuric compounds that result in several poisonous effects which depends on its route of exposure and chemical form. It is widely used in human actions and acquaintance of this metal from both artificial and natural sources is considerably growing. Excessive contact to mercury brings about modifications in central nervous system (CNS), cardiovascular system, renal system, immune system, which possibly result in fatigue, irritability, tremors, headaches, behavioral changes, incoordination, dysarthria, hypertension, hallucinations in human and animals that has extensive significances, comprising variations in endothelial functions. This review paper, indicate the mercury exposure, effects of mercury on human health including endothelial and cardiovascular function, central nervous system.

Keywords: Mercury, Endothelial and Cardiovascular Function, Central Nervous System

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Introduction

The Mercury is considered as the heavy metal of recognized toxicity that is distinguished for the purpose of health disaster of public. It exists in several forms that is inorganic mercury (Hg^0) and mercurous (Hg^{2++}) or mercuric (Hg^{++}) salts; and organic mercury, which contains compounds in which mercury is attached to a structure comprising carbon atoms (methyl, ethyl, phenyl, or such similar groups). The various forms of mercury contain chemical configuration in biological performance, medical importance, and pharmacokinetics. The human health is affected by the exposure to mercury, while variations occurring due to human contact to mercury called for the consideration of medical and scientific world.

According to US Government Agency for Toxic Substances and Disease Registry, the mercury ranked as third and the most poisonous components or constituents on planet to lead and arsenic which endures to be discarded into water-soil, tainted into the atmosphere and also consumed into water and food. By increasing 1.5% of mercury per year, human actions have tripled the sum of mercury in atmosphere.

Below this figure represent the multiple means through which humans come in contact to mercury.

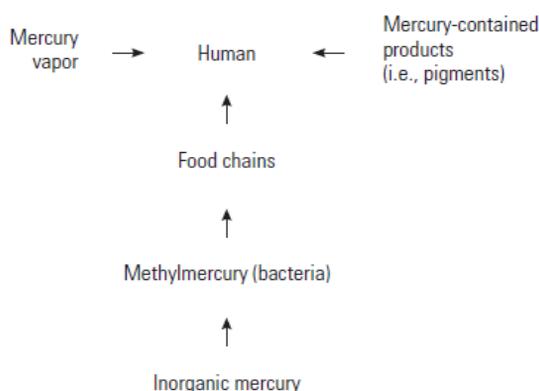


Figure 1: Mercury route for Exposure in Humans

Ecological mercury basically occur in its fundamental form that is inorganic and organic mercury. Initially Mercury exist as in liquid form, which even though of its low vapor ($2 \mu\text{m Hg}$), can be transformed in the room temperature as vapor considering its low latent heat of evaporation and its comparative nonappearance from immediate surrounding air. Due to burning of mercury or

mercury vaporization, toxic vapors are formed that contain constituents which can get into the respiratory system and pass freely into circulation.

Mercury Characteristics

At normal temperature and pressure, mercury is considered to be a highly malleable liquid. Mercury is mainly categorized into three different classes: elemental, inorganic and organic mercury. The mercury occurs in varied arrangements: inorganic mercury basically consists of metallic mercury and mercurous i.e. Hg^+ or mercuric i.e. Hg^{++} salts and metallic mercury; whereas organic mercury, which is also termed as organo-metallic conclusively form covalent bond between the carbon atom and mercury of an organic functional group like phenyl, methyl or ethyl group.

Inorganic Mercury Compound

Elemental Mercury or Metallic Mercury Compounds: This type of mercury is hardly absorbed and show very less danger to one's health in its liquid form but when it is present in vapor state, elemental mercury is freely absorbed by lungs and thus leading to devastating harm to the body. Elemental or metallic mercury is hugely intermingle by diffusion and hence capable of passing with the help of blood-brain, cell membranes and placental obstructions to effect the target organs because of its soluble characteristics. Mercury endures peroxidase-mediated oxidation and catalase in RBCs as well as tissues in bloodstream and later changed into mercurous mercury and inorganic mercuric mercury. Hence that procedure restricts the rate of absorption. The inorganic mercury consist of low lipophilicity with restricted capacity to cross cell membrane. Elementary mercury is helpful in sphygmomanometers and thermometers due to constant lack of vitreous adherence to surfaces, volumetric expansion and high surface tension. Metallic mercury are allowed to be used to high thermal conductivity and low electrical resistance in electrical and electronic materials. Metallic mercury utilizes in electrochemical process in soda and industries of chlorine due to its high oxidation power.

Mercuric Mercury and Mercurous Mercury Compounds: The mercurous mercury is type of mercury which is very less absorbed in the body and present in mercurous chloride form. The usage of metallic mercury is altered into both the mercuric

mercury and elementary mercury in the human body. Mercuric mercury is the amalgamation of mercury with sulfur, chlorine or oxygen. Mercuric mercury also spotted in diverse forms like HgCl_2 i.e. mercuric chloride, considered highly lethal and corrosive; mercury sulfide (HgS), that frequently helpful for pigmentation of paints the since of its red color; mercury fulminate i.e. $\text{Hg}(\text{CNO})_2$ is reflected as an explosive detonator. These compounds are utilizes as a preservative for the purpose of development of photographic film then it is swallowed inadvertently or for suicidal purpose. Mercuric mercury is bind to the sulfhydryl groups or erythrocytes, glutathione or metallothionein in blood stream and is transferred or postponed in plasma. This mercury amasses in fetal tissues, amniotic fluid and placenta and hence do not cross the barrier of blood brain skillfully.

Organic Mercury

It is also called organometallic that give the outcome from a covalent bond mutually shared between mercury and carbon atom of an organic functional group such as methyl, ethyl, or phenyl group. Methyl mercury reacts with sulfhydryl groups across the body, consequently possibly interrupting the functioning of any cellular or subcellular structure. Mercury is implicit to obstruct with protein synthesis and DNA transcription which involved the protein synthesis in the developing brain with annihilation of endoplasmic reticulum and desertion of ribosomes. It is connected with decrement of NK cells i.e. Natural Killer cell movement and disproportion in Th2:Th1 ratios backing auto-immunity.

Effect on Central Nervous System

In the mercury compound, methyl mercury is principally accountable for the neurological modifications present in animals and humans. Its contrivances are associated to deadly growth in reactive oxygen species (ROS). Wounds are instigated by methyl mercury in CNS that are associated to the capacity to intensify the oxygen species reactive. Nervous system effected by mercury is intrusion with the making of energy which basically weaken cellular purification procedures affecting the cell to die or live in a condition of chronic malnourishment. Mercury is related with amplified tissue oxidative destruction, and children having autism had suggestively excessive urinary levels of lipid peroxidation while compared to controls. Mercury can harm the blood brain barricade which enables permeation of brain by

other lethal metals and substance in central nervous system. The consequence of mercury on central nervous system causes symptoms including paranoia, depression, , inability to concentrate, extreme irritability hallucinations, tremors of the hands, head, tongue, lips, jaw and eyelids, memory loss, weight loss, continuously low body temperature, headaches, drowsiness, fatigue, and insomnia. Mercury also causes numerous influences on other sensory systems including retinopathy, blindness, hearing loss optic neuropathy, abnormal touch sensation, and a reduced sense of smell.

Effect on Cardiovascular System

Effect of mercury mainly concerned to CNS but inorganic mercury too generates intense damage to heart muscles. Prenatal contact to methyl mercury may disturb growth of cardiovascular homeostasis, in toddlers with lower birth weight, systolic and diastolic blood pressure, increase 13.9mm Hg when cord blood mercury concentration upturn from 1 to $10\mu\text{g/l}$ cord blood. Mercury contact associate with augmented threat of myocardial infarction coronary dysfunction, atherosclerosis, and hypertension. Oxidized low-density lipoprotein (LDL) have the stages of mercury levels. It is repeatedly spotted in atherosclerotic abrasions that are connected with progress of atherosclerotic disease and acute coronary inadequacy. Through the inactivation of "paraoxonase", toxic mercury effect on cardiovascular system i.e. enzyme which reduces the LDL oxidation procedure and that contains significant anti-atherosclerotic action. Deadly consequence of mercury showed on heart, blood and blood vessels that is not completely explicated and this tool is assumed to comprise an upsurge with the oxidative pressure. Connection with mercury upsurges generation of free radicals, hypothetically in Fenton reaction because of the major part of mercury [111–113] and a decrease in the measure of antioxidant enzymes, like as glutathione peroxidase.

Effect on Renal System

Mercury level tends to accumulate more in kidney as compared to brain and liver. Nuclear factor κB (NF- κB) is a thiol-dependent transcriptional aspect that helps cell existence and guards cells from apoptotic incentives. Mercuric ion Hg is known one of the sturdiest thiol-binding mediators that harms NF- κB activation and DNA binding at less μM concentrations in kidney epithelial cells resulting to apoptosis. In this, proliferate the plasma creatinine

level upon methyl mercury inebriation for 5ppm mercury by renal dysfunction. By using mercury, causes to damage kidney and proposes an association between mercury subjection and severe tubular necrosis, chronic renal disease, glomerulonephritis, nephrotic syndrome, and renal cancer. Subjection to mercury can lead to several kidney damages comprising: tubular dysfunction, syncretistic nephrotic syndrome, nephritic syndrome, subacute-onset nephrotic syndrome, nephrotic-range proteinuria, secondary focal segmental glomerulosclerosis, membranous glomerulonephritis, and glomerular disease.

Effect on Immune System

By failure of immune system, chronic infectious diseases are not caused but are a sentient variation of the immune system to an otherwise fatal heavy metal environment". Immune system function is damaged by mercury that is most probable to its deadly influences on the polymorphonuclear leukocytes (PMNs). Mercury through destruction of adrenocorticosteroids generation stops usual excitation of PMNs fabrication and also distresses PMN functioning by constraining their capability to finish foreign substances. Allergies, asthma, and autoimmune-like symptoms are developed by mercury, especially rheumatoid. In central nervous system, mercury can produce an immune response and induce alteration in immune cell production and function. Increased levels of mercury by ingestion of mercury with bacteria, molds, and yeasts which are thought to function in a protective manner to absorb excess mercury body. Mercury effects on immune system of human body that includes amyotrophic lateral sclerosis, allergic disease, arthritis, autism/attention deficit hyperactivity disorder, autoimmune thyroiditis, epilepsy, eczema, multiple sclerosis, psoriasis, rheumatoid arthritis, scleroderma, systemic lupus erythematosus, and schizophrenia.

Effect on Reproduction

In case of concentration of methyl mercury is quite excess in mothers, they do not conceive but in case of low concentration of methyl mercury, they have low degree of pregnancy, the foetus is either terminated or is stillborn. At even lower doses conception and live birth happened but child agonized from grave neurological indicators. In case of male, mercury have adversative consequences on epididymal sperm count, testicular weight, and

spermatogenesis. But in case of female, toxic mercury inhibit the discharge of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) from the frontal pituitary that disturb estrogen and progesterone stages resulting to painful or irregular menstruation, ovarian dysfunction, tipped uterus, premature menopause.

Review of Literature

Langworth et al. (1997), concluded that subjection to mercury vapor in dentistry can range at higher levels. Reduce the exposure of mercury by improving nominal apparatus and improved criterions of hygiene. Completed the health screening program by participants in which includes examination of mercury in urine. The U-Hg stages were predominantly connected to number of amalgam restoration placed, hours of practice, type of cooling and heating system, and type of amalgam capsules used method of amalgam preparation and application. The subjection of mercury induces the contrary health effects in dentistry.

Hyman (2004), dictated that population cannot meritoriously expel mercury and is at superior hazard than overall population and that this vulnerability is probably because of diet, genetic differences, antibiotics, exposure to other toxicants, etc. According to this paper, mercury is a threat cause in numerous diseases but can be measured securely and body decontaminated, extenuating some of its consequences.

Bridges and Zalups (2010), concluded that mercuric ions are transported to various organ system and tissues. In various organs and tissues, engrossment of amino acid, drug and anion carriers in acceptance and exudation of mercuric ions. Intestinal absorption of Hg^{2+} and CH_3Hg^+ happens, the thorough contrivances engaged in the acceptance and exudation of mercuric ions by enterocytes have not been recognized.

Stow et al. (2011), in arctic, exposure of mercury at current levels have adverse impacts on human health, mainly developing in fetus and children and required the further research to regulate the subtle influences of mercury on human healthiness that are persistent. In arctic population, needed to relationship between mercury and cardiovascular disease in further research.

Houston (2011), concluded that mercury brings in the mitochondrial dysfunction with lessening in

ATP, diminution of glutathione and upsurge in lipid peroxidation. Oxidative strain and decrease in oxidative security are common. Mercury effects on vascular that contain some symptoms including reduction in oxidative defense, oxidative strain and inflammation, vascular smooth muscle dysfunction, thrombosis, dyslipidemia, immune and mitochondrial dysfunction, and endothelial dysfunction. The medical consequence of mercury including CHD, hypertension, MI, sudden death, cardiac arrhythmias, increased carotid IMT, reduced heart rate variability, CVA, carotid artery obstruction, renal dysfunction, generalized atherosclerosis, proteinuria and insufficiency.

Nabi (2014), concluded that pathways of mercury by means of food, air, water, cosmetics, pharmaceuticals etc. that are impact on human health and aspects like bio-magnification of mercury along the food chain ambiguous the issue. By several studies, effect of toxic mercury as industrial health danger for chloralkali workers, dental personnel, and goldminers.

Rice (2014), concluded that earliest record of China, in which “Mad Hatter disease” was occurred by the effect of mercury toxicity due to which several people was lost. But in Japan “Minamata disease” was occurred that was spread by the mercury and so many people was lost.

Conclusion

Mercury plays an important role in various numerous organ system and tissues of human. Increasing the impacts of mercury on the health of human over the years by estimation of epidemiological concerns. Mercury effects contain the pathways due to which toxicity effects are occurred such as air, food, water, pharmaceuticals and cosmetics etc. The complete influences of mercury on renal, cardiovascular system, central nervous system, reproduction and immune system of human health due to which some symptoms are seen such as irritability, fatigue, behavioral changes, tremors, headaches, dysarthria, incoordination, hallucinations, hypertension. In case of lesser dose of mercury, noxiousness effect is quite low and security precaution is not engaged generally.



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