

A Review Paper on: Cadmium Toxicity

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Abstract

A review has been made of current knowledge, published and unpublished, relating to cadmium toxicity. Cadmium is a heavy metal that occurs as a natural constituent in earth crust along with Copper, Lead, Nickel and Zinc. Cadmium is vastly used in batteries, coating, plating, alloys etc in various industries. Human are commonly exposed to cadmium by inhalation and ingestion. Cadmium enters in air and binds to small particles where it can combine with water or soil causing contamination of fish, plants and animal in mono form. Spills at hazardous waste sites and improper waste disposal can cause cadmium leakage in nearby habitats. Foodstuff like liver, mushroom, shellfish, mussels, cocoa powder and dried seaweeds are cadmium rich increasing the concentration in human body and in food chain lead to acute and chronic intoxication due to bio magnification. Health effects include diarrhea, stomach pain, bone fracture, reproductive failure and possibly even infertility, damage to central nervous system, psychological disorders. The organic matter in soil absorbs cadmium increasing the risk of survival of various plants and also increase uptake of toxin metal in food. The review is about the study of toxicity mechanism of cadmium in human beings and plants and biological phenomena involved.

Keywords: Cadmium • Vitamin D • Electrolysis • Stabilizers

Introduction

Cadmium naturally occurring metal and it is derived from the Latin word *camia* and the Greek word *kadmia* the ancient name of calamine. The symbol is Cd and atomic no 48. It was discovered in 1817 by Stromeyer and Hermann, both from Germany. It is found as an impurity in zinc carbonate. It situated between zinc and mercury. It present as divalent ion in nature [1].

Cadmium is used in television screen, lasers, batteries, paint pigments, cosmetics. 600 metric tons are produced annually in United States pigment coating, electroplating of steel, nuclear reactors. An alloy is made by mixing and melting of two or more metals. Consumer products-cigarette, craft glaze, jewelry, metal coating. Usage of phosphate fertilizers.

Most cadmium metal today is use as a byproduct of the extraction, smelting and refining of the nonferrous metals like zinc, lead and copper. Disposing the waste into environment have unique properties of specific industrial properties. Cadmium is also produced from recycling of spent nickel cadmium batteries its largest use [2].

Cadmium is soft, malleable, ductile, silvery white metal. Cadmium is resistant to corrosion and use as protective layer on other metal. It burns and release toxic fumes.

Unique physical properties are use in pigments, coating, stabilizers, specialty alloys and electronic compounds but mostly in rechargeable nickel cadmium batteries. Almost all of these uses today are industrial uses as opposed to consumer uses. The recent trends in consumption of cadmium in application where cadmium is a deliberate addition and not an impurity.

Literature Review

Cadmium is an element which classified as transitional metal. Cadmium has vapor pressure of 1 mmHg at 394 degree integrate and is odorless. Cadmium is restricted to corrosion. Cadmium metal and its oxides are insoluble in water. Occurs in oxidation state of +2. Some cadmium salts are water soluble such as cadmium chloride, cadmium sulfate, cadmium nitrate; other insoluble salts can become more soluble by interaction with acids, light and oxygen. The melting point of cadmium is 321 degree centigrade [3].

Oxidation state of cadmium is +2. It also exists as +1. Cadmium burns in air to form brown amorphous cadmium oxide. Hydrochloric acid, sulfuric acid and nitric acid dissolve cadmium by forming cadmium chloride (CdCl_2) (Volpe AR).

In higher organisms it has no known function. It found in some marine diatoms. Increase the level of antioxidants to protect the cell against macro molecular damage.

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At the surface, metal present extremely at low concentration where photosynthetic activity deplete algal nutrients and due to decomposition of organic matter the concentration increase in depth. Cadmium replaces zinc under the condition of zinc concentration. Cadmium can be used to block cadmium channels in chicken neurons.

Human exposure to cadmium is inhalation and ingestion. Ten to fifty percent is absorbed in dust depend upon the size of particle [4]. Cigarette smoking effects on kidney and blood Cd level increase in smokers than non-smokers. Welding can produce severe chemical pneumonitis. Contamination of drugs and dietary supplements is the source of contamination.

Cadmium is transported throughout body after absorption. 30% absorbed in kidney and 30% absorbed in liver. Half if of cadmium is 75 to 128 days but half-life does not represent deposition in organs not clearance from the body. Cadmium is poorly present in hair, urine and blood. Body burden of cadmium will require urine provocation testing [5].

Cadmium induces tissue injury through oxidative stress, epigenetic changes in DNA expression, inhibition of home synthesis, impairment of mitochondrial function potentially inducing apoptosis. Depletion of glutathione has been observed. Effects are magnified by other metals such as Pb and As [6].

Clinical toxicity of cadmium depends upon route, quality and rate of exposure. Diabetics are more susceptible to renal damage from cadmium exposure than controls. Cadmium may also impair vitamin D metabolism in kidney [7]. The most important example is itai-itai disease in Japan. Which combine severe pain from osteomalacia with osteoporosis renal tubular disinfection, anemia and calcium mal absorption. Cadmium affects the cardiovascular system in several ways. Cadmium is apparently brought into vascular wall by cadmium laden monocytes. Calcium exposure is known as risk factor for developing insulin resistance [8]. The cadmium effect on insulin resistance minimized by Fe, Ca, Mg and Zn. Distribution of major nutrients water column distribution is important. At the surface metal present extremely at low concentration where photosynthetic activity depletes agal distribution. Cadmium is the good example of which has a nutrient like profile and the accumulation of the cadmium is fossilized test of marine invertebrates. Marine invertebrate are use past nutrients concentration in the sea [9].

Cadmium is considered as toxic metal and hazardous to both human and animal life. It also stimulates cell proliferation, apoptosis and inhibits apoptosis. It induce cell death which leads to tissue damage in kidney. Cadmium affects renal function. The role of cadmium in induction of atherosclerosis in rabbits. Effects of cadmium is shown for 6 months on biochemical changes.

Sperm concentration in serum is very important factor in reproduction cadmium exposure decrease sperm count in serum.

Cadmium acute exposure leads to inflammation such as cough, drynrrs, irritation of nose and headache, dizziness. Cadmium is found in tobacco air and food *in vitro* exposure effects endothelial

dysfunction and causes cardiovascular disease. Cadmium may interface with anti-oxidative stress by binding to metellothionein [10]. Cadmium induces hormone disturbances like affect in vitamin D metabolic pathways that is calcium related bone change to release bone change. Cadmium increases the concentration of estrogen receptor and its binding. Cadmium affects others tissues such as lungs, diabetes, hypertension, mammary glands, periodontal tissues. Cadmium blood pressure association disorder was greatest among non-smokers, intermediate among former smokers, absent from current smokers. Cadmium level increase diabetes.

Buildup of cadmium levels in air, water, soil has been occurring particularly in industrial areas. Environmental exposure to cadmium has been particularly problematic in Japan where many people consumed rice that was grown in cadmium-contaminated irrigation in water. This was how as ithai-ithi disease. Food is another source of cadmium. Plants contain small amount of cadmium in non-industrial areas, but high level in kidney and liver of adult animals. The daily intake of cadmium through food varies by geographic region. Intake is reported to be approximately 8 to 10 microgram in Europe.

Smoking is a significant source of cadmium exposure. Even small amount of cadmium from smoking is highly toxic to human exposure, as the lungs absorb cadmium more efficiently than the stomach [11].

In fab 2010 cadmium was found in entire line of Wal-Mart exclusive milly cyrus jewelry. This charm was tested at behest of the associated press and were found to contain high levels of cadmium. On June 4 cadmium was detached in paint use in promotional drinking glasses for the movie Shrek Forever After sold by McDonald's restaurants triggering a recall of 12 million glasses.

Cadmium and its components are highly toxic and exposure is known to cause cancer. It is primarily associated with lungs, porstate, kidney cancer and recently cause pancreatic cancer. It also associated with brest cancer and urinary cancer.

Healthy people 2020 target

Level of cadmium in blood samples for 95% of the population aged 1 year and older to below 1.12 microgram per liter. Healthy people in 2020 set of goals set by fourth by the department of Health and Human Sciences [12].

Contact can irritate eye and skin. Exposure to cadmium may cause metal fume fever. This is flu like illness with symtoms of metallic taste in a mouth headache, fever, and cough. Cadmium can cause vomiting, nausea, abdominal pain. Inhaling cadmium can irritate lung causing coughing and short breathe. It may affect male and female reproductive system. It may cause anemia, loss of sense of smell.

The kidney is the critical target organ for general population as well as for occupation exposed populations Cadmium accumulate for long time and at high dose is known to produce health effects and associated with bone disease.

Discussion

Globally, heavy metal pollution is a major issue which has seriously threatened sustainability of environment. The toxic heavy metals emerging sources like industries, tannery, sewage waste and other metals discharging industries have been found adversely affect the density, physiological activities of soil micro bacteria [13]. Among various heavy metals, cadmium heavy leather metal is widely used in batteries. For coating electro plating, PVC stabilizers and as components in alloys formation in various industries. Due to lack of regulatory policy for controlled and safe discharge cadmium is added to the environment through anthropogenic effects like combustion of fossil fuels. The overuse of and abuse of cadmium has however hugely dented human health by acting as carcinogen and mutagenic elements [14]. Nickel which is present in low concentration in the environment cause serious effects. For instance, Ni can cause gene to toxicity, several cancerous types, toxic effects on immune system, damage to other metabolically active tissues.

Some of the destructive impacts of heavy metals on microbes are alternation in cell surface morphology and growth behavior. Cell membrane disruption. Inhibition of enzyme activity. Oxidative phosphorylation leading to lipid peroxidation. Denaturation of microbial proteins.

Nowadays, cadmium exposure has decreased in many countries but it is very long biological half-life and human activities related to cadmium should be restricted to minimal or harmful effects. Cadmium considerably exists in environment, as a result of human activities, such as the use of fossil fuels, metal ore combustion and waste burning. Leaking sewage sludge to agriculture soil may cause cadmium compounds absorbed by plants and accumulate various human organs [15].

Cadmium accumulates in liver. Low molecular weight protein called metal othionin in liver from complex with cadmium. Released from liver into blood and in various organs of body. Prolonged exposure result increase in body deposit material in kidney.

Cadmium can be taken in orally chronically without risk of adverse health effects, is 0.0002 mg/kg/day of cadmium based on its renal effect [16].

Wash hands with water after handling chemicals. In case of any serious case contact your local poison center. Confusing measure may include:

- Enclosing chemical processes for severely irritating and corrosive chemicals.
- Using local exhaust ventilation for chemicals that may be harmful with single exposure
- Using general ventilation to control exposure to skin.
- Before entering a place with cadmium make sure that explosive concentration does not exist.
- Use high effective particulate air filter when vacuuming.
- Always wash at the end of work shift.

Most important source of airborne cadmium is smelters. Other sources of airborne cadmium include cadmium burning fossils fuels such as coal or oil and incineration of municipal waste such as plastics and nickel-cadmium batteries. Cadmium may also escape into the air from iron and steel production facilities [17].

When released into the atmosphere by smelting, cadmium compounds can be associated with reliable-sized airborne particles can be carried out long distances. It is deposited onto earth below by rain water. Once on ground, cadmium moves easily through the soil layer and is taken up into the food chain by uptake of plants such as leaf, vegetables, roots, grains [18].

Cadmium oxide also exists as small particles in air fumes which are result of smelting soldering. A certain percentage of these particles are reparable.

From the soil, certain plants take up cadmium more avoidly then they do other metals such as lead and mercury [19]. Cadmium also found in meat, especially sweetmeat such as liver and kidney. In certain areas, cadmium concentration as elevated in shellfish and mushrooms [20]

There are negligible amount of cadmium exposure through skin. It is not considered a major route of exposure to this chemical. However background levels of cadmium in food, water and ambient air are not health concern for general North America population. For example in the Jinzu and Kakehashi river basins in Japan, there are areas with soil contamination with cadmium with rice that absorb cadmium and life time eating this contaminated rice can lead to a serious kidney and bone disorder called itih-ithi disease especially in women.

Safety standards

With increasing evidence of cadmium toxicity both national and international agencies have sought to regulate its exposure. Because much is known to the toxic and health effects of cadmium there is large data base from which to set standards for occupational exposed to cadmium [21]

OSCHA has established workplace levels to protect the health of people occupationally exposed to cadmium. The OSCHA limits are:

- Permissible exposure limits TWA: 5 microgram per meter cube.
- The National institute of occupational safety and health has set an intermediately dangerous to life and health level which 9 mg/m cube.
- Drinking water-maximum commitment level for cadmium in drinking water 0.005 mg/L
- Soil EPA bio soils rule states that amount of cadmium that applied on soil is 85 mg/kg fill material.
- Cadmium toxicity has effects on human health and animals.

Study to human health issues by focusing on carcinogenicity, nontoxicity, circulatory disease and life expectancy. Currently cadmium considered carcinogenic for human health. Induce cancer in

different tissue of animals in laboratory. There are inconsistent reports on relationship of cadmium exposure with the life expectancy of people living in cadmium polluted areas [22].

Conclusion

Cadmium is heavy metal hazardous to all living organism here it effect on various organisms were studied. Cadmium involves different mechanisms to include its harmful effects on many biological activities. In human adverse effects of cadmium on liver kidney and all organs of body accumulates which argue for public health measure aimed at reducing exposure. There are many methods by which this heavy metal can be suppressed in its activities forming the future perspective for reduce metal toxicity involving cadmium toxicity. The preventive measure in high risk patients must be practiced and important to make preventive stages for people and limiting cadmium industrial releases into the enviorment helping to avoid cadmium toxicity.

Cadmium can be removed from drinking water with sodium from caution exchanger. Reverse osmosis will remove 95% of cadmium in the water. Electrolysis will also remove the majority of cadmium. Human normally absorb cadmium into the body either by ingestion dermal exposure is generally not regarded to significant. It is widely accepted that approximately 2% to 6% of the cadmium ingested is actually taken up into the body.

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