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Lead and its Effect on Humans: A Mini-Review

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Abstract:- Lead is a common heavy metal that affects the environment and accumulates in people through different mechanisms like absorption, interfering with their heart, brain, and bone health. Lead is a poisonous element that occurs naturally in trace amounts in the earth's crust, is toxic to both people and animals, and has negative health effects. Lead toxicity is a serious environmental illness with catastrophic effects on the human body. In this review study, the long-term health effects of lead exposure are examined. Organs like the kidney, brain, and reproductive system are among the acute and ongoing effects of lead poisoning, cancer, hypertension, neurodegeneration, and other serious illnesses have all been related to lead exposure, In this article, the research on the toxicity of lead is reviewed along with current revisions. The harmful effects of lead on the renal, reproductive, neurological, and other systems are also emphasized. The methods for treating lead poisoning are finally provided together with some current developments. For searching the literature, websites including Google, Google Scholar, SciFinder, and PubMed were employed.

Keywords:- *Heavy Metals, Lead, Carcinogenic.*

I. INTRODUCTION

The specific gravity of heavy metal (HM) elements is greater than 5 g /cm³ and they have an atomic mass larger than 20, HM contamination is currently a big issue in many places of the world[1]. HMS make up a sizable percentage of the periodic table and, most of them are environmentally distributed and get influenced by anthropogenic activities. [2]. Both natural and manmade factors have the potential to release HMs into the environment, and mining operations are one of the main anthropogenic sources that contribute to emissions [3]. Numerous sources, including small-scale enterprises (including the battery, metal-smelting, and cable-coating industries), vehicle emissions, and diesel generator sets, are linked to the deposition of HMs. [4]. When HMs are discharged into the atmosphere, they take the shape of tiny solid, liquid, and gaseous particles of various sizes. HMs and trace elements may vary depending on the geographic origins, which could cause extreme toxicity[5]. HMs are building up in soils and posing a major hazard to human life as a result of the overuse of agrochemicals and shifting environmental circumstances[6]. The use of food polluted with HMs can substantially deplete the body of some vital nutrients, which further contributes to the loss of immune defenses, the development of malnutrition-related growth impairments, and the high prevalence of upper gastrointestinal cancer rates [7].Lead (Pb) known as the Plumbam in latin, was one of the first elements to be identified as HM. Pb is a dense, bluish-gray metallic element[8]. Environmental Pb exposure is still a concern for public health, even at low lead levels, there are health impacts in children and adults, even if Pb exposure has reduced over the past few decades. Smoking, breathing contaminated air, ingesting contaminated food, water, or dust, as well as doing so in locations with high traffic or industrial emissions, all result in exposure[9]. Pb is a member of group 14 of the periodic table and has an atomic number of 82 [10]. Pb is utilized in more than 900 different fields, including the mining, smelting, and battery industries. Pb contributes to 1.5% (900,000) of fatalities worldwide per year, which is more than all other causes of mortality combined and nearly equal to the number of HIV/AIDS deaths (954,00) [11]. Pb, which makes up 0.002% of the Earth's crust and is the second-most poisonous element after arsenic (As), has a natural concentration below 50 mg /kg[12]. It is generally harmful to most plants through food, [12]. It is generally harmful to most plants through food, water, and air. Pb pollution in the environment is a major concern, as a result, remediation of contaminated medium necessitates direct removal or cleanup because it cannot be removed through degradation. There are numerous technologies available to purge surroundings contaminated with metal. However, most of these technologies are expensive to adopt and can affect the already harmed ecosystem much more [13], water washing won't get rid of Pb from fruits and vegetables[10]. Pb poisoning is typically caused by ingesting contaminated food or water, lead-based paint is believed to be easily absorbed into the bloodstream and to have negative effects on some organ systems, including the immune system, cardiovascular system, central nervous system, and kidneys. However, poisoning can also occur through unintentionally ingesting contaminated dust, soil, or paint. Furthermore, Pb may cause inflammatory reactions in many organs and upset the equilibrium of the oxidant-antioxidant system, its exposure can disrupt physiological processes [14]) .Increased blood Pb levels have an impact on behavior, cognitive function, postnatal growth, delayed puberty, and lower hearing ability in infants and kids. In adults, Pb causes cardiovascular, central nervous system, kidney, and fertility problems. Pb can impair fetal growth in the early stages of pregnancy [12]. Pb poisoning can be identified by looking for changes in blood cells that can be seen under a microscope or by removing thick lines from children's bones that can be seen on X-rays[15].

II. SYMPTOMS OF LEAD TOXICITY

The general symptoms include dizziness, stomach pain, body pain, appetite loss, anxiety, encephalopathy, dementia, seizures, and coma. These symptoms could be imperceptible and resemble those of other illnesses [16]. Symptoms of Pb poisoning include aberrant behavior, which differs from person to person. However, depending on the unknown characteristics of each individual, the Pb levels at which symptoms develop vary greatly. Children with Blood lead level(BLL) of 80 to 100 µg/dl and adults with BLLs of 100 to 120 µg/dl can develop acute encephalopathy, irritability, agitation, headaches, confusion, ataxia, sleepiness, convulsions, and coma are among the symptoms. BLL concentrations between 25 and 60 µg/dL cause neuropsychiatric symptoms such as irritability, trouble concentrating, slowing of motor nerve transmission, and headaches[15],[16]. There are no safe amounts of Pb, however, the signs of Pb poisoning are roughly proportionate to Pb concentrations. When the total BLL is 10 µg/dL for an extended length of time, the risk of cognitive problems increases, though the cutoff may be even lower. If BLL is greater than 50 µg/dL, other symptoms (such as cramping in the abdomen, constipation, trembling, and mood swings) may manifest. Slight Pb poisoning of 10 to 25 µg/dL brought on by recurrent exposure over time can be sneaky [17]. If PbB is more than 100 µg/dL, encephalopathy is possible, Extremely high PbB levels (i.e., >100 µg/dL) can result in serious overt symptoms such as prolonged vomiting and encephalopathy, and outcomes [18].

III. SOURCES OF LEAD EXPOSURE

Pb is predominantly released via a variety of human-made sources, such as mining, ore smelting, coal burning, battery storage, industry effluents, car exhausts, metal plating, leather tanning, finishing processes, fertilizers, pesticides, and additives in gasoline and pigments[19]. A frequent way to be exposed to Pb is through paint. Dust, window frames, walls, the exterior of houses, or other surfaces may contain Pb paint [20], Pb is being released into the environment because of its extensive industrial use, as it cannot be broken down, it contaminates drinking water and the earth's crust, exposing people to its hazardous effects and perhaps having an epidemiological impact [21].The main cause of Pb contamination occurs in fruits and vegetables when they are grown close to places with roadways or highways this is due to the emission of leaded fuels from vehicles [22]. Corrosion in metal packaging can cause Pb to migrate to stored goods, increasing the amount of Pb in food [23].

A. Pb exposure due to industrialization

Pb is mostly generated through coal combustion, industrial processes, smelting, and the burning of both leaded and unleaded gasoline. Since the 1950s, Pb emissions have increased significantly in the majority of emerging nations, III Effects

B. The Nervous System's Effect

The nervous system is the most significant organ affected by persistent exposure to high blood Pb levels in terms of health impacts that are irreversible[26]. Some of the direct neurotoxic effects of Pb include apoptosis, excitotoxicity, effects on neurotransmitter storage and release mechanisms, mitochondria, second messengers, cerebrovascular endothelial cells, and both astroglia and oligodendroglia.[27]. The inability to focus for long periods, irritability, forgetfulness, and dullness are the early symptoms of the effects of Pb exposure on the central nervous system. When compared to other organ systems, the nervous system appears to be the most susceptible and a top target for Pb-induced poisoning[28]. Children have more harm to the central nervous system from Pb poisoning, while adults are more aware of the repercussions on the peripheral nervous system[29]. Acute encephalopathy, the most severe symptom of Pb poisoning, includes recurrent vomiting, ataxia, seizures, papilledema, and impaired consciousness [30]. Children who are acutely exposed to high amounts of Pb may experience neurological effects such as encephalopathy and neurodegenerative disorders [31]. According to studies, low levels of chronic exposure still impair neurobehavioral development, as evidenced by decreased IQ and symptoms like ADHD, resulting in peripheral nerve system neurodegeneration. Peripheral neuropathy is a common sort of abnormality, invasion of the extensor motor nerves by neuropathy [32].

C. Pb poison to kidney

Pb is not known to have any health benefits; instead, it has been found to have negative impacts on several bodily systems. Children, including newborns, are especially more susceptible to the negative effects of Pb because of their growing brains [33]. Pb-related kidney damage is still a complex issue in industrial toxicology, and there are still many unanswered questions. As per the national kidney organization, Pb-related kidney disease is now extremely uncommon, particularly in the United States and Europe. Less than 1% of kidney failure cases are thought to be brought on by Pb exposure. Typically, it is connected to professions like stained glass artisans and metal smelters where workers are exposed to extremely high levels of Pb [34].

D. Effect on Pregnancy

Exposure to Pb may be dangerous for people, especially for unborn children or children who are developing, which has raised public concern and generated a lot of study interest [35]. (Fig 3 shows some possible effects of Pb on newborn babies) Inhalation is the primary method of exposure to the environment. Pb-contaminated air and drinking water supply through the Pb-contaminated pipe are the main sources of Pb exposure, in particular children are exposed to Pb through a variety of hobbies, such as playing with painted toys and repeatedly ingesting substances that aren't food, etc. [33]. The ability of children and adults to repair harm from Pb poisoning's harmful effects may vary. The fact that children have a longer lifetime to express the effects of hazardous exposure should also be taken into consideration. Due to the potential long-term effects on children's growth and development, Pb exposure is a serious public health concern

for pregnant women and their developing fetuses [36]. Studies show that up to 0.4% of women of reproductive age may have elevated blood Pb levels. (About 10 µg/dL or higher). Serious Pb poisoning (blood level greater than 45 µg/dL) in pregnant women is uncommon.) [37]. There are no safe levels of Pb exposure for pregnant women because the toxic effects were shown even at concentrations lower than those that were previously thought to be harmful. Studies show that prenatal Pb exposure increases the risk of early or unplanned pregnancy, and decrease in children's cognitive ability, high blood pressure, and low birth weight[38] (fig 4 shows some possible effects of Pb on pregnancy). An earlier study revealed a link between children's cognitive development and mean maternal blood Pb levels of 6.5 µg/dL. Furthermore, exposure to Pb during pregnancy (5µg/dL) was found to have a detrimental effect on children's cognitive development even at 24 months [39][40].

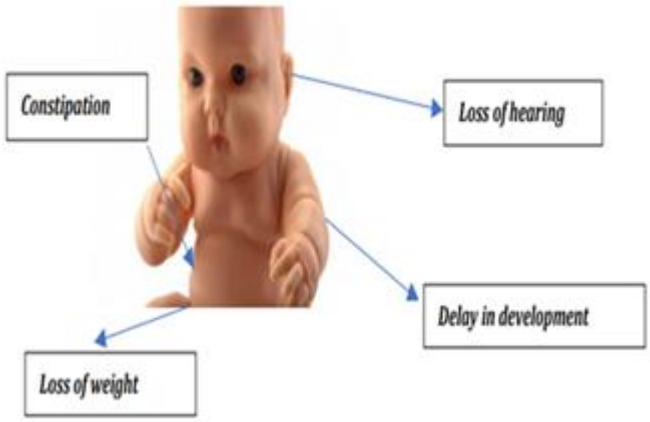

Fig 1 Effects of lead on newborn baby[41]

E. Cardiovascular toxicity

Widespread environmental pollutant Pb is known to hurt brain development. Although blood Pb levels have significantly decreased in developed nations due to concerted public health efforts to prevent environmental exposure to Pb, however low-level Pb exposure continues to be a risk factor for cardiovascular disease [42]. Chronic Pb exposure can seriously harm many different systems, sometimes irreparably harming the nervous, hematopoietic, circulatory, and reproductive systems. It can also cause learning disabilities, hearing loss, and kidney, heart, and bone problems, as well as impair many cellular functions and enzyme systems[42]. The main cause of death and a major factor in the global illness burden is cardiovascular disease, which claims an estimated 17.9 million lives per year. 80% of these fatalities are caused by myocardial infarction and stroke exposures to environmental toxins, such as Pb.[43], [44]. However, Pb's cardiovascular consequences go beyond just hypertension and raised blood pressure. exposure to Pb has additionally been linked to a rise in the prevalence of clinical cardiovascular endpoints like coronary heart disease, stroke, and peripheral arterial disease [43]. A second study revealed a favorable link between blood Pb levels and total peripheral resistance, poorer cardiac output, and decreased stroke volume in kids (9 to 11 years old) who were subjected to acute stress while the blood lead level was below 10 micron/dL [45]. It is crucial to look at how lead exposure affects middle-aged individuals' and young people's cardiovascular systems differently [46].

F. Lead (Pb) poisoning to Male/Female infertility

An extensive range of physiological, biochemical, behavioral, and negative impacts have been linked to Pb exposure. There is proof that Pb exposure causes several reproductive problems in people. Premature membrane rupture, spontaneous abortion, low birth weight, preterm delivery, fetal growth restriction, pregnancy hypertension, preeclampsia, and gestational diabetes have all been linked to Pb exposure in women. Men who are exposed to Pb are more likely to experience problems with spermatogenesis, diminished libido, chromosomal damage, and other reproductive issues. HMs exposure, especially from substances associated with the workplace, such as (Pb), is a significant risk factor for male fertility. Even though exposure to Pb might impair spermatogenesis and result in low-quality semen, studies on the connection between Pb exposure and harm to the male reproductive system, however, have shown mixed results. Due to the association between semen Pb and blood Pb, many studies have examined the relationship between blood Pb and semen quality. Men's semen quality measures have been shown to decline when exposed to inorganic Pb in some cases. Sperm count may be decreased by seminal plasma with high Pb contents. Pb can also have an impact on sperm morphology and sperm motility.[47][48][49]. The Pb buildup has an impact on several endocrine glands and is linked to hormonal imbalance that impairs reproduction in Pb-exposed individuals [33]. Numerous findings indicate that nutritional, industrial, and environmental factors may have an impact on male fertility in humans [50]. Pb exposure at hazardous levels is common and can have pathologic consequences on numerous organs[51]. Numerous industrial chemicals are known to be harmful to human reproduction, particularly occupational and environmental exposure to heavy metals like lead. Typically, it is believed that the danger is directly correlated with exposure time and rising concentrations. [52].

G. Pb on teeth

Dental caries is one of the conditions that afflict people the most frequently on a global scale. Despite tremendous gains in oral health, 60–90% of kids in most developing countries still suffer from dental caries[53]. Pb is one of the contributing factors in some communities where dental cavities remain a severe issue despite the widespread use of fluoride and fluoridated toothpaste [54]. Along with the concerns to overall health, Pb exposure also causes problems to dental health. Men are more likely to lose teeth than women, but exposure to Pb may also affect how teeth and bones form enamel, this can lead to caries, delayed dental enamel development, worsened dental fluorosis, and periodontal bone loss, as well as a high prevalence of hypoplastic enamel defects and extremely elevated Pb levels in bones and teeth, teeth containing more Pb had greater abrasion and discoloration scores. [55][56]. An investigation demonstrated a gender-specific relationship between Pb exposure and dental caries in the primary teeth of males aged 8 to 12 years. Environmental Pb exposure results in a variety of dental issues. In numerous groups, it was found that Pb

exposure during adolescence and the early stages of adulthood is associated with a higher incidence of dental caries[57]

H. Pb in hair

One of the main means of the substance's excretion is human hair. According to several studies, exposure to HMs is substantially higher in hair than in blood or urine [58].

IV. REMEDY OF PB TOXICITY

Pb poisoning is difficult to detect since the signs do not present right away, even after exposure to Pb. Because of this, when Pb poisoning is suspected, fundamental information should be ascertained through a medical interview that considers the symptoms stated by the patient. The most crucial step in tracking progression is determining the blood Pb levels after verifying the presence of Pb poisoning[28]. as well as people who have been exposed to Pb for an extended period at work. Undoubtedly [59].

A. Chelation therapy as an advanced Pb toxicity remediation

Chelating elements bind to Pb in extracellular fluid and are unable to pass through cell membranes. While there are advantages to their usage in situations of acute poisoning, they are not advised for cases of chronic poisoning since they induce critical metal loss and may produce undesirable pharmacological effects such as hepatotoxicity or nephrotoxicity[28]. Disodium calcium edentate, also known as calcium chelate of ethylene-diamine-tetraacetic acid, is a chelating salt (EDTA), These chelating substances are very receptive to remover. Since lead has a higher affinity for the lead chelating agent than calcium does, exchange results in the formation of the lead chelate. After then, the substance is eliminated by urine, leaving behind safe calcium [15].

B. Nanoparticles as a lead remediation

The potential of nanoparticles(less than 50 nm) as Pb adsorbents is quite good, Pb has been removed using nano-adsorbents such as magnetic iron oxide nanoparticles (MNPs), clay materials, silica, alginate biopolymer, activated carbon, metal oxides, nano-titanates, etc. [12].

C. New drugs

Although other medications besides the chelating agents have been suggested for the treatment of Pb poisoning, more proof is required to support their safety and effectiveness before recommending their use as an alternative or adjunct therapy to the recommended pharmacological treatment. Thiamine, a water-soluble vitamin, increases the removal of Pb from the liver and kidneys and lessens the oxidative damage brought on by Pb intoxication when combined with CaNa2 EDTA (50 mg/kg/day) for three days [61]

V. CONCLUSION

Industrial and agricultural practices are the cause of the source of Pb, bioaccumulation, and health risks of Pb most organs are impacted by Pb poisoning in both children and adults, understanding the therapy is therefore crucial. Keeping in mind that Pb cannot be eliminated from the body once it has been ingested, medical treatments and dietary supplements may assist in reducing the amount of Pb accumulated in specific organs and aid in the removal of Pb from organ tissues. Different remediation approaches are available for lowering the concentration to reduce these Pb-based health hazards however some simple precautions like washing hands before eating, maintaining a healthy diet, avoiding painted toys and over-the-counter medicines, and wearing the appropriate body armor may all reduce the chance of exposure of Pb.

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