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Study of Lead Pollution, Impact on Health and prevention

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Abstract
Lead is soft metal and stable metal which is often used in manufacturing of batteries and as anti-knocking additive in gasoline. Some European countries, USA and Canada phased out leaded gasoline due to research which indicates that 60% off all lead emission come from automobile exhaust. Other major source of lead includes mining, smelting and refining of lead, nickel and copper ores. In water, lead tends to accumulate in aquatic organism through food chain and by direct uptake. Accumulation of lead in soils occurs at municipal waste sites because of various electronic components, ceramics and batteries. Lead is believed to cause hypertension, reproductive disorders, neurological and metabolic problems. The present study is an overview of sources, health issues, control and prevention of lead pollution.

Key Words: sources of lead, lead pollution, lead poisoning, health issues, control, prevention.

I. Introduction

Lead is one of the oldest metals known to man. The word "lead" is of Anglo-Saxon origin. It is one of seven metals discovered by men in early stages. Since decades it has found wide range of applications and is therefore, prevalent in natural environment. It is naturally found as ore Galena (PbS). The average lead content of igneous rock is about 15 ppm. It is concentrated as sulfide deposits in many parts of the world which is easily minded and smelted. Ancient peoples used lead for ornaments, dish trays, as a core for bronze statues, as sinkers for fishing Nets etc. Greeks and Romans used lead for sweetening the bitter taste of food cooked in bronze pots, storing olive oil, preparing wine etc. However, it is a dangerous and insidiously deceptive poison. Kids and youngsters are the most common victims of lead poisoning.

Sources of Lead

Lead has been mined and used by man from ancient times. It is naturally occurring heavy metal and also found in air, water, food stuff, soil and dust either from natural or anthropogenic source. Its ductility, high strength, high density, impermeability and other properties make, it a very useful metal. It is bluish white transition metal.

Lead is used in acid storage batteries, ammunition, solder and casting materials. Lead coated steel sheets have sound attenuation properties and are commonly used in construction of apartments. Lead-asbestos anti-vibration pads are employed in foundations for buildings exposed to vibrations from nearby rail or road traffic. Leaded porcelain enamel is used as a protection against radiation in nuclear powered reactors. Collapsible tubes, caulking materials and corrosive liquid containers are also made from lead. Anti-corrosive and highway traffic safety paints incorporate lead salts. Lead monoxide, also called litharge, is an orange-yellow pigment that is used in glazing pottery. When acidic foods, like fruit juices and pickles, are stored in improperly glazed earthenware, lead slowly leaches from the glaze and becomes a component of the diet. Lead enters drinking water from old conduit water pipes.

Tetra ethyl lead, is an important gasoline additive. Though an extremely poisonous substance, it possesses anti-knocking characteristics. During combustion of gasoline, it is converted into lead oxide. The latter is subsequently reduced to elemental lead that gets deposited in the combustion chamber. The deposit causes slow corrosion of the engine. In order to avoid the degradation of the engine, a mixture of ethylene dibromide is added to gasoline. During combustion, lead (II) chloride and lead (II) bromide are produced. These halides are not only resistant to reduction but are also volatile and are therefore, emitted with exhaust.

Estimation

Though there are several techniques for analyzing environmental lead, the spectrophotometric method is the most popular. In this method, lead is extracted from the environmental sample as a colored lead dithizonate complex. The color intensity of the complex reflects the concentration of lead.

If lead is to be determined in blood, tissue, soil or vegetation, the sample is digested in a mixture of 80% nitric acid and 20% perchloric acid. Perchloric acid serves to oxidize organic constituents of the carbon dioxide and water, while nitric acid converts lead content into soluble lead nitrate. If the atmospheric content of

lead is to be determined, then air is passed through filter materials, such as fiber glass, asbestos or porous plastic. The residue left on the filter is digested in nitric acid perchloric acid mixture. If lead is to be determined in water, a measured quantity of the sample is evaporated to dryness. The residue which is left out is digested in nitric acid-perchloric acid mixture.

The pH of the digested solution is adjusted to 8.5-9.0 by adding a buffer. Next, a mixture of ammonium citrate, potassium cyanide and hydroxylamine are added. Ammonium citrate prevents the precipitation of alkaline earth and transition metal hydroxides and phosphates. Potassium Cyanide is it masking agent to prevent the extraction of metals, such as copper and zinc. Hydroxylamine is added to prevent the oxidation of dithiazone.

A solution of dithizone in an organic solvent like carbon tetrachloride is then added.The lead content of the sample is converted into lead dithizonate complex.This complex being soluble in carbon tetrachloride passes into organic phase the aqueous phase is discarded.The absorbance of the organic phase is measured by atomic absorption spectrophotometer, (AAS) at 510 nm.Following the Lambert -Beers law, the intensity of the absorbances proportional to the concentration of lead- dithiozonate, and that in turn, is proportional to the concentration of lead in the environment sample.

Lead Poisoning

Lead poisoning also called Plumbism, has proved to be more dangerous to the children then the adults. It is not excreted from our system but stored over many years in our tissues, mainly in bone marrow from where it is released into blood stream to reach the cellular system.It can damage nervous system, kidneys of adults and increase in hypertension.In pregnant women itincreases chances of miscarriage, premature delivery and still birth.Children are susceptible tovarious physiological, neurological, kidney and blood disorder including partial hearing loss or loss of learning abilities.Once the lead enters the human body it tends to concentrate in the bones.It remains in the bones in a relatively inert form causing no ill effect however when the body feels shortage of an essential element like calcium or phosphorus, the blood leeches out these minerals from the bones and supplies it to relevant organ.In this process lead too become labile and enters the blood stream. It then concentrates in the tissues where it imparts toxic effects. Since the metabolic rates are higher in children than in adults, the chances of lead being leached out of the bones are more in case of them.

II. Impact of Lead Poisoning observed in several ways:

1. Enzyme Inhibition

Lead coordinates with the sulphydryl function in enzymes. This causes an inhibition of enzymatic activity. The clearest manifestation of the inhibitory effect of lead is the disturbance in the biosynthesis of heme. The latter is the iron-containing biomolecule that is percussor to hemoglobin, the oxygen carrying pigment of the red blood cells. Heme is also an essential constituent of theother respiratory pigments, the cytochromes, which play key roles in energy metabolism. The decrease in heme biosynthesis leads at first to a decrease in the life span of red cells and later to a decrease in the number of red cells. To compensate the shortage, the blood forming tissue steps up its production of red cells. However, the rate of production is less than the rate of disappearance. Therefore, in a person suffering from lead poisoning, immature red cells, called reticulocytes and basophilic stippled cells, appear in circulation, causing anemia.

2. Kidney Impairment

Acute lead poisoning causes impairment of kidney functions.Lead tends to concentrate in the proximal renal tubules lining. There is an increaseof amino acids, glucose and phosphate in the urine because the damaged tubular cells fail to reabsorb these substances as completely as the normal tubular cells do. The energy storage system of the body suffers. Exposure to even milder doses of lead cause chronic nephritis, a disease characterized by searing and shrinking of kidney tissue.

3. Neurological disorders

Central nervous system effects are the most serious manifestation of lead poisoning. Continuous exposure to lead over prolonged periods causes encephalopathies or brain damage by two mechanisms. Firstly, the blood capillaries reaching the brain start leaking and cause edema, that is swelling of the brain. There is not enough space to accommodate a swelled brain within the periphery of the rigid skull. Therefore, the brain cells get damaged. Secondly, the cells constituting the motor nerve extremities are damaged and the conduction of nerve impulse is impaired. Symptoms of encephalopathy update with the onset of vomiting ataxia, periods of alternative stupor and hyperirritability. Subsequently, they culminate in delirium, convulsions, coma and death. For reasons already cited, children are more sensitive to neurological damage than the adults. In adults, most of the neurotoxic effects are reversed once the exposure to lead ceases. In children they are not.

4. Behavioral problems

When a person is exposed to milder doses of lead, the neurological damage manifests itself in form of behavioral problems. In such cases the symptoms include excitement, restlessness, insomnia, nightmares, impairment of memory and loss of concentration. In adults, these effects are reversed once the exposure to lead stops. The picture with children, however, is very different. In a few cases childhood attacks of symptomatic lead poisoning can produce in a child hostile, aggressive and destructive behavioral patterns so that there may eventually be a demand for institutionalization. In larger number of cases, children suffer because of dulling of mentation and chronic hyperkinesis. The former is followed by educational abnormalities; the latter by an impulsive behavior, with a tendency to violence.

5. Reproductive Problems

Woman employed in pottery works, where exposure to lead is high, are more liable to be sterile than those in general population. If they become pregnant, the pregnancy is more likely to result in miscarriage or stillbirth. If the child is born living, there is a higher infant mortality. Plumbism in father also affects the survival, vigor and fertilization of the offspring.

6. Teratogenic effects

Children born to women who are exposed to lead during pregnancy suffer from convulsions and a form of macrocephaly characterized by a square shaped head. It has also been observed that children born to women who suffered from lead poising during their childhood may also show birth defects. This means a girl growing up in a lead polluted environment, might years later, pass that lead to her offspring. During young age, lead becomes concentrated in the girl's bones. During pregnancy, calcium is removed from a woman's bones and passed to the blood stream. It then enters the placenta to help build the developing embryo's skeleton. In this process lead also comes out of the bones, crosses the placenta and enters the fetus, where it elicits teratogenic effects.

Control and preventive measures

The most commonly used technique to reduce airborne lead emissions is the electrostatic precipitator. Lead-based commodities are being replaced by more environmentally friendly materials. The use of titanium dioxide in place of lead pigments in paints has brought down cases of adverse effects. Unleaded petrol is gradually replacing the conventional leaded gasoline. Reformation of gasoline to produce equivalent octane rating in the absence of tetraethyl lead is accomplished by increasing the somatic hydrocarbon content of gasoline feedstocks and by installing catalytic converters in the automobiles.

In the new townships, emphasis is being placed on urban planning strategies to reduce lead pollution. Major sources of lead in the urban environment originate from automobile exhaust emissions and from industrial stacks. Accordingly, planning to assure minimum human exposure to high lead concentrations requires relocating main traffic, automobile parking complexes and industrial sites in such pockets where the prevailing winds and atmospheric transport directions are away from the areas of high-densitypopulation. This strategy may seem to be of academic interest only, yet it highlights the increasing importance of pollution control measures.

Recovery of Lead from Spent Lead Acid Batteries:

The disposal of scrap batteries is a serious problem which causes environmental concern. An eco-friendly electrolytic route has been investigated for the extraction of lead from scrap batteries. The route comprises breaking of batteries, separation of portions of metallic and lead compounds, desulphurization, leaching followed by electrowinning. The lead compound portion is desulphurized using sodium hydroxide to lead monoxide which is leached with fluoroboric acid. Electrolytically pure lead cathode deposit is obtained by electrowinning.

Electrochemical treatment of dyes in textile, cosmetics, food and pharmaceutical industrial effluents:

Electrochemical method can be successfully applied for the treatment of effluents that are having coloringcompounds. By using electrochemical technique, the color could be removed completely from the intense dark colored solution of Naphthol Yellow S, Rhodamine B, Orange II, Sudan III, Eosin Yellow, Alizarin Red S, Erythrosine, Indigo carmine, Paten Blue VF and Tartrazine.

Eco-friendly utilization of non-biodegradable polymeric waste in modification of bitumen for waterproofing system:

Various methods have been developed for the effective utilization of polymeric wastes in the bitumen for waterproofing application. Two kinds of polymeric wastes areisocyanate waste and second are plastics waste. Sealing compound/water proofing coating utilizing the isocyanate production waste and water proof roof mastics from plastics waste have been developed.

Application of photocatalysts in the treatment of water and wastewater:

The advantages of photocatalysis to degrade the commonly used textile and leather dyes from the aqueous solution using Tio/ZnO catalyst in the presence of UV solar light is of great use to reduce lead pollution. Photocatalysis is also good technique to treat industrial effluents.

III. Conclusions

Human activities have seriously upset the natural cycle of lead and urgent action is needed to prevent continuing and cumulative poisoning with lead. Improved plant control in industrial operations and improving the automobile design are suggested so that lead free gasoline can be used and at the same time emission of other pollutants like carbon monoxide in the exhaust should be controlled by using suitable catalytic control devices. Immediate attention is needed for controlling lead pollution because in no other case the normal level in human so close to the prescribed safety labels.

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