CLINICAL MANAGEMENT GUIDELINE ON

LEAD POISONING

IN BANGLADESH

স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়

unicef
for every child

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MESSAGE

Lead poisoning is affecting children on a massive and previously unknown scale. Around 1 in 3 children – up to 800 million globally – have blood lead levels at or above 5 micrograms per deciliter (µg/dL), the level at which requires action. In Bangladesh, it is estimated that 35.5 million children are affected with blood lead levels above 5 µg/dL, making the country the fourth most seriously hit in the world regarding the number of children affected.

Several recent Blood Lead Level (BLL) testing studies conducted by the IEDCR and icddr,b in 2022 have found lead in the blood of 100% of the children (total 1460) tested for BLL in 4 districts as well as in Dhaka city. 40% to 80% of those Children have higher blood lead level than WHO recommended <5 micrograms per deciliter. However, no level of lead in blood lead is safe. All the above data signify an alarming sign that lead pollution has posed a severe public health threat to Bangladesh.

Considering the severity of the lead poisoning in Bangladesh and its possible devastating effects, the Directorate General of Health Services (DGHS), the Ministry of Health and Family Welfare Services and UNICEF have been working together to implement Protecting Every Child Potentials (PECP) project since last quarter of 2020. Therefore, the Technical Implementation Committee (TIC) of PECP, DGHS has developed this National Guideline on Clinical Management of Lead Poisoning to build the capacity of the government health service providers on prevention, diagnosis, treatment and management of lead poisoning in Bangladesh.

Since the inception of PECP, the PMR of DGHS and UNICEF have been working continuously to build consensus on the urgent need to develop Health System's capacity to fight against lead. The capacity of 35 national-level master trainers from the Health and Education sectors of GoB and UNICEF has been built through facilitating a Training of Trainers- so that this pool of Master Trainers can build capacities at the subnational level and in the communities to address lead poisoning in Bangladesh, specifically in 4 PECP districts covering health facilities, schools and communities, roll out from July 2023 under the leadership of PMR, DGHS.

Considering the WHO Clinical Management Guideline of Lead Poisoning as a foundation, this Clinical Management Guideline of Lead Poisoning in Bangladesh has been drafted, revised and finalised following a series of workshops and consultations engaging public health and clinical experts on Neurology, Gynecology, Pediatrics, Nephrology, Medicine and other relevant backgrounds from different medical university and colleagues and hospitals, DGHS, UNICEF, Pure Earth (PE), ESDO and icddr,b. I sincerely thank them for their valuable technical input and time to review and finalise the guideline.

My special thanks to Dr. Anwar Sadat, DPM, PMR, and Dr. Md. Akhtaruzzaman, DPM, NCDC, DGHS and UNICEF colleagues for their hard work in providing technical support in the development of this guideline.

Finally, I thank UNICEF Bangladesh for providing technical and financial support to implement the PECP and develop the Guidelines.

With best compliments-

Professor Dr. Mazharul Islam
Line Director, Planning, Monitoring and Research (PMR).
& Chairperson, Technical Implementation Committee,
Protecting Every Child Potentials initiative
DGHS, Mohakhali, Dhaka-1212

MESSAGE

Environmental health hazards are often overlooked and neglected globally, they are putting children at risk and the child survival gains of the last decades may be lost to environmental health hazards. About 26 per cent of deaths in children under five years of age can be prevented by addressing environmental risks. Children today face a new set of challenges that were inconceivable just a generation ago. All over the world, climate change and environmental degradation are threatening child survival, health, and well-being. Children's unique metabolism, physiology, and developmental needs, make them more vulnerable. UNICEF is elevating action on climate change and environmental pollution in its programmes such as the Healthy Environments for Healthy Children to strengthen primary health care, with a focus on prevention.

Evidence has shown that lead, mercury, cadmium, arsenic, and other toxic metals impair children's health and development. Lead is a prevalent metal, widely used in various industries and households, and remains a significant public health concern worldwide. The impact of lead poisoning is particularly severe in children, causing irreversible damage to their cognitive and physical development. Each year, Bangladesh loses US$16 billion in GDP from reduced lifetime earning potential among the lead exposed population.

UNICEF has supported the Institute of Epidemiology, Disease Control and Research to conduct the blood lead level surveillance study in four districts in 2022. The findings were alarming. All 980 children (100%) tested had detectable levels of lead in their blood. Another UNICEF supported study conducted by the International Center for Diarrhoeal Disease and Research, Bangladesh in 2022, also revealed barriers within the health system to address lead poisoning. They included lack of awareness and training among health care providers, as well as lack of management guidelines and diagnostic facilities to detect lead poisoning.

The development of this clinical management guideline for lead poisoning is timely. I congratulate the Directorate General of Health Services for this achievement. This guideline will equip healthcare professionals with knowledge and skills to provide information and counseling to patients and effectively manage lead poisoning cases.

Combating environmental health hazards demands immediate attention and coordinated efforts from all stakeholders. Every child has the right to a healthy environment, and we all have a role to play. By addressing lead poisoning and prioritizing clinical management skills for healthcare professionals, Bangladesh can pave the way for a healthier and brighter future for its children.

Maya Vandenent
Chief, Health
UNICEF

PREFACE

It is our immense pleasure to publish the Clinical Management Guideline on Lead Poisoning in Bangladesh. This national guideline has been developed based on the WHO Clinical Management Guideline on Lead Poisoning. To customize the WHO guideline into the Bangladesh context, a team of experts from the Directorate General of Health Services (DGHS), IEDCR, International Center for Diarrheal Disease Research, Bangladesh (icddr,b), UNICEF and Pure Earth developed the draft guideline. The draft guideline was extensively reviewed through two national workshops by a team of clinical and public health experts from different medical colleges, university, and hospitals under the leadership of the Non-Communicable Disease Control (NCDC) - DGHS.

A Technical Committee has been formed consisting with 21 members from the DGHS, UNICEF, icddr,b, as well as different medical colleges and universities such as BSMMU, DMC, ShSMC and several government and private hospitals with expertise and background from Public Health, Neurology, Gynecology, Pediatrics, Clinical and Medicine etc. In a consultative workshop on 6 November 2022, the technical committee reviewed the guideline drafted based on the WHO and CDC (Center for Disease Control) clinical management guidelines on lead poisoning.

After incorporating feedback the revised guideline has been distributed among all technical committee members, who have further reviewed the guideline. Following another consultative workshop on 10 November 2022, at DGHS the draft Clinical Management Guideline has been finalized. The final edited version of the guideline has been approved by the DGHS.

I thank all stakeholders and technical committee members, for their valuable input and suggestions that helped us to finalize the guideline. My special thanks to UNICEF for supporting us in the development, design, and publication of this guideline.

I hope it will help us to build capacity of health service providers and clinical experts in diagnosis, treatment and management of lead poisoning in Bangladesh.

9.7.2023

Prof. Dr. Md. Robed Amin
Professor of Medicine &
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CHAPTER 1

Background

At a glance

- Cumulative toxicant that affects multiple body system
- Particularly harmful to young children
- Distribution to the brain, liver, kidney, and bones
- Stored in the teeth and bones, where it accumulates over time
- Human exposure is usually assessed through the measurement of Lead in blood
- Lead in bone is released into the blood during pregnancy and becomes a source of exposure to the developing fetus
- There is no level of exposure to lead that is known to be without harmful effects
- Lead exposure is preventable

Lead poisoning has been one of the most significant preventable causes of neurologic morbidity from an environmental toxin for centuries. A heavy metal, Lead is ubiquitous in our environment but has no physiologic role in biological systems. Lead toxicity is a particularly insidious hazard that can cause irreversible health effects. It interferes with several body functions, primarily affecting the central nervous, hematopoietic, hepatic, and renal systems producing severe disorders. Acute toxicity is related to occupational exposure and is relatively uncommon. Chronic toxicity, on the other hand, is much more common.

Lead is a naturally occurring heavy metal present in the earth's crust. Some lead is released into the environment through geophysical processes such as the weathering of rocks and volcanic activity. However, this is of minor importance compared with human activities to extract, process, and use lead, which accounts for most of the lead in the environment. Once lead is released into the environment, it is deposited on surface soil and water. Lead remains in the soil indefinitely unless it is remobilized or removed.

Lead has several properties, such as resistance to corrosion, malleability, and high density, that make it useful for many purposes. Organic lead compounds (tetraethyl and tetramethyl lead) were used extensively between the 1930s and the 2000s as anti-knocking additives to petrol to improve engine performance. The primary use of lead is in storage batteries (e.g., for motor vehicles, solar power, and uninterrupted power supply). Lead is also used extensively in the construction and chemical industries. It is used in ammunition, shielding systems against ionizing radiation, and lining tanks and pipes. Metallic lead is a significant component of many alloys, such as those used for solders, type metal, specialty steel, brass, and bronzes.

It may also be used in ballasts and wheel weight in motor vehicles. Inorganic lead salts are used in pigments, paints, enamels, glazes, glass, plastics, and rubber compounds. Lead is also included in some cosmetics and traditional medicines. Leaded petrol is banned in all countries, and organic lead compounds use has significantly decreased. Tetraethyl lead, however, continues to be used in some aviation fuel (Avgas) for piston engine aircraft.

The ongoing emphasis on the abatement of lead environments places added emphasis on occupational exposure to lead (e.g., among workers at smelters or battery recycling plants). Such exposure is a continuing problem. Whereas occupational exposure remains an occasional concern, the most significant public health issue related to lead at present is the exposure of young children to decaying fragments of leaded paint. More recently, due to aging infrastructure, contaminated drinking water has become a cause of childhood lead exposure.

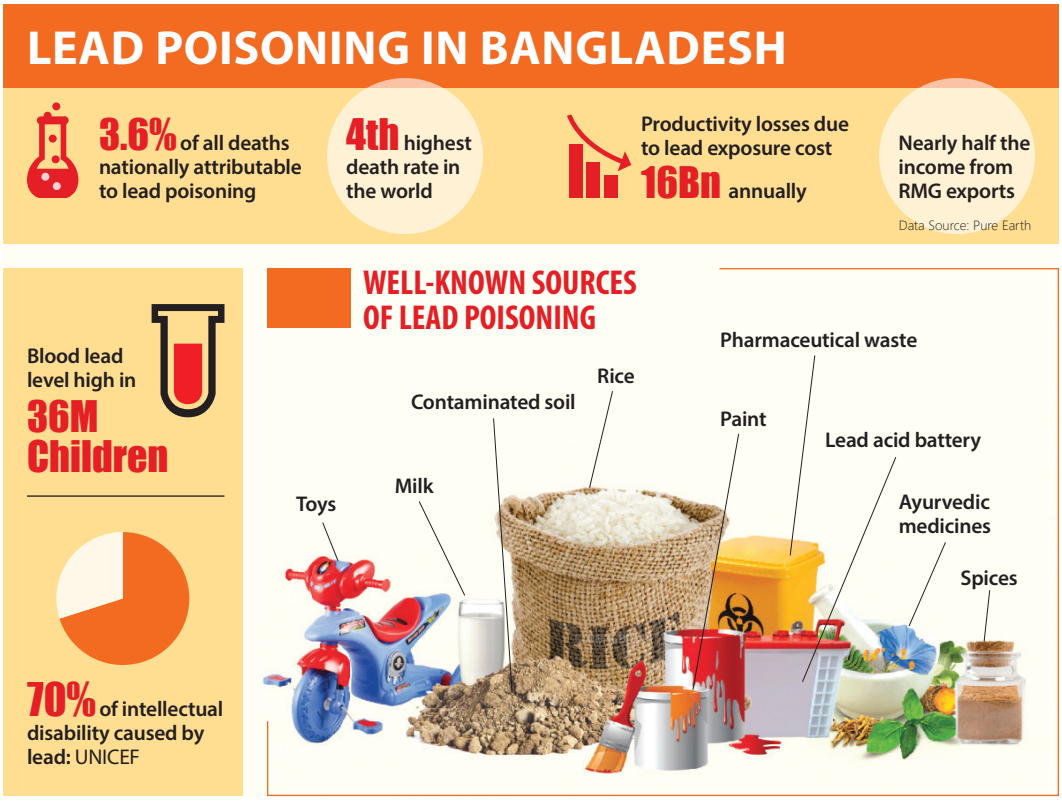
A brief on the situation in Bangladesh

Nearly a third of the world's 800 million children are affected by lead poisoning. In Bangladesh, more than 35.5 million children are affected. The significant sources of lead exposure are Used Lead Acid Battery (ULAB) recycling, turmeric adulteration, and paint. More than 1,100 informal ULAB sites have been identified in Bangladesh (Toxic Sites Identification Program by Pure Earth). More than 70 sites near the capital city have high to alarming levels of lead in the environment, which may cause intellectual disability in children, stillbirth, miscarriages, and a rise in antisocial behaviors. Besides Dhaka, six other districts – Gazipur, Tangail, Mymensingh, Khulna, Bogra, and Magura – have also been identified as lead hotspots.

The significant source so far identified the illegal and substandard recycling of used lead acid batteries (ULABs). This poses significant levels of environmental lead pollution and is suspected of contributing to high blood lead levels among the population in Bangladesh. The increased demand for ULABs has been on a steep rise recently, especially in the transportation sector and solar energy. Hundreds of unregulated recycling of ULABs can be found in and surrounding Dhaka and other places surrounding the country. One can also find children working at small workshops, using lead acid batteries and other Lead containing materials. The informal economy represents a substantial portion (89% of the labor force) of Bangladesh's workforce and productivity. With an overall increase in the resources-recovery activities in the country, the collection of ULABs and their smelting have become widespread, including in the informal sector. These unregistered factories produce 5-6 Lacs units a year and deprive the government of revenue (Pure Earth).

The Institute of Epidemiology, Disease Control and Research (IEDCR) with support from UNICEF, conducted blood lead level surveillance (BLLS) study in 2022 among 980 children aged less than 18 years in both high risk (Tangail & Khulna) and low risk lead contaminated sites (Sylhet & Patuakhali) in four districts in Bangladesh. All 980 (100%) children tested at both high risk (informal used lead acid battery - ULAB recycling sites) and low risk sites (non-ULAB recycling sites) had lead in their blood. About 40% had high levels above 5µg/dl, above the WHO cut-off value for an intervention. Around 65% of study children had blood lead levels above 3.5 µg/dL, above the CDC reference value (<3.5 µg/dL) for which interventions are needed. Sources of lead exposure are not limited to the Used Lead Acid Battery recycling activities. At the ULAB sites, males had higher levels of lead in their blood than females. The reason could be that male adults worked, and male children played close to ULAB sites.

Dhaka Rapid Marketplace Screening in 2021 found that among the tested 367 samples (items) from the market in 4 cities in Bangladesh, Lead was found in 96 samples (Pure Earth, 2021). High levels of lead in local toys, paints, aluminum, ceramic cookware, pigments, sweetener containers, etc.



Studies and surveillance regarding lead-chromate adulterated turmeric (icddr, b, 2020) identified multiple possible sources of lead exposure in rural Bangladesh. The isotopic analysis confirmed that adulterated turmeric is the source of high BLL for pregnant women.

Also, a study was conducted to determine the lead content of popular household and industrial paints in Bangladesh and compare the situation with the previous year (ESDO, 2022). Among the samples analyzed, 30.8% contained high lead content (ranging from 90 to 250 ppm). The remaining (69.2%) decorative paints contain less than 90 ppm of Lead. A devastating scenario has been identified for industrial paints. High lead content was detected in 50% of the samples. Industrial paints in orange colors contained the highest levels of Lead at 97000 parts per million.

A systematic review conducted by Majumder, AK et al., in 2021 identified 175 Pb-contaminated sites through soil sample assessment in Bangladesh. The study determined

Pb concentrations in air (0.09–376.58 µg/m^3, mean 21.31 µg/m^3), river water (0.0009–18.7 mg/l, mean 1.07 mg/l), river sediments (4.9–69.75 mg/kg, mean 32.08 mg/kg), fish (0.018–30.8 mg/kg, mean 5.01 mg/kg), soil (7.3–445 mg/kg, mean 90.34 mg/kg), vegetables (0.2–22.09 mg/kg, mean 4.33 mg/kg) and diet items (0.001–413.9 mg/kg, mean 43.22 mg/kg) of which 38.8%, 27.8%, 54.5%, 68.8%, 9.7% and 100% of samples, respectively, exceeded related World Health Organization (WHO), Food and Agriculture Organization (FAO), United States Environmental Protection Agency (USEPA) and Bangladesh Standard Testing Institution (BSTI) guidelines. The study also found that Bangladesh's industrial soils are severely polluted with Pb (7.3–445 mg/kg). A high Pb concentration has been found in fish muscle and foods, including leafy and non-leafy vegetables collected from different places in Bangladesh.

Previously conducted studies in Dhaka, Bangladesh, also suggested that children's IQ decreased linearly with increasing Blood Lead levels (Hassan, MS et al., 2013).

Pediatric lead poisoning

Pediatric lead poisoning was first reported in the late 1800s in Australia, and interest in childhood lead poisoning and its manifold clinical presentations has burgeoned. It should be noted that toxic metals, including Lead, can be transmitted from a mother to her child via breast milk.

Lead poisoning is probably the most critical chronic environmental illness affecting modern children. Despite efforts to control it and apparent success in decreasing incidence, severe cases of lead poisoning still appear in hospital emergency departments (EDs), clinics, and private physicians' offices.

In children, virtually no organ system is immune to the effects of lead poisoning. Perhaps the organ of most concern is the developing brain. Any disorganizing influence that affects an individual at a critical time in development is likely to have long-lasting effects. Such is the effect of Lead on the developing brain. Effects on the brain appear to continue into the teenage years and beyond. A high index of suspicion is necessary for physicians treating pediatric patients.

Protecting children from exposure to lead is vital to lifelong good health. No safe blood lead level in children has been identified. Even low levels of Lead in the blood have been shown to affect learning, the ability to pay attention, and academic achievement. While the effects of lead exposure may be permanent if caught early, there are things parents can do to prevent further exposure and reduce damage to their child's health. The most important step parents and caregivers, healthcare providers, and public health professionals can take preventing lead exposure before it occurs. Preventing childhood lead exposure is cost-effective.

Case Study: Kathgora, Bangladesh

One night without warning, dark, acrid smoke began rising from the bamboo jungle near Sharmin Akhter's small house in Kathgora. Every night thereafter for more than a year, the fires glowed deep in the underbrush and the smoke rose. Black dust fell like rain, coating leaves, trees, houses, livestock with a fine inky powder. Akhter's buffalo began acting strangely, roaming aimlessly and foaming at the mouth before suddenly dying. Two goats also died.

As Akhter would tell Pure Earth investigators in November 2019, she did not know that the black smoke and dust from the fires in the jungle were a threat to her family and her livestock. Her children played in the jungle, running through the leaves and grass coated with the fine black powder and climbing onto the piles of broken battery cases.

Only later did Sharmin Akhter and her neighbours learn that lead dust and fumes from informal used lead-acid battery recycling and open-air smelting furnaces had tainted their land and poisoned their children.

"We didn't realize how bad smelting was," Akher told a Pure Earth investigator. "If I knew the side effects, I would have prevented my children from going there."

By the time that villagers understood what was happening in Kathgora, the small town of about 300 people 15 kilometres northwest of Dhaka had been badly contaminated by two informal operations that recycled used lead-acid batteries.

Amzad Hossain had leased his land to the battery recyclers for 7,000 taka or roughly $83 USD a month without knowing how dangerous informal lead recycling could be. His neighbours complained to him about the smoke and claimed that their livestock were dying.

"The people surrounding the smelting area, they do not live, they do not sleep, they do not eat," Hossain said in November 2019. When Hossain went into the jungle to inspect his land, he saw that the once prolific mango and jackfruit trees bore no fruit; he found a goat that had just given birth to a stillborn.

With the complaints mounting and alarmed by what he'd seen, Hossain told the recyclers to leave his land. They refused, he said, until under more pressure from village leaders, he warned them, "Please leave this place or the local people will attack you."

The recyclers fled, leaving behind acres of heavily contaminated land.

In 2017, Pure Earth and the Bangladesh Department of Environment selected Kathgora to be the site of a demonstration remediation project, believed to be the first of its kind in Bangladesh. The Department of Geology of the University of Dhaka and the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) were implementation partners.

Pure Earth team members found children playing on and around piles of broken batteries on the former recycling sites where soil testing showed lead concentrations of over 100,000 ppm – 250 times the US EPA limit of 400 ppm.79 Early blood testing on a group of 75 children under the age of 7 found that all had elevated blood lead levels ranging from 8 µg/dL to 47 µg/dL with an average of 21.3 µg/dL.80

Some of the children had complained of itching skin after playing at the abandoned recycling site, probably from coming into contact with sulphuric acid spilled from broken batteries, but had otherwise seemed fine, their mother told Pure Earth investigators.

Landowner Amzad Hossain, appalled by what had happened, joined the clean-up organized by Pure Earth, supervising the workers, housing team members, cooking for the clean-up crew and washing contaminated clothes at the end of the day.

Local workers wearing masks and protective gear collected and disposed of abandoned lead-acid battery waste, then scraped and collected top-soil, which was buried in a pit. Clean soil excavated from the pit was used to cover the former ULAB sites. Roads were paved and homes were cleaned. Local workers carried out the clean-up, which was supported in part by UNIDO, the OPEC fund for International Development, the European Commission and USAID.

Nine months after the clean-up, repeated testing found that children's blood lead levels had declined on average by 4.3 g/dL. About 18 months after the clean-up was completed, children's blood lead levels had dropped by an average of 9.1 g/dL - a 42 per cent reduction.

While blood lead levels have come down, Akhter said her older son has become forgetful and is not doing as well in school as he did before the recyclers began burning lead in the jungle. He seems small for his age. Akhter asked if there is medicine that will help her son become as he was before; she was told there is not.

According to the World Bank, an estimated 1,100 informal ULAB recycling sites put more than a million people at risk in Bangladesh. The Kathgora sites are among 288 legacy informal battery recycling sites in Bangladesh that Pure Earth and and the Department of Geology of the University of Dhaka have identified and assessed since 2011.

Informal ULAB recycling is a significant source of lead exposure in Bangladesh, which, according to the Institute for Health Metrics and Evaluation, has the world's fourth-highest rate of death attributable to lead exposures. Its population average blood lead level has been calculated at 11.65 µg/dL.

CHAPTER **2**

Principal Sources of Exposure to Lead

At a glance

- Lead can be found throughout the environment.
- Homes probably contain lead-based paint. When the paint peels and cracks, it makes lead dust, and lead exposure also occurs when they swallow or breathe in lead dust.
- Certain water pipes may contain Lead.
- Lead can be found in some products, such as toys and jewelry.
- Lead is sometimes in candies or traditional home remedies.
- Specific jobs and hobbies involve working with lead-based products, like stain glass work, and may cause parents to bring Lead into the home.
- Children who live near airports may be exposed to lead in the air and soil from aviation gas.

Figure 1: Lead-containing products found in Bangladesh by X-Ray Fluorescence Spectrometers for Elemental Analysis conducted by icddr, b

XRF ANALYSIS SAMPLES WITH HIGH LEVEL OF LEAD (Pb)

In the first phase, a total of 163 samples of 11 types of items were screened; lead is found in 40 samples of 9 types of items' category.

Dhaka city, phase 01, samples:

- Spices - 13 samples
- Pottery - 6 samples
- Ceramics - 3 samples
- Medicines 14 samples
- Cosmetics 46 samples
- Toys - 7 samples
- Paints 11 items
- Other foods - 21 samples
- Other non-food items - 22 samples
- Other non-food items (pigment) 11 samples
- Cookware from recycled aluminum - 9 samples

Lab Test Result:

- Vegetables, Fresh Turmeric 17922 PPM
- Vegetables, Cauliflower 3998 PPM

The preliminary findings show that 96 samples are lead-positive among 367 samples, where the major sources were aluminum cookware, ceramic foodware, local paints, toys, amulets, pigments, and other non-food items.

RMS RESULT PHASE 01 at DHAKA CITY

AMULETS

- Amulets: 252000 PPM

CERAMICS

- Tea Mug: 3718 PPM

ALUMINIUM COOKWARE

- Spatula 2054 PPM
- Pan 1738 PPM
- Pan 1081 PPM
- Pitcher - 622 PPM
- Saucepan 403 PPM

PIGMENTS

- Deep Yellow Pigment: 153000 PPM

OTHER NON-FOOD ITEMS

- Orange color Mug - 3387 PPM
- Sweetener container - 3050
- Plastic box - 1931 PPM

TOYS

- Duck - 722 PPM
- Ring - 277 PPM

RMS RESULT PHASE 02 at KHULNA, RAJSHAHI, BARISHAL DIVISIONS

In the second phase, a total of 204 samples were screened; lead is found in 56 samples.

Khulna, Rajshahi, Barishal, Phase 02, samples:

- Aluminum cookwares: 47
- Toys - 31
- Spices - 49
- Paints- 30
- Rice - 13
- Cosmetics - 34

LOCAL PAINT: YELLOW PIGMENTS

- Khulna: 31360 PPM
- Rajshahi: 28902 PPM
- Barisal: 12230 PPM

ALUMINUM COOKWARE & FOOD WARES, CERAMIC FOOD WARES

- Khulna: 853 PPM
- Rajshahi: 2118 PPM
- Barisal: 1310 PPM

TOYS

- Khulna 606 PPM
- Rajshahi 1814 PPM
- Barisal - 755 PPM

REFERENCE LEVELS

- Decorative Paint - 90 ppm (UNEP, Bangladesh)
- Toys - 90 or 100 ppm for paint or coatings (US Consumer Product Safety Commission)
- Rice & cereals - less than 0.1 mg/kg) as defined by WHO/FAO
- Raw & processed turmeric - 2.5 ppm (mg/kg). (BSTI)
- Spices other than turmeric - 2mg/kg (QCVN 8-2:2011/BYT)
- Major Starch - 0.1-0.5 ppm (US FDA; WHO/FAO)
- Cosmetics & Vermilion (Sindoor) - 10 ppm for lipstick; 20 ppm for other types (FDA)
- Metal foodware: 100pmm
- Ceramic foodware: 100ppm
- Plastic foodware: 100pmm
- Herbal/traditional medicines: 10ppm (WHO)

Because of the wide range of uses for lead and its environmental persistence, there are multiple sources and pathways of exposure (Fig. 1) in Bangladesh. Some critical sources include lead paint, lead emissions from industries, leaded water pipes and fittings, lead-containing traditional medicines and cosmetics, and lead-glazed food vessels. More information on sources is provided below. The relative importance of each source varies from country to country.

The essential sources of lead:

- Used Lead Acid Batteries (ULABs)
- Lead-based paint from repair, repainting, renovation, and remodeling work.
- Pica.
- Tainted food (eating candies, spices, food additives, and other foods from abroad, especially if they appear to be noncommercial products of unknown safety).
- Tainted foodware (imported lead-glazed ceramic pottery, pewter, brass containers, or utensils to cook, serve, or store food).
- Aluminum cookware made from metal scraps.
- Tainted medicine or personal care products [imported medicines and herbal remedies (Azarcon, Ayurvedics); cosmetics and ceremonial powders (tiro, kohl, kajal, surma); and personal care products (litargirio), etc.].
- Water with lead levels exceeding 15 parts per billion (ppb).
- Some occupations or hobbies may involve lead exposure. These include construction or home renovation/repair; firing ranges; battery or electronics manufacturing or recycling; soldering or casting metal; oil field work; mining; and aviation gas used in small planes.
- Prior exposure.
- Recent immigration from a lead pollution-prone country(s).

Environmental exposure

Informal, small-scale industries such as lead-acid recycling batteries and lead smelting to make filling weights result in significant exposure to lead, both directly and from environmental contamination.

Lead paint is a source of environmental contamination in and around the home when deteriorating paint crumbles and flakes to form part of household dust. Stripping lead paint by burning or abrasive methods also contaminates the environment and can be a source of exposure for those engaged in paint-stripping and people living in the vicinity.

Outdoor structures such as steel bridges and flyovers painted with lead paint may contribute to the lead content of surrounding dust and grit. Repair and repainting

of metal structures and demolition of old buildings can release large amounts of lead particles into the air and onto the soil in surrounding areas, and this Lead can then be blown or tracked into homes.

Leaded petrol is no longer a significant source of exposure for the world's population. However, the continued use of Lead in some aviation fuels exposes populations around airports to lead.

Lead is released as fumes and particulates are deposited into soil and water, which can be taken up by food crops and animals and enter the human diet.

The environment may be contaminated with lead around mines, smelters, and factories that process lead when emission controls are inadequate.

Food and drink

Since the considerable reduction in lead emissions from petrol, food, and water have become more important sources of lead exposure. Lead in drinking- water is usually the result of leaching from household plumbing systems rather than a natural contaminant. The sources include lead pipes, brass fittings, and lead leached from soldered connections in copper piping. Acidic water (below pH 8) and higher temperatures increase the solubility of Lead from pipes and fittings.

Food and beverages can be contaminated when prepared or stored in lead-containing utensils or vessels. These include cooking pots made from recycled metal (aluminum cookware), lead-ceramic-glazed pottery, some glassware, and food tins with lead solder.

Ingestion of sweets (candy) contaminated by lead-containing dyes used on wrappers has also resulted in lead exposure. Lead poisoning from the consumption of illicit alcohol ("moonshine") distilled in car radiators solder with lead has also been reported. Crops grown on contaminated land and animals that forage on the land may accumulate lead, thereby becoming sources of exposure for consumers. Industrial effluents contaminated with lead and other toxic metals can pollute the soil , air and water bodies. Irrigation of rice farms, vegetable farming and fish farming using lead polluted water sources can result in lead contaminated rice, vegetables and fish.

Although it does not usually occur in Bangladesh, the hunted game shots with lead ammunition are a potential exposure source for people who regularly eat this meat. Lead from ammunition can contaminate the flesh of the animal, and lead shot embedded in the flesh may also be eaten, retained in the GI tract, and absorbed. Outbreaks of lead poisoning have been caused by flour ground with millstones fixed with lead components. Spices may be deliberately adulterated with lead compounds or be contaminated by other means.

Traditional medicines and cosmetics

Traditional medicines may contain lead as an intended ingredient or as a contaminant, and there have been numerous reports of poisoning in children and adults. These medicines may be used for many conditions, including GI complaints, skin conditions, infertility, erectile dysfunction, epilepsy, and diabetes, or may be taken as tonics or aphrodisiacs. Lead-containing traditional cosmetics such as Surma, Kohl, and Sindoor have caused toxic effects, particularly in children.

Lead objects

Children can be exposed to lead by mouthing toys painted with lead paint or brass keys and may accidentally swallow lead objects such as filing or curtain weights and lead jewelry. Adults may also ingest lead foreign bodies, intentionally or accidentally, for example, as a lead shot in a hunted game. Ingestion of ground lead-glazed pottery by pregnant women can cause maternal and fetal lead poisoning.

Occupational exposure

Lead is the most widely used non-ferrous metal, and many occupations are therefore associated with the risk of exposure. The industries include mining, smelting, and refining operations, high-temperature lead applications such as welding and spray-coating, lead grinding and cutting; battery manufacture and recycling; scrap metal recycling; production of paints, pigments, ceramics, glazes, enamels, and rubber; building renovation and decoration, construction and demolition, and plumbing and tank cleaning.

Other smaller-scale occupations involving lead exposure include gun smiting, glass polishing, brass polishing, lock smiting, jewelry, pottery, and stained glass. Firing ranges are another source of exposure. Para-occupational exposure can occur when people who work with Lead bring home lead dust on their bodies and clothing.

Miscellaneous sources

Lead poisoning has also been associated with a variety of other substances, including lead-contaminated opium and other drugs of abuse and lead nipple shields used by a mother of a breastfed infant. Poisoning has been reported after ingesting snooker cue chalk, lead roofing plates, and solder. Ingestion of soil or clay by pregnant women is a source of lead exposure in some communities. Lead poisoning can also arise from retained bullets and shrapnel.

CHAPTER 3

Routes of Exposure & Toxicokinetics

Key Points

- Ingestion is the most common route of lead exposure for children and leads to elevated blood lead levels.
- Inhalation can be a significant exposure pathway, particularly for workers in lead industries, "do-it-yourself," home renovators, persons with hobbies (stained glass making/soldering), smokers, and children exposed to secondhand smoke.
- Embedded or retained leaded foreign bodies can be a source of ongoing lead exposure.
- Trans-placental exposure to the unborn child can happen if the mother is exposed to lead.

The most important routes of exposure to lead are ingestion and inhalation (Figure 2). Acute lead poisoning may occur after ingesting a toxic amount of lead salts such as lead acetate or tetraoxide. However, most cases of oral lead poisoning result from regular ingestion of small amounts of lead-containing material such as contaminated dust or soil (pica), flakes of lead paint, contaminated food, lead-containing traditional medicines, or from ingesting a lead foreign body.

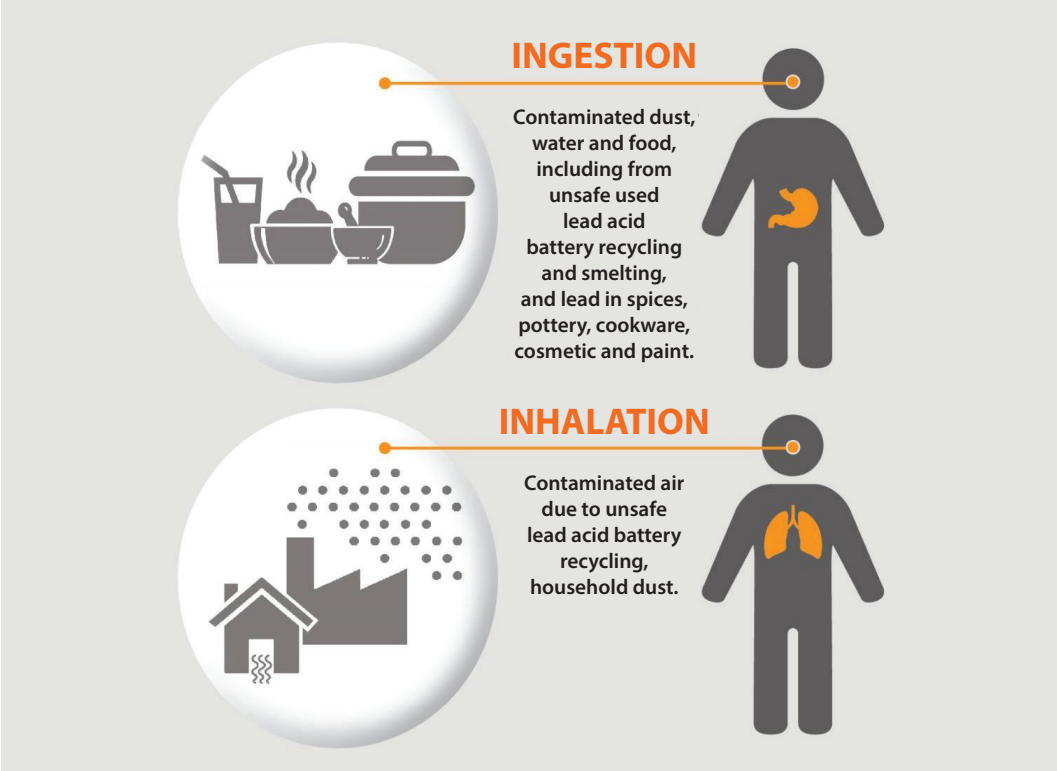
Young children are particularly likely to ingest contaminated soil and dust because they spend much time in one place, play on the ground, and have frequent hand-to-mouth contact and mouth objects that may contain or be contaminated with lead. Children with pica may persistently eat flakes of leaded paint or lead-contaminated soil.

Inhalation of lead as fumes or particles is a significant occupational route of exposure. Inhalation may also occur in the home if there is airborne dust contaminated with lead, for example, because of paint stripping.

Dermal exposure can occur occupationally or using cosmetic products containing lead, but this is considered a minor route.

Injections of lead compounds have occasionally been reported.

Figure 2: Main two pathways of lead exposure



Trans-placental exposure

Lead can pass from a parent to their unborn baby. The good news is that lead exposure is preventable. Now is the time to keep your baby safe from lead poisoning.

If an adult has been exposed to lead for a long time or has had high levels of lead in their blood, the lead stored in their bones can be released into the blood during pregnancy. This means that the lead level in their blood can increase during pregnancy. Iron deficiency, a common phenomenon found in pregnant women in Bangladesh, may cause the increased to absorb more Lead. Calcium deficiency can also exacerbate lead release into the fetus during pregnancy. If a person is exposed to lead during their pregnancy, their developing baby can also be exposed.

Lead in the blood during pregnancy can:

- Increased risk for miscarriage
- Cause the baby to be born too early or too small
- Hurt the baby's brain, kidneys, and nervous system
- Cause the child to have learning or behavior problems

Toxicokinetics

a. Absorption

Absorption of lead from the GI tract is affected by dietary factors, age, nutritional status, genetic factors, and the form of lead. In adults, approximately 3–10% of ingested lead is absorbed, and the remainder is eliminated in the feces. Infants and young children absorb a more significant proportion of ingested lead, 40–50%. Fasting and dietary deficiencies of iron or calcium are reported to enhance absorption. The impact of dietary zinc intake on lead absorption is unclear.

Absorption of particulate lead by inhalation depends on particle size, concentration, and ventilation rate. Age is also a factor: children may have higher exposure than adults as they breathe proportionately more air per unit of body weight. Tiny particles of Lead (< 1 μm) are deposited in the lower respiratory tract, where the Lead is almost entirely absorbed. In contrast, larger particles (1–10 μm) are likely to be deposited in the upper airways, transferred by mucociliary transport to the esophagus, and swallowed. Models have been developed to estimate the blood lead concentration associated with different levels of airborne occupational exposure to lead.

Dermal absorption is minimal for inorganic Lead and much more significant for organic lead compounds. Retained lead fragments such as gunshot pellets or bullet fragments may become a source of lead absorption.

Risk factors include prolonged contact of the fragments with synovial, pleural, or cerebrospinal fluid, the position of the projectile near a bone or joint, or an associated bone fracture, particularly a tarsal bone fracture.

Absorption is also more significant if the projectile is fragmented or there are numerous pellets, as both increases the surface area for absorption. The time between injury and raised blood lead concentrations is highly variable, ranging from 3 months to over 50 years in published reports.

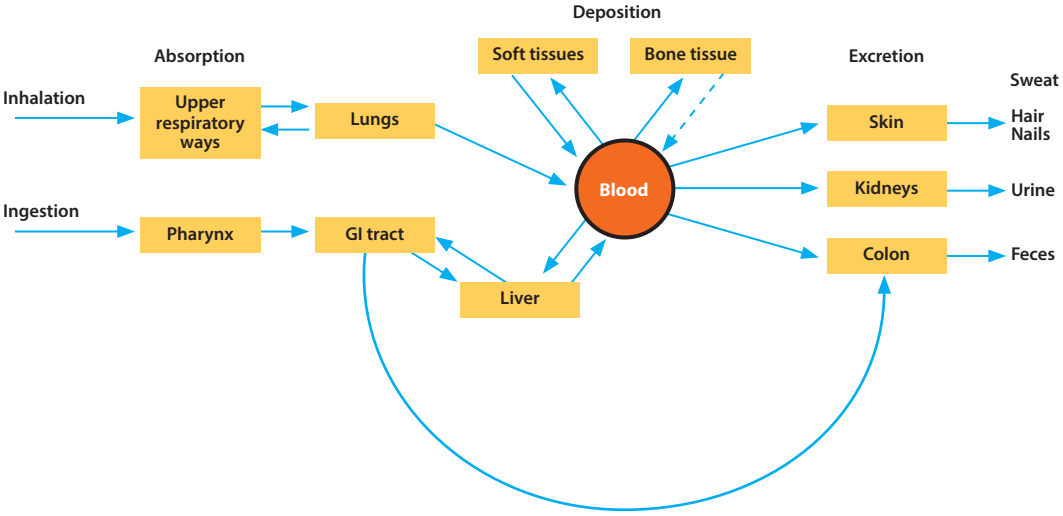


Figure 3: **Lead in the body (from entry to elimination) (collected from The National Academies Press, USA: Lead in America)**

b. Distribution

Once absorbed, lead is initially bound to erythrocytes in the blood and is distributed to soft tissues and bone. Blood and soft tissues represent the active pool, and bone is the storage pool. Adults' highest soft tissue concentrations are in the liver and kidney cortex. Lead is also distributed to teeth and hair.

The blood lead concentration reflects recent exposure to lead from exogenous sources and, when there has been previous exposure to lead, also includes lead redistributed from skeletal stores. Most blood lead is in erythrocytes, and the remainder, typically < 1%, is in plasma. The latter fraction interacts with cells in tissues throughout the body.

The binding sites on erythrocytes are saturable; consequently, as more lead is absorbed, a more significant proportion is available in plasma to distribute to tissues (Figure 3).

In chronically exposed individuals, bone contains > 90% of the body burden of lead in adults and > 70% in children. Lead forms stable complexes with phosphate and can replace calcium in hydroxyapatite, which forms the main crystalline matrix of bone. Lead can therefore deposit in bone during growth and remodeling. A labile pool of lead in bone readily exchanges with lead in plasma.

As lead is excreted from the blood by normal processes or after chelation therapy, it is replenished from the stored in bone. Lead can also be released from bone during metabolic processes that increase bone turnover, such as during pregnancy, lactation, menopause, hyperthyroidism, bone cancer, and immobilization due to bone fractures. Lead accumulates in bone over living up to the age of 50–60 years, followed by a decrease due to age-related changes in diet, hormonal concentrations, and metabolism.

During pregnancy, the blood lead concentration increases due to increased resorption of maternal bone to meet the calcium needs of the developing fetal skeleton. There is a decrease in the second trimester due to hemodilution, and the blood lead concentration rises again in the third trimester and continues post-partum, particularly in lactating women. There is no placental barrier to lead, and maternal and fetal blood lead concentrations are similar.

Lead is present in breast milk from exogenous sources or remobilized from skeletal stores. There is a non-linear relation between the concentrations of lead in blood and breast milk, with milk lead concentrations increasing disproportionately at blood lead concentrations > 40 µg/dL. No cases of lead poisoning resulting from exposure to lead in breast milk alone have been identified.

c. Metabolism

Inorganic lead is not metabolized but is reversibly bound to amino acids, proteins, and sulfhydryl compounds. Organic lead compounds are metabolized to inorganic lead. Alkyl compounds such as tetraethyl lead and tetramethyl lead undergo oxidative dealkylation to form the highly neurotoxic compounds triethyl and trimethyl lead, respectively.

d. Elimination

Absorbed lead is eliminated primarily in urine and feces. Small amounts are excreted in sweat, saliva, hair, nails, and breast milk.

Lead is rapidly eliminated from blood and soft tissues, with 50–60% being eliminated from blood in 30–40 days. Lead is eliminated slowly from bone stores, the half-life depending on age and the intensity of exposure. As children's bones are still growing, the bone compartment is more labile than that of adults, and lead moves faster from bone to blood. The half-life for cortical bone is estimated to range from 0.23 years at birth to 3.7 years at 15 and 23 years in adults. In individuals with an elevated bone lead burden, cessation of lead exposure typically results in an initial fast decrease, with a half-life of several months, representing a reduction of lead in soft tissues, followed by a more prolonged phase with a half-life of years, representing the release of lead from skeletal tissues.

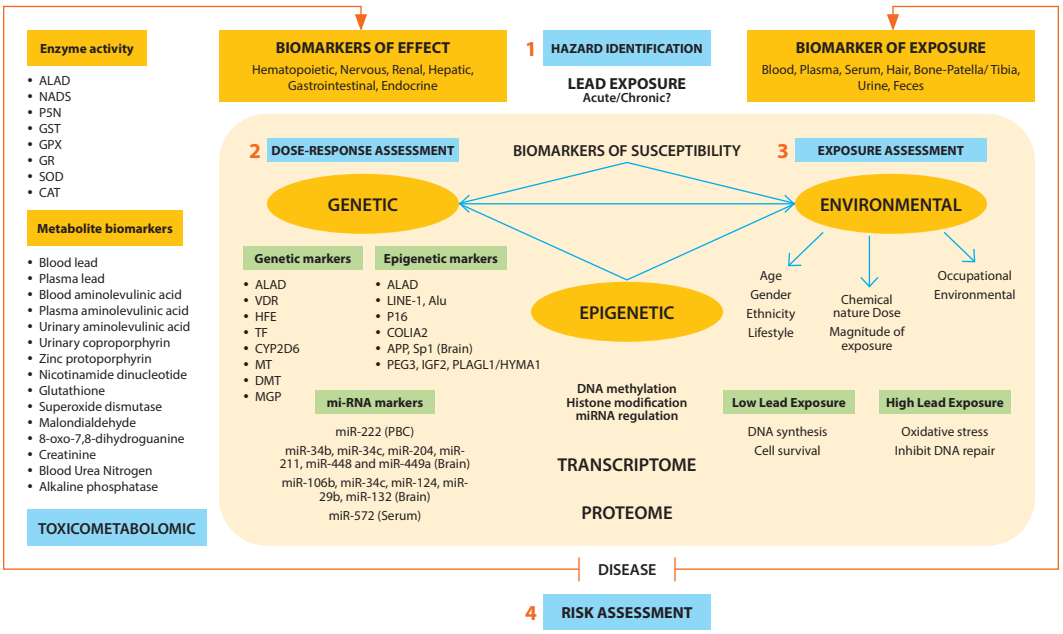
CHAPTER 4

Toxicity of Lead

Mechanisms of toxicity

The pathophysiology of lead is complex. Lead has no apparent physiological function. It has an affinity for sulfhydryl groups and other organic ligands in proteins and can mimic other biologically essential metals, such as zinc, iron, and calcium. As a result of these properties, lead has several modes of toxic action that depend on the dose and target organ. The modes of action include changes in ion status and cell signaling, changes in protein binding, oxidative stress, inflammation, endocrine disruption, cell death, and genotoxicity.

Figure 4: Schematic representation of exposure, effect, and susceptibility biomarkers for assessing Pb toxicity. Pb: lead.



Toxic effects

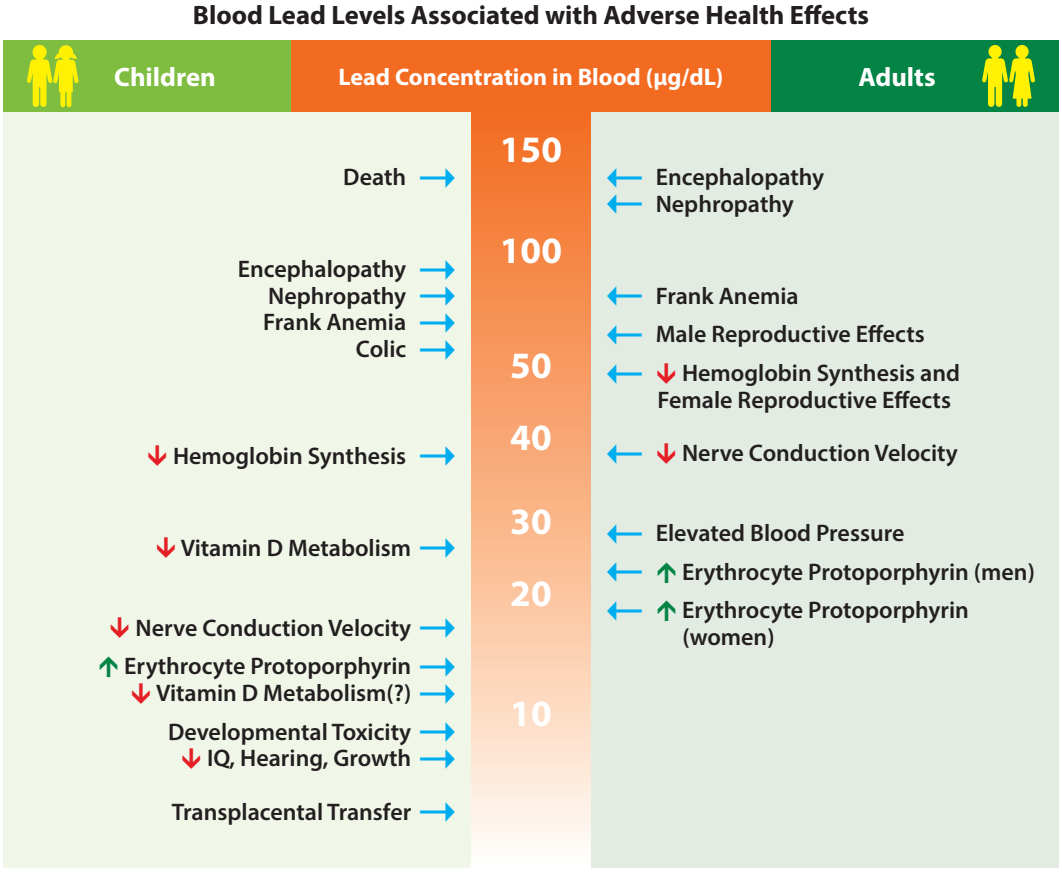
The toxic effects of lead affect almost all body systems. The effects of the most significant public health significance, i.e., adverse neurodevelopmental effects in children and cardiovascular disease in adults, are non-specific and largely subclinical. In addition, there is a considerable inter-individual variation in dose-response relations for lead toxicity, and the presenting signs and symptoms are highly variable in adults and children. The toxic effects may include GI, hematological, neurological, and renal effects and effects on the reproductive, immunological, endocrine, and cardiovascular systems. In severe poisoning, life-threatening encephalopathy may occur.

The features of acute and chronic poisoning are similar. In acute poisoning, GI and hepatic effects can occur within 1–2 days, followed by renal impairment and hematological and neurological effects over several days to weeks after exposure. After acute ingestion, some patients remain asymptomatic or show only mild effects, even with a high blood lead concentration, while others may develop severe poisoning. Retention of a lead foreign body can be a source of prolonged lead exposure.

Blood lead concentration is the most used measure of exposure, although it represents only about 1% of the total body burden of lead, the remainder being in soft tissues and bone. The concentration of lead in the blood reflects recent exogenous exposure and endogenous redistribution of lead from the bone. There is a considerable inter-individual variation in the blood lead concentration at which specific signs of poisoning manifest. Some individuals may be clinically well when they have blood lead concentrations associated with encephalopathy and death in others. In a review, the full spectrum of clinical effects, from no symptoms of poisoning to fatal encephalopathy in children, were reported to occur within 100–200 µg/dL. The same variation applies to subclinical effects such as on IQ, so children with the same blood lead concentration do not necessarily have the same risk of impaired neurodevelopment.

Furthermore, a low blood lead concentration in adulthood does not necessarily indicate that lead exposure was always low. High exposures earlier in life might have caused organ damage that manifested only in adulthood. With those caveats in mind, Summary Figure 5 presents information about health effects in adults and children associated with specific blood lead concentrations derived from reviews and large case series.

Figure 5: Adverse health effects of lead



Note: ↑ increased function and ↓ decreased function **Source:** ATSDR, 1992

Pregnancy

Lead has long been known to affect reproductive outcomes in women adversely and has been used as an abortifacient. Even at low levels, maternal exposure is associated with reduced fetal growth, lower birth weight, hypertension, potentially preeclampsia, preterm birth, and spontaneous abortion.

Immunological effects

Prenatal and childhood exposure to lead may be associated with increased asthma and allergy risks. Studies in experimental animals suggest that exposure to lead reduces host resistance to bacterial and viral infections.

Effects of blood lead levels on children and adults

Blood Lead Levels in µg/dL (micrograms per deciliter)	Effects
Children & Adults	
<5 µg/dL	Decreased IQ, cognitive performance and academic achievement; increased incidence of problem behaviours and diagnosis of attention deficit/hyperactivity disorder; reduced fetal growth (based on maternal blood concentration); impaired renal function; reduced synthesis of aminolevulinic acid dehydratase (ALAD), contributing to anaemia
<10µg/dL	Delayed puberty; developmental toxicity
<20 µg/dL	Increased level of erythrocyte protoporphyrin; decreased vitamin D metabolism; decreased calcium homeostasis
>20 µg/dL	Anaemia
>30 µg/dL	Reduced nerve conduction velocity; increased vitamin D metabolism; increased risk of hypertension in adulthood
>40 µg/dL	Decreased haemoglobin synthesis
> 50 µg/dL	Severe neurological feature
> 60 µg/dL	Abdominal coli; features of acute poisoning but no encephalopathy
> 90 µg/dL	Encephalopathy
> 105 µg/dL	Severe neurological features
150 µg/dL	Death
Adults	
<5 µg/dL	Impaired renal function; reduced synthesis of delta-aminolevulinic acid dehydratase, contributing to anaemia
<10 µg/dL	Hypertension, increased cardiovascular-related mortality, spontaneous abortion, preterm birth
> 40 µg/dL	Peripheral neuropathy, neurobehavioural effects, abdominal colic
> 50 µg/dL	Decreased haemoglobin synthesis

Source: The World Health Organization

CHAPTER **5**

Diagnosis of Lead Poisoning

History

The clinical presentation varies widely, depending upon the age, amount of exposure, and duration. Because of its higher lipid solubility, organic lead causes more significant toxicity and predominantly affects the neurological system. Younger patients tend to be more affected than older children and adults because lead is absorbed more effectively from children's gastrointestinal (GI) tract.

Signs/Symptoms

Initially, lead poisoning can be hard to detect — even people who seem healthy can have high blood levels of lead. Signs and symptoms usually do not appear until dangerous amounts have accumulated.

In children

Lead poisoning symptoms in newborns (Babies exposed to lead before birth might):

- Be born prematurely
- Have lower birth weight
- Have slowed growth

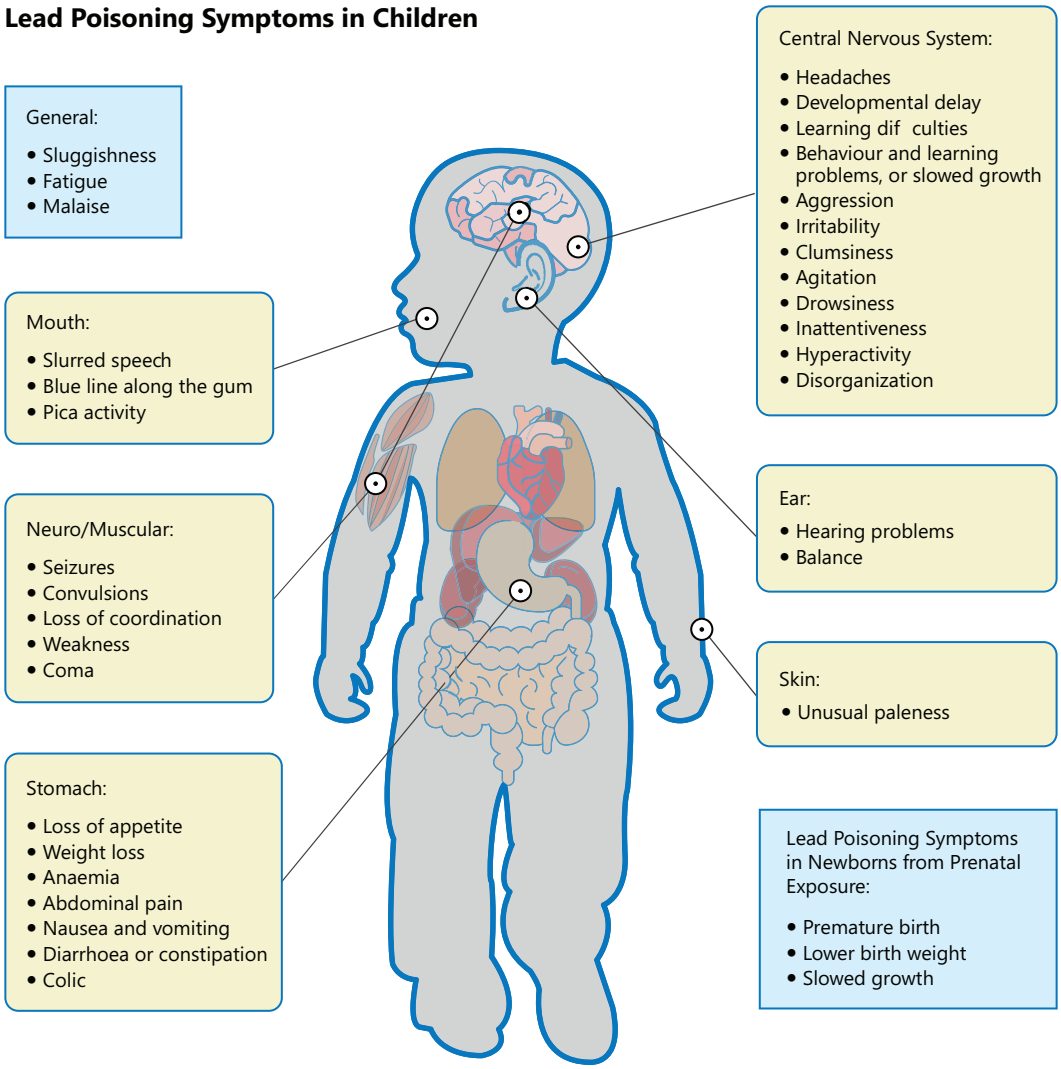
Children are more at risk from lead poisoning for several reasons:

- They are more likely to pick up lead contamination from the soil and consume it then.
- They are also closer to a ground level more frequently and, therefore, more at risk of breathing in dust from the floor.

Signs and symptoms of acute lead poisoning include:

- abdominal pain and vomiting
- jaundice
- lethargy
- black diarrhea
- irritability
- loss of appetite
- weight loss
- sluggishness and fatigue
- constipation
- hearing loss
- seizures
- eating things, such as paint chips, that aren't food (pica)

Figure 6: Signs and symptoms of lead poisoning in children



However, symptoms are more likely to appear over time. **This is known as chronic poisoning** (Figure. 6 and 7).

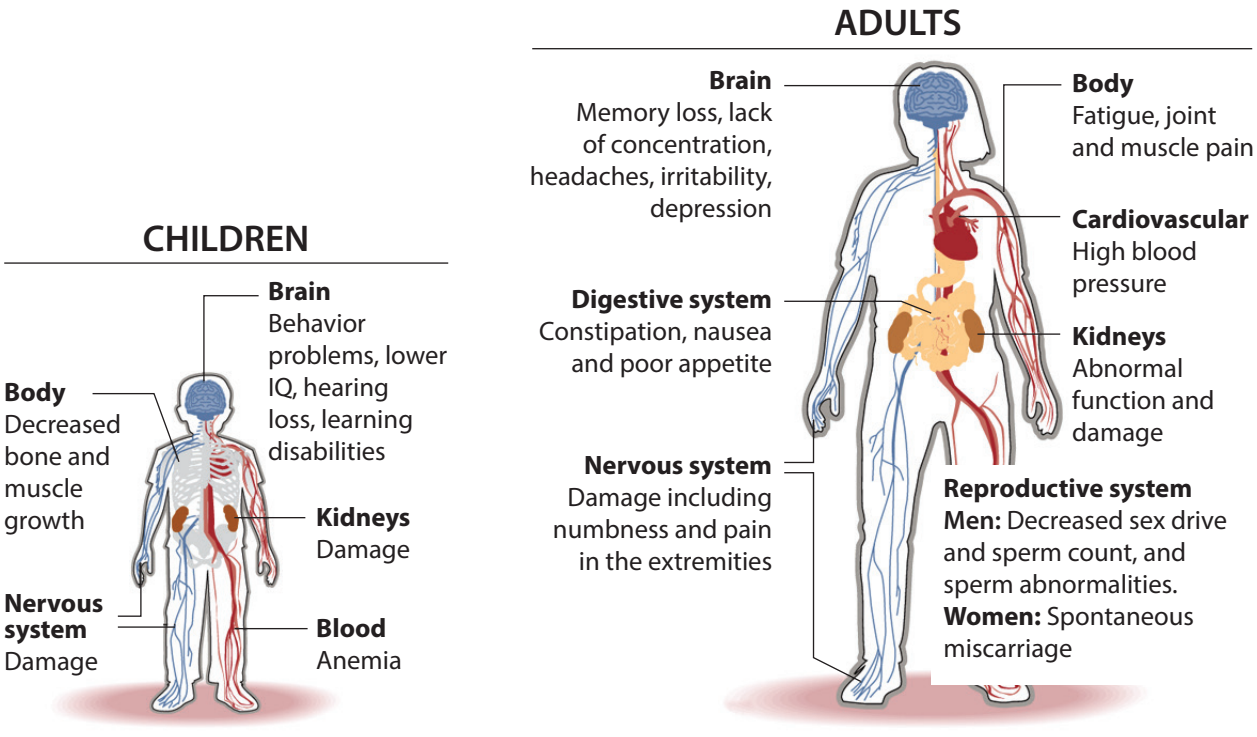
These include:

- slowed body growth
- reduced IQ, developmental delay
- loss of appetite and weight loss
- blue tinge around the gums
- anemia

- hearing loss and **reduction in other senses**
- neurological weakness in the later stages
- learning difficulties
- lethargy, seizures, stupor, coma
- encephalopathy, which affects the brain and can lead to death
- The presence of fever does not rule out the diagnosis, which must still be considered.

Young children absorb lead 4 to 5 times the trusted source **more readily than adults, and because their bodies are still developing, the risks are further increased**. Investigate the patient's medical history, including developmental milestones or delays, hygiene, pica, and previous exposure to lead. Evidence suggests that delayed weaning is associated with excessive pica and lead poisoning. It is commonly found that lead-poisoned children are bottle-fed for protracted periods. Inquire about the patient's siblings (e.g., ages, developmental history, school performance, and blood lead levels [BLLLs] if known).

Figure 7: A brief signs and symptoms of lead poisoning in adults and children



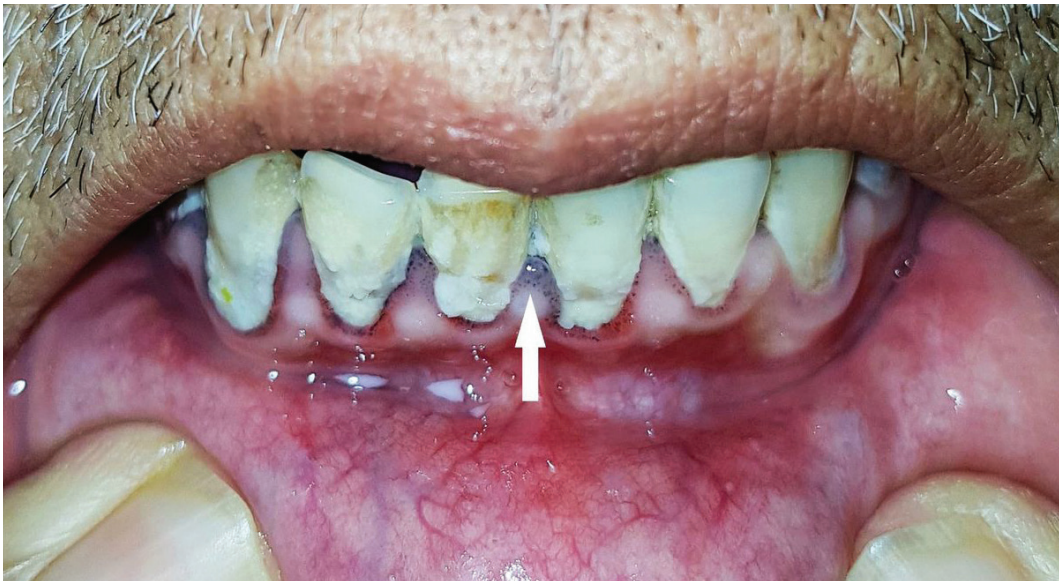
In adults

Although children are primarily at risk, lead poisoning is also dangerous for adults. Signs and symptoms in adults might include:

- abdominal pain is usually the first sign of a high dose of Lead being ingested
- high blood pressure
- joint and muscle pain
- constipation
- headache
- mood disorders
- anemia
- tingling, pain, and numbness in the extremities
- memory loss and decline in mental functions
- unusual taste in the mouth, often described as metallic
- difficulty sleeping
- reduction in sperm volume and quality
- foot or ankle drop in the later stages
- weakness of extensor muscles (e.g., foot drop, wrist drop)
- delirium, hallucinations
- frequently sleep disorders.
- Papilledema, cranial nerve abnormalities, and signs of increased intracranial pressure (ICP).
- Cranial nerve involvement, particularly involvement of the optic nerve, is not uncommon. Chronic lead exposure has been shown to cause optic neuritis and blindness.
- Adults with poor dental hygiene may demonstrate lead lines appearing on gingival tissue (pyorrhea and the subsequent precipitation of lead sulfide), a characteristic finding in any heavy metal poisoning.
- In men, lead causes a reduction in libido, abnormal spermatogenesis, chromosomal damage, and infertility.
- Women experience an increased incidence of stillbirth, miscarriage, pregnancy-induced hypertension, and prematurity.

Adults may develop gout, acute arthritis, and carpal tunnel syndrome. Those who work in jobs that involve lead have a higher risk of presenting the signs and symptoms other than those in other occupations. Examples would include auto repair shops and home improvements.

Figure 8: Burton's line, also known as the Burton line or Burtonian line, is a clinical sign found in patients with chronic lead poisoning. A skinny, black-blue line is visible along the margin of the gums at the base of the teeth.



The sign was described in 1840 by Henry Burton, "The edges of the gums attached to the necks of two or more teeth of either jaw, were distinctly bordered by a narrow leaden-blue line, about the one-twentieth part of an inch in width, while the substance of the gum retained its ordinary color and condition."

Laboratory diagnosis

Suggested laboratory tests to evaluate lead intoxication include:

a) Complete blood count (CBC) with peripheral smear

b) Blood lead level.

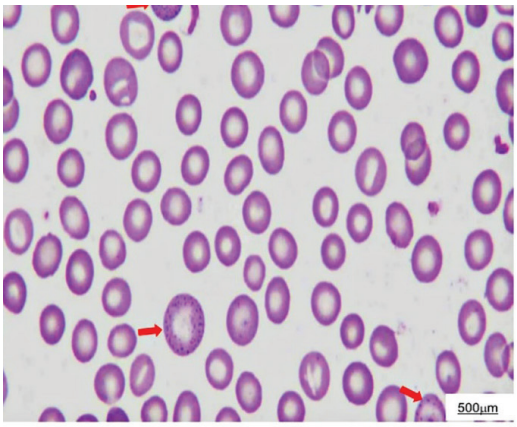
c) EP and zinc protoporphyrin (ZPP) levels

d) Blood urea nitrogen (BUN) and creatinine level

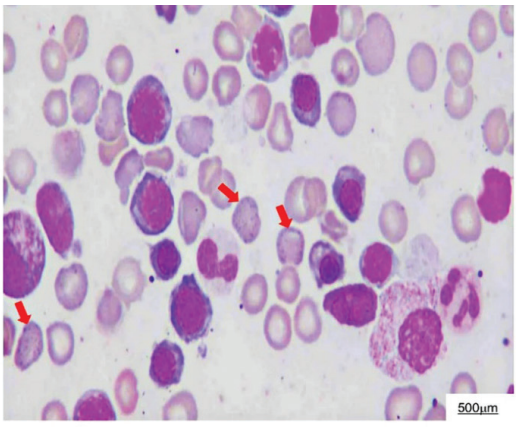
e) Urinalysis.

CBC with Peripheral Smear: In a lead-poisoned individual,

the hematocrit and hemoglobin values -	May be slightly to moderately low
the differential and total white count -	May appear normal
the peripheral smear -	May be either normochromic and normocytic or hypochromic & microcytic may reveal hypochromic microcytic anemia
	Basophilic stippling of the erythrocytes (fig: below), characteristic of lead poisoning, is uncommon in children, usually seen only in patients who have been significantly poisoned for a prolonged period.
	Eosinophilia may appear in patients with lead toxicity but does not show an apparent dose-response effect



A. Peripheral blood smear



B. Bone blood smear

Polycythemia, Polychromasia
Reticulocytosis, Anisopoikilocytosis
Thrombocytopenia, Neutropenia

BUN, Creatinine, and Urinalysis	Features of dehydration, with concentrated urine
	Glycosuria, Amino-acidemia, Hypophosphatemia

These parameters may reveal only late, significant effects of Lead on renal function

The fractional excretion of uric acid (normal range 5% to 10%; less than 5% in saturnine gout; greater than 10% in Fanconi Syndrome)

The standard lead content of urine is 0.08 mg/L, but in poisoning, 0.15-0.30 mg/L can be found.

EP and ZPP Levels

Until recently, the test of choice for screening asymptomatic children and other populations at risk was EP, commonly assayed as ZPP

An elevated level of protoporphyrin in the blood results from accumulation secondary to enzyme dysfunction in the erythrocytes. It reaches a steady state in the blood only after the entire circulating erythrocytes have turned over, about 120 days.

Average values of ZPP are usually below 35 ug/dl., Hyperbilirubinemia (jaundice) will cause falsely elevated 433 readings when the hematotluorometer is used. The major disadvantage of using EP (ZPP) testing as a method for lead screening is that it is not sensitive at the lower levels of lead poisoning.

EP is elevated in iron deficiency anemia, sickle cell, and other hemolytic anemias. In erythropoietic protoporphyria, a sporadic disease, EP is markedly elevated (usually above 300 u.g/dl.),

Confirmatory testing for lead poisoning

The blood lead concentration is best measured in a venous blood sample for diagnosis and treatment decisions. Capillary samples, usually obtained by a finger-prick, are considered acceptable for screening purposes, and this is their primary use. An elevated lead concentration measured in a capillary sample should be confirmed by laboratory measurement in a venous sample. In exceptional situations, when venous samples cannot easily be obtained, and life-saving treatment would be delayed, capillary samples may be analyzed for diagnosis, with a confirmatory laboratory analysis of venous samples as soon as possible (Table 1).

CDC uses a blood lead reference value of 3.5 µg/dL to identify children with blood lead levels that are higher than most children's levels. However, no safe level of lead in children has been identified. Low levels of lead in the blood can negatively impact a child's health and should be considered a concern.

Both capillary and venous samples can be analyzed using higher complexity methods such as inductively coupled plasma mass spectrometry (ICP-MS) or graphite furnace atomic absorption spectroscopy (GFAAS). However, venous samples are more reliable at identifying lower blood lead levels than capillary samples when analyzed using higher complexity methods (i.e., ICP-MS and GFAAS).

A finger-prick test that shows a blood lead level at or above CDC's blood lead reference value is usually followed by a second test to confirm it.

Table 1: Recommended Schedule for Obtaining a Confirmatory Venous Sample

Capillary Blood Lead Level (µg/dL)	Time to Confirmation Testing (in the month)
≥3.5–9	Within 3 months
10–19	Within 1 month
20–44	Within 2 weeks
≥45	Within 48 hours

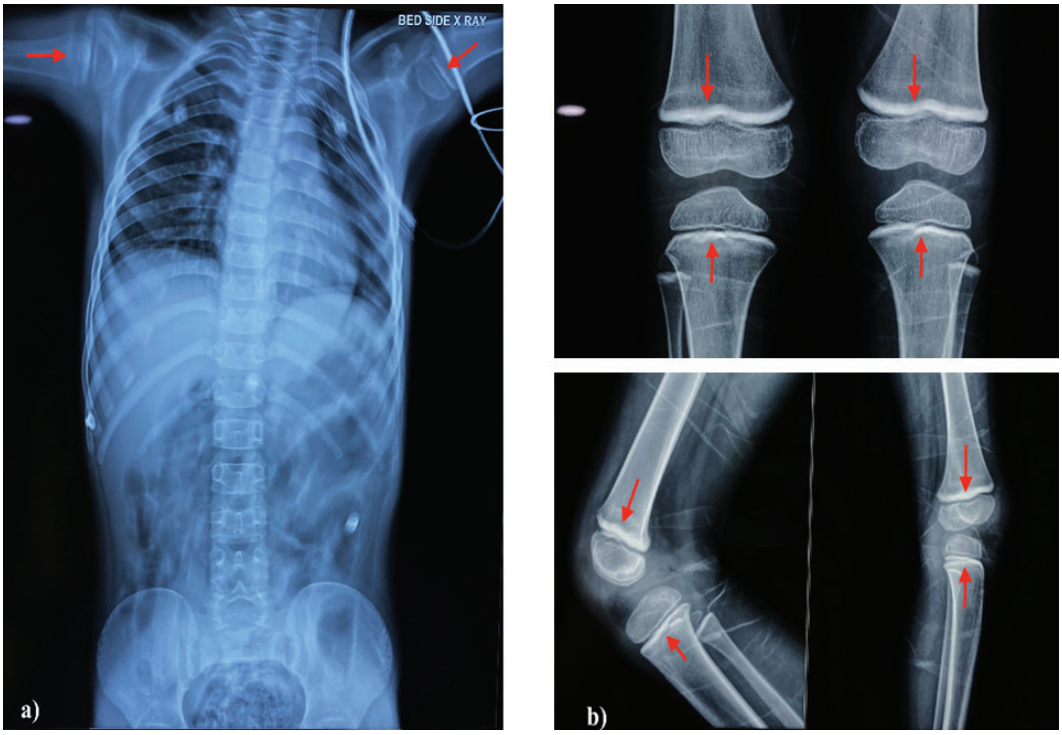
The criterion standard is a whole blood lead level (BLL). Any BLL greater than 5 µg/dL is considered positive and consequential. For all children with lead in blood, the source of lead should be identified and the child should be removed from the exposure. Patients with BLLs between 10 and 20 µg/dL require removal from the exposure, repeated testing, and follow-up.

Radiographic features

Plain radiograph

- may show bands of increased density at the metaphyses (broad, dense bands) (Figure 9)
- can affect any metaphysis, but the involvement of the proximal fibula and distal ulnar metaphyses is highly suggestive
- may show bone-in-bone appearance
- an abdominal x-ray may reveal radio-opaque foreign bodies in the bowel

Figure 9: Radiographic demonstration of lead line in bones



MRI Findings

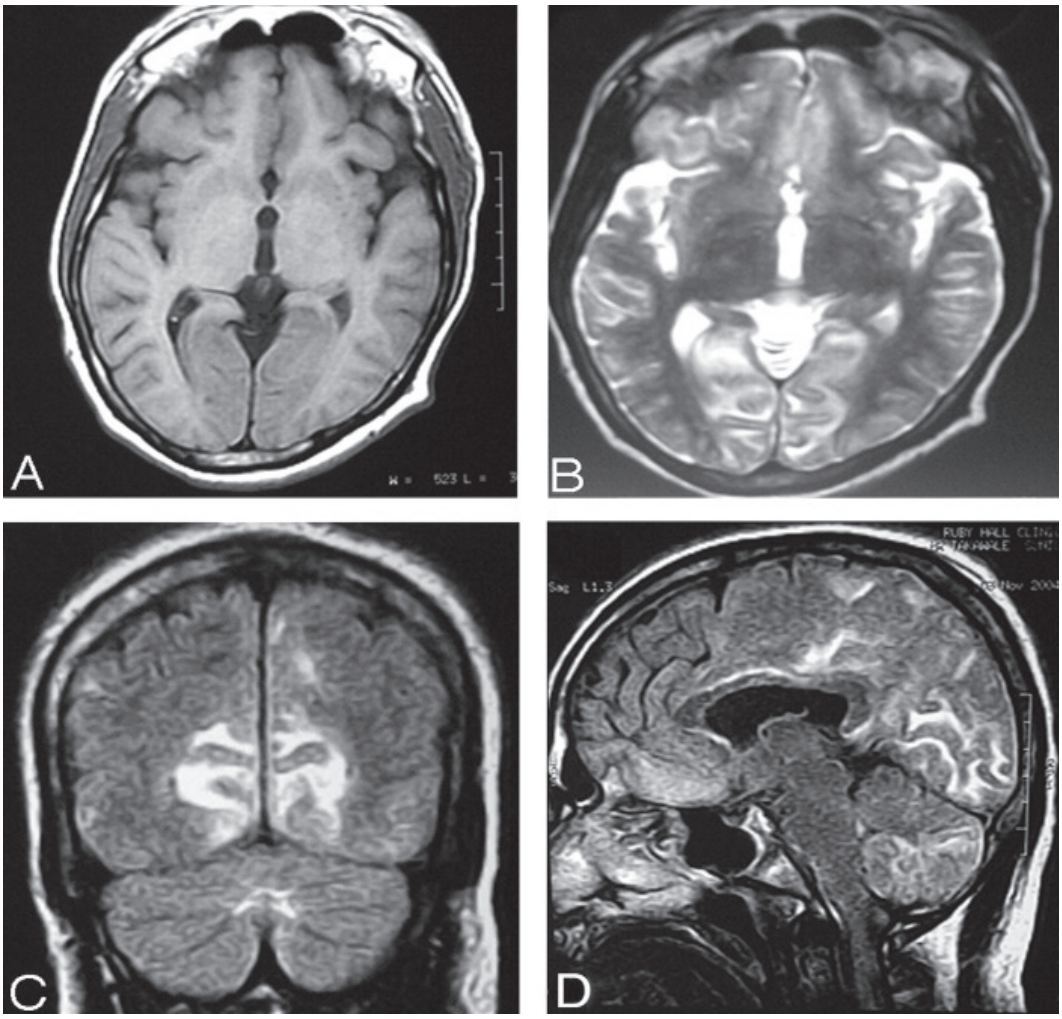
Bilateral symmetric involvement of the thalamus and lentiform nucleus of the brain with the hyperintensities in T2 weighted axial images suggesting sub-cortical white matter toxic demyelination.

Pre-chelation MR imaging

A–**C**, T1- and T2-weighted axial, and FLAIR (respectively) coronal MR images show cortical gray matter and subcortical white matter lesions in the occipital lobe with edema and sulcal effacement.

D, FLAIR sagittal image shows the involvement of subcortical white matter in the frontal regions, parieto-occipital lobe, body of the corpus callosum, and cerebellum.

Figure 10: Pre-chelation MR imaging



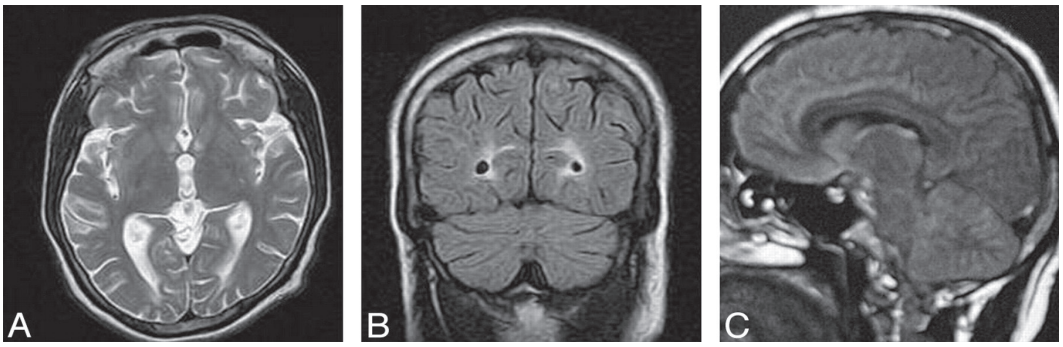
Source: Atre AL, Shinde PR, Shinde SN, Wadia RS, Nanivadekar AA, Vaid SJ, Shinde RS. Pre- and posttreatment MR imaging findings in lead encephalopathy. AJNR Am J Neuroradiol. 2006 Apr;27(4):902-3. PMID: 16611788; PMCID: PMC8133999.

Post-chelation MR imaging

A and **B**, T2-weighted axial and FLAIR coronal images show near-total resolution. Few focal subcortical white matter lesions are still seen in the occipital lobe.

C, FLAIR sagittal images show near-total resolution.

Figure 11: Post-chelation MR imaging



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Differential diagnosis

Lead poisoning, with or without encephalopathy, may result in neurologic, renal, hepatic, or cardiac damage. All organ systems may be potentially damaged by lead. A possibility that symptoms may progress with chelation exists, and the treating physician must be prepared to manage them. Such complications may include inappropriate antidiuretic hormone (SIADH) excretion, increased ICP, renal impairment from the chelated lead complex, and hypertension.

Lead poisoning or lead toxicity is lead exposure that results in illness and requires immediate medical attention. It is used to describe cases when there are severe health effects related to high blood lead levels. If blood lead levels are 45 micrograms per deciliter (µg/dL) or greater, healthcare providers may recommend medication to help remove lead from the body. However, children are susceptible to lead, and exposure at lower levels has been shown to cause harm. CDC provides a summary of Recommended Actions Based on Blood Lead Level. The differential diagnosis of lead poisoning that is commonly reported are as below:

a. Acute Anemia

b. Chronic Anemia

c. Confusional States and Acute Memory Disorders

d. Constipation in Emergency Medicine

e. Depression and Suicide

f. Diabetic Neuropathy

g. Emergent Management of Guillain-Barre Syndrome

h. Epileptic and Epileptiform Encephalopathies

i. Frontal Lobe Syndromes

j. Gout and Pseudogout

k. Heavy Metal Toxicity

l. Mercury Toxicity

m. Organic Solvent Neurotoxicity

n. Radial Mononeuropathy

Can Mothers Breastfeed Their Children If They Have Blood Lead Levels (BLLs) of 3.5 µg/dL or Higher?

If a pregnant or lactating woman has blood lead levels (BLLs) ≥3.5 µg/dL, the health care provider should attempt to determine the source(s) of lead exposure, working with the local health department and occupational medicine specialists as needed for environmental assessment and case management. It is recommended that mothers with BLLs <40 µg/dL should breastfeed, but it is important to note:

- Infant BLLs should be monitored if their mother's BLLs are between 3.5 and 39 µg/dL. Breastfeeding should continue for all infants with BLLs below 3.5 µg/dL.
- If infant BLLs are rising or failing to decline by 3.5 µg/dL or more, the healthcare provider should contact the local health department for environmental sampling. If no external source is identified, maternal BLLs are ≥20 µg/dL, and infant BLLs are ≥3.5 µg/dL, breast milk may be the source of lead exposure. Mothers should consider temporarily pumping and discarding their breast milk until maternal BLLs are lower.

Mothers with BLLs ≥40 µg/dL are encouraged to pump and discard their milk until their BLLs drop below 40 µg/dL.

- Testing breast milk for Lead is not recommended.

What Are Some Kinds of Lead Hazards Breastfeeding Women Might Be Exposed To? How Can They Protect Themselves and Their Infants?

Breastfeeding women should be aware of or avoid the following:

- Lead-based paint from repair, repainting, renovation, and remodeling work.
- Pica.
- Tainted food (eating candies, spices, food additives, and other foods from abroad, especially if they appear to be noncommercial products of unknown safety).
- Tainted foodware (imported lead-glazed ceramic pottery, pewter, brass containers, aluminum cookware from recycled metal scraps, or utensils to cook, serve, or store food).
- Tainted medicine or personal care products [imported medicines and herbal remedies (Azarcon, Ayurvedics); cosmetics and ceremonial powders (tiro, kohl, kajal, surma); and personal care products (litargirio), etc.].
- Water with lead levels exceeding 15 parts per billion (ppb).
- Some occupations or hobbies may involve lead exposure. These include construction or home renovation/repair; firing ranges; battery or electronics manufacturing or recycling; soldering or casting metal; oil field work; mining; and aviation gas used in small planes.
- Prior exposure due to any reason.

CHAPTER **6**

Management of Lead Poisoning

Approach considerations

The most crucial step in treatment is to prevent further exposure to lead. An accurate assessment of environmental and occupational exposure is essential. Modifying children's behavior to decrease hand-to-mouth activity is beneficial.

The criterion standard is a whole blood lead level (BLL). Any BLL greater than 5 µg/dL is considered positive and consequential. Patients with BLLs between 10 and 20 µg/dL require removal from the exposure, repeated testing, and follow-up.

Dietary measures

The diet should be adequate in energy (caloric) intake and replete in calcium, zinc, and iron. Low dietary intake of vitamin D may increase the accumulation of lead in bones, whereas low dietary intake of vitamin C and iron may increase lead levels in blood in subjects ranging from middle-aged to elderly. Although no studies have specifically addressed treating lead exposure with calcium and iron supplementation, it is a logical therapy to help limit lead absorption.

Nutritional supplementation with iron and calcium

In all cases, nutrition counseling should be given to promote diet diversity, food combinations that improve calcium and iron absorption, and counseling on reducing lead exposure. This information can be provided for pregnant women during routine antenatal care visits.

Calcium and iron may compete for absorption; therefore, if supplementation with both nutrients is required, they should be taken at different times of the day.

Calcium intake can be assessed by taking a dietary history and comparing intake with nationally recommended values. As the optimal dose for mitigating the effect of lead exposure is unknown, reference should be made to national intake value guidelines or WHO/FAO guidance. Care should be taken in sourcing calcium supplements, as those derived from biological sources such as animal bone may be contaminated with Lead. It is suggested that children's dietary calcium intake be re-assessed after 3 months. If it is still inadequate and the blood lead concentration remains elevated, consideration should be given to a further period of supplementation. For pregnant women, calcium should be given for the duration of pregnancy, and consideration should be given to extending administration into lactation.

Iron deficiency can be determined from an estimate of the serum ferritin concentration and a marker of inflammation (e.g., C-reactive protein or a1-acid glycoprotein). If this is not available, the evaluation of anemia is a non-specific marker of iron deficiency. Note that anemia may also be a feature of lead poisoning. The optimal dose and duration of iron supplementation to mitigate the effects of lead exposure are unknown; therefore, reference should be made to WHO guidance for treating iron deficiency, which recommends a minimum treatment duration of 3 months, after which iron status should be re-assessed to evaluate continuation. In malaria-endemic areas, the possible harm of iron supplementation should be balanced against the additional susceptibility of children with malaria to the neurotoxicity of Lead and the possibility that iron may benefit.

GI decontamination

The most appropriate method of GI decontamination varies from case to case. Factors to be considered include the size, nature, and quantity of the lead object(s) or lead-containing material ingested, the time that the material has been in the stomach or other parts of the GI tract, evidence of lead absorption, the clinical condition of the patient and the availability of resources for the intervention.

Endoscopic procedures are standard practice for removing foreign bodies when there is a risk of harm to the patient, and national and international professional societies have developed evidence-based and evidence-informed clinical guidelines. In the case of objects in the stomach, the use of oesophagogastroduodenoscopy may obviate surgery.

General skills in abdominal surgery (including laparoscopic methods) should be available at secondary and tertiary medical services WHO guidance on appendectomy is available.

Whole Bowel Irrigation (WBI) should be conducted only with an iso-osmotic polyethylene glycol-electrolyte solution.

Chelation therapy

The mainstay of treatment is chelation therapy (Table 2). Chelation agents contain sulfhydryl groups that bind or chelate lead, and the resulting complex is excreted either renally or hepatically. The chelation agents penicillamine and succimer are given orally, whereas dimercaprol, edetate (EDTA), and calcium disodium (CaNa2 EDTA) are administered parenterally.

These agents reduce body stores of Lead. Reducing blood lead levels also may mobilize skeletal stores of lead. Therefore, caution must be exercised in using chelation agents because of their adverse effects and ability to mobilize lead.

Chelation therapy, especially in the setting of encephalopathy, can be complicated. If appropriate treatment facilities are unavailable, consider transferring to an institution that can manage an encephalopathic patient and has a provider experienced in lead poisoning and chelation therapy. Ideally, children should be treated in specialized pediatric intensive care units.

Chelation therapy reverses *Fanconi syndrome, transient hypertension, and tubular structural changes* observed in histopathology findings.

Dimercaprol (BAL in Oil)

Dimercaprol (British antilewisite [BAL], or 2,3-dimercapto-1-propanol) was the first chelator used in encephalopathic individuals and is the drug of choice for the treatment of lead toxicity. It is a chelating agent for intracellular and extracellular Lead that diffuses into red blood cells (RBCs) and rapidly crosses the blood-brain barrier. Sulfhydryl groups combine with ions of heavy metals to form soluble, nontoxic complexes that are excreted renally. Dimercaprol is excreted primarily in bile, making it an agent that can be used in patients with renal failure.

Combination therapy with dimercaprol and CaNa2EDTA is recommended in all cases of severe, acute intoxication (e.g., BLL > 100 µg/dL), mainly when encephalopathy is present. Dimercaprol is administered IM every 4 hours, mixed in a peanut oil base; therefore, it should not be used in patients allergic to peanuts. The dose is increased to 7 mg/kg in severely poisoned patients with great caution. Adverse effects are fever, pain at the injection site, nausea, vomiting, headache, and sterile abscess formation.

D-penicillamine (Cuprimine, Depen Titratabs)

D-penicillamine (3-mercapto-D-valine), a second-line oral chelating agent, is a hydrolysis product of penicillin that is FDA-approved for the treatment of Wilson disease and cystinosis. It has been used as an oral chelator of lead for 30 years but has never been licensed for this indication by the FDA.

Penicillamine is effective orally and has few adverse effects. It can be administered over an extended period (weeks to months) for children with lead levels below 45 µg/dL. Penicillamine is available in capsules of 125 mg and 250 mg. Pyridoxine supplementation is required. Adjust the dose for patients with compromised renal function.

Table 2: Summary table on chelation therapy

Chelating agent	Indication	Dosage	Pregnancy	Lactation
Dimercaprol	BLC ≥ 70 µg/dL (Adjunct with CaNa2 EDTA if BLC > 100 µg/dL)	4-5 mg/kg every 4 hour for 3-5 days	Category C*	Safety not established
$CaNa_2$ EDTA	BLC ≥ 45 µg/dL or lead encephalopathy	1000 mg/m^2/day or 50 mg/kg for 5 days (maximum 1 g/day) IV (in normal saline or D5W) over 8-12 hours IM every 8-12 hours Could be repeated after 2-4 day rest period.	Category C (But is the preferred agent)	Safety not established
D-penicillamine	BLC 45 to 69 µg/dL	Adults: 250 mg every 6 hours Children > 6 months: 10-15 mg/kg for 4-12 weeks	Contraindicated	Contraindicated
DMSA	BLC 45 to 69 µg/dL	10 mg/kg or 350 mg/m^2 every 8 hours for 5 days; then reduce to every 12 hours for 14 days. Could be repeated after a 2-week rest period. 30 mg/kg/day for at least 5 days with at least 1 week rest period (more efficacious (44)) Not recommended for children < 12 months	Category C	Contraindicated**

BLC: blood lead concentration; $CaNa_2$ EDTA: calcium disodium ethylenediaminetetraacetic acid; DMSA: 2–3 mesodimercaptosuccinic acid (succimer); IV: intravenous; IM: intramuscular; D5W: dextrose 5% in water
*Human studies are lacking, animal studies are either positive for fatal risk or lacking. Although risk cannot be ruled out, benefits may justify the potential risks. **Lactation should be discouraged during treatment with succimer

Long-term monitoring

All patients treated for lead poisoning require extensive outpatient follow-up. Such follow-up intends to avoid further lead exposure and maintain lead levels in the acceptable range.

After chelation, the blood lead level should be rechecked in 7–21 days to determine whether repeat chelation therapy is required. Chelation therapy, either oral or intravenous, may be continued in an outpatient setting if indicated. Carefully monitor kidney and liver function during therapy.

Assess the source of lead. The involvement of the local health department can assist in this regard. Do not discharge patients from the hospital until they can go to a lead-free environment. Children should not be allowed to return to a lead-contaminated environment; if they are exposed to more lead, their lead levels will rapidly rise again.

There is a general belief, probably incorrect, that once chelation is terminated, BLLs will rebound rapidly. Numerous publications have discussed the effect of lead stored in bone. In light of the known kinetics of lead in the body and the reports of expected decreases in lead levels over time, this would not appear to be expected because the half-life of lead in bone is measured in years. Thus, significant elevations in BLL after the termination of chelation should be considered probable re-exposure.

Whether or not chelation therapy has been given, it is essential to re-evaluate the patient periodically, including the blood lead concentration, to determine the effectiveness of measures to terminate exposure and chelation and whether further action is necessary. If preventive measures are not successful, the blood lead concentration will continue to rise.

Chelation therapy removes lead from blood and soft tissues, but remobilization occurs if there are significant bone stores, and the blood lead concentration will rise again. The interval before a re-evaluation of a patient depends on the severity of the poisoning, the initial blood lead concentration (PbB), and whether the patient belongs to a vulnerable group. The WHO guideline development group suggested the following intervals:

Children, adolescents, and pregnant women:

- ***PbB > 30 µg/dL:*** after 2–4 weeks
- ***PbB 5–29 µg/dL:*** after 1–3 months
- ***PbB < 5 µg/dL:*** after 6–12 months, if there is continuing concern about possible lead exposure

Other adults:

- ***PbB > 50 µg/dL:*** after 2–4 weeks
- ***PbB 30–50 µg/dL:*** after 1–3 months
- ***PbB 5–29 µg/dL:*** after 3–6 months

A shorter interval is suggested for severe poisoning, higher blood lead concentrations, and children, adolescents, and pregnant women. As young children absorb proportionately more lead than adults, their blood lead concentrations may rise more rapidly. The fetal period and childhood are periods of susceptibility to the neurotoxic effects of lead. During pregnancy, physiological changes may result in increased blood lead concentrations and greater exposure of the fetus.

The increased need for calcium for the developing fetal skeleton results in increased calcium absorption from the maternal GI tract and may also increase lead absorption. In addition, stored lead may be released as maternal bone is resorbed. As children exposed to lead may suffer impaired neurocognitive and behavioral development, the WHO guideline development group advised periodic assessment for signs of difficulty in meeting developmental goals, ideally until the end of secondary education. These children should be given whatever support is available locally.

Other medications also used at present against lead poisoning are provided below (not popular in Bangladesh due to unavailability):

Succimer (Chemet)

Succimer, or meso 2,3-dimercaptosuccinic acid (DMSA), is an analog of dimercaprol used in lead poisoning. It has a high sensitivity for Lead, but its ability to chelate essential trace metals is low. It is available in capsules of 100 mg. The use of this agent in patients with lead levels higher than 60 µg/dL has not been carefully studied.

Edetate calcium disodium

CaNa2EDTA is nearly the perfect chelator. It is water-soluble, can be administered either intravenously (IV) or intramuscularly (IM), allows lead to be renally eliminated, is not metabolized, and has few toxic effects. Its main limitation is that it removes Lead from extracellular spaces only.

CaNa2EDTA should be given IV, diluted to a concentration of less than 0.5% in 5% dextrose in water (D5W) or isotonic saline. In patients with acute lead encephalopathy and increased intracranial pressure, dilution to a concentration of less than 3.0% may be necessary, or the IM route may be preferred to limit fluids. Ideally, the first dose of dimercaprol should be given at least 4 hours before CaNa2EDTA. CaNa2EDTA may initially aggravate symptoms of lead toxicity because it mobilizes stored Lead. When CaNa2EDTA is given IM, the same daily dose is divided into 2-6 doses. IM preparations of CaNa2EDTA are highly irritating to muscles and intensely painful. Lidocaine or procaine with IM preparation lessens the pain.

CHAPTER 7

Preventive Measures

There is no cure for lead poisoning. That is why preventing exposure to lead, especially among children, is essential. **Finding and removing lead sources from the child's environment is needed to prevent further exposure.** One can help reduce the harmful effects of lead exposure by talking to their doctor and getting connected to learning, nutritional, and behavioral programs as soon as possible. The preventive measures are as follows:

Residential preventive measures

Some measures people can take to protect their families from lead poisoning are described below.

a) Avoid lead-based paint to paint the houses.

b) Children should not have access to surfaces with peeling lead-based paint. Children should be kept away from chipping or peeling wall paint.

c) All lead sources should be cleaned and isolated.

d) Avoid using lead-based products of any kind (e.g., turmeric, surma, sindoor, etc.)

e) Washing children's hands, bottles, pacifiers, and toys often.

f) Making sure children eat nutritious meals high in iron and calcium.

g) You cannot see, taste, or smell lead in drinking water. The best way to know the risk of lead exposure through drinking water is to conduct a lead test on the water.

h) Wipe floors, windowsills, and other surfaces every two to three weeks to prevent the accumulation of lead-contaminated dust.

i) Remove shoes before entering the house to prevent lead-contaminated soil from being tracked.

j) Grass should be planted in areas of bare soil or

k) mulch or wood chips used to cover the areas.

l) Shower and change after working around lead-containing items like stained glass or ammunition.

m) Eat a healthy, nutritious diet to minimize the absorption of lead.

House renovation

If people are renovating a house with lead-based paint, they should ensure the following:

- Children and pregnant women should avoid being in any house undergoing renovation.
- Do not sand lead-painted surfaces or use an open flame torch, as those methods produce many small lead particles that can be inhaled.
- Old paint should be covered with new paint, so long as it is not peeling or chipped. Alternatively, paneling or encapsulation can be used, like a thick coat of paint.
- Protective clothing should be worn and then changed before leaving the site.
- Do not eat or drink in any area contaminated with lead dust.

Non-residential (Community level) preventive measures

To reduce exposure to other non-residential sources of lead, the following measures can be taken:

a) Traditional medicines or cosmetics that may contain Lead should be avoided.

b) Containers, tableware, or cookware should be shown to be lead-free.

c) Any recalled toys should be removed.

d) If plumbing contains lead piping or fittings, the cold tap should be run for at least a minute before tap water is used. Hot tap water must not be used for cooking or preparing baby formula as it is likely to contain higher levels of lead

e) Asking the local water authority to test their water for lead. If there is lead in their tap water, steps can be taken to reduce or eliminate exposure.

f) Using only approved methods for removing lead hazards. Country-approved lead-safe certified contractors can safely renovate houses and other buildings.

g) Removing shoes or wiping soil off shoes before entering any house.

h) Environmental measures for the prevention of lead poisoning include abatement of lead paint usage, removal of lead from gasoline, and removal of lead solder from cans. Skilled and experienced workers must perform lead abatement in dwellings.

i) For adults, occupational measures focus on engineering controls, such as isolation by containment and local exhaust systems, personal protective equipment (e.g., respirators), and good work practices.

j) Workers should be educated regarding the health risks of Lead and sources that may cause poisoning.

k) Community awareness program regarding – lead poisoning, healthy behavior, and community nutrition initiatives.

National-level preventive measures

Primary Prevention – regular & periodic testing and monitoring of the health status of suspected individuals.

Secondary Prevention – population/area-based screening programs

Laws & Policy formulation

✓ The government should formulate a national regulatory framework to control the manufacture, import, export, sale, and use of lead-added products and enforce the laws and regulations strictly.

✓ Developing and enforcing environmental, health, and safety standards for manufacturing and recycling lead-acid batteries.

✓ Formulation of multi-sectoral networking and collaborative efforts for "synergistic impacts."

The potential focus could be:

- Regular monitoring and reporting on blood lead level testing
- Building awareness, prevention, and control measures on minimizing children's exposure
- Establishing treatment facilities, management, and remediation, including strengthening governmental systems, fostering non-government organizational platforms for appropriate detection, monitoring, and referencing as well as enhanced educational interventions and cognitive behavioral therapy to manage the adverse effects of lead exposure better
- Exploring sources of exposure and making the public aware through education campaigns
- Legislation and policy, including developing, implementing, and enforcing environmental, health, and safety standards for manufacturing and recycling lead-acid batteries and e-waste, and enforcing environmental and air-quality regulations.

Considering the health and well-being of the population of the country, eliminating lead poisoning is a crucial central pillar. The roll-out of blood lead testing in national surveillance protocols is urgent. Maintaining protective regulations and vigilance in the production industry is critical to avoid devastating consequences; therefore, eradication is needed to combat all sources of contamination through strict safety policies. Thus, we need strict commitment to reduce lead exposure, where government should take urgent action to ensure all children are being fed and educated in a safe, secure, and healthy environment.

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Annex

STEPS Clinical guideline for managing lead poisoning

(Refer to the Clinical Guideline document for details)

At the early stages, lead poisoning can be hard to detect and people who look healthy can have high levels of lead in their blood.

Detailed history and examination are important for early identification and management. In addition to general history taking and examination of patients, the following additional steps can guide health workers at the Primary Health Care level to identify and manage cases of lead exposure.

Step A: Take history to identify sources of lead exposure

- Determine duration of exposure
- Ask about environmental or occupational exposure to lead eg battery recycling industry
- Take a dietary history to assess whether iron and calcium intake is adequate
- Ask about intake of herbal medications
- For pregnant women, ask about pica eg ingestion of clay etc.

Step B: Evaluation of severity of lead exposure

Assess for the following signs of severe exposure to lead:

- Developmental delay
- Learning difficulties
- Irritability
- Pallor/Anaemia
- Decreased attentiveness

Evaluate for other signs and symptoms of lead poisoning:

- Gastrointestinal features such as anorexia, abdominal pain etc.
- Neurological features such as headache, lethargy, convulsions etc.
- Signs of Kidney dysfunction
- Signs of Liver dysfunction etc.

Young children with lead exposure should undergo neurodevelopmental assessment (refer to chapter V of the guideline).

If a solid lead object is ingested/pierced/placed within the body (eg implant, pellet or bullet), refer to a higher center for immediate removal.

When a case of lead exposure is suspected, evaluate patient with laboratory investigations including blood lead levels, if available.

Step C: Reduction and termination of exposure

- If source is identified, advise for removal from the source eg discard coloured clay toys, avoid recycled aluminium cookware, soil remediation etc (Please read the flipchart on lead poisoning and show to the patient)
- Counsel the patient and family about harmful effects of lead (Please read the flipchart on lead poisoning and show to the patient)
- Counsel on good nutrition especially adequate intake of iron and calcium, and vitamins C and D (Please read the chapter 6 of clinical management guideline for lead poisoning)
- If necessary, nutritional supplementation like Iron, Folate, Calcium etc should be given. (Please read the chapter 6 of clinical management guideline for lead poisoning)

STEPS: Clinical guideline for managing lead poisoning (in Bangla)

পদক্ষেপ সীসা বিষক্রিয়ার জন্য ধাপে ধাপে ক্লিনিকাল ম্যানেজমেন্ট নির্দেশিকা

(বিশদ বিবরণের জন্য ক্লিনিকাল নির্দেশিকা নথি পড়ুন)

প্রাথমিক পর্যায়ে সীসার দূষণ শনাক্ত করা কঠিন হতে পারে এবং কোন ধরনের লক্ষণ ছাড়াই রক্তে উচ্চ মাত্রার সীসার উপস্থিতি থাকতে পারে।

বিশদ ইতিহাস এবং শারীরিক পরীক্ষা প্রাথমিকভাবে সীসা দূষণ সনাক্তকরণ এবং ক্লিনিক্যাল ম্যানেজমেন্ট এর জন্য অত্যন্ত গুরুত্বপূর্ণ। রোগীর ইতিহাস গ্রহণ এবং শারীরিক পরীক্ষা করার পাশাপাশি নিম্নলিখিত ধাপগুলো প্রাথমিক স্বাস্থ্য পরিচর্যা স্তরের স্বাস্থ্যকর্মীদের সীসা দূষণের রোগী সনাক্ত করতে এবং রোগীর চিকিৎসা পরিচালনা করতে সাহায্য করতে পারে।

ধাপ ১: সীসা দূষণের উৎস সনাক্ত করতে বিশদ ইতিহাস নিন

- সীসা সংস্পর্শের সময়কাল (সম্ভাব্য কতদিন ধরে সীসা দূষণের শিকার হয়েছিল) নির্ধারণ করুন।
- পরিবেশগত বা পেশাগত কারনে সীসার সংস্পর্শে ছিলো কি না তার সম্পর্কে জিজ্ঞাসা করুন যেমন ব্যাটারি পুণর্ব্যবহারযোগ্য শিল্প।
- খাদ্যাভ্যাসে আয়রন এবং ক্যালসিয়াম পর্যাপ্ত কিনা তা মূল্যয়ন করতে একটি খাদ্যতালিকার ইতিহাস নিন।
- ভেষজ ওষুধ খাওয়ার ইতিহাস সম্পর্কে জিজ্ঞাসা করুন।
- গর্ভবতী মহিলাদের জন্য পিকা অর্থাৎ কাদামাটি খাওয়ার অভ্যাস ইত্যাদি সমস্যা আছে কিনা জিজ্ঞাসা করুন।

ধাপ ২: সীসা দূষণের তীব্রতার মূল্যায়ন

সীসার তীব্র সংস্পর্শে নিম্নলিখিত লক্ষণগুলো আছে কি না তা মূল্যায়ন করুন:

- শিশুর বিকাশগত বিলম্ব।
- নতুন কিছু শিখতে অন্য শিশুদের চেয়ে বেশি সময় লাগা যেমন, পড়াশুনা না বুঝা, স্কুলে পারফরম্যান্স খারাপ হওয়া।
- মেজাজ খিটখিটে হওয়া।
- চামড়া ফ্যাকাশে হওয়া/রক্তাল্পতা।
- মনোযোগ হ্রাস।

সীসা দূষণের অন্যান্য লক্ষণ ও উপসর্গগুলো মূল্যায়ন করুন:

- পরিপাকতন্ত্র সংক্রান্ত লক্ষণ যেমন ক্ষুধামন্দা, পেট ব্যথা ইত্যাদি।
- স্নায়বিক বৈশিষ্ট্য যেমন মাথাব্যথা, অলসতা, খিঁচুনি ইত্যাদি
- কিডনি কার্যকরিতা কমে যাওয়ার লক্ষণ যেমন শরীর ফুলে যাওয়া, পায়ে পানি আসা ইত্যাদি।
- যকৃতের কার্য়করিতা হ্রাসের লক্ষণ ইত্যাদি।

সীসা সংস্পর্শে এসেছে এমন শিশুদের "নিউরোডেভেলপমেন্টাল অ্যাসেসমেন্ট" করা উচিত (নির্দেশিকাটির অধ্যায় ৫ দেখুন)

শরীরে যদি কোন সীসা যুক্ত বস্তু প্রবেশ করে/বিদ্ধ করা হয়/দেহের মধ্যে স্থাপন করা হয় (যেমন ইমপ্লান্ট, পেলেট বা বুলেট) তাহলে অবিলম্বে অপসারণের জন্য একটি টারশিয়ারি লেভেল এর স্বাস্থ্য কেন্দ্রে যান।

যখন সীসার সংস্পর্শ ছিলো বা আছে বলে সন্দেহ করা হয়, তখন যদি সম্ভব হয় ল্যাবরেটরি পরীক্ষার মাধ্যমে রক্তে সীসার মাত্রা পরীক্ষা করা প্রয়োজন।

ধাপ ৩: সীসার সংস্পর্শ থেকে দূরে থাকার জন্য করনীয়

- যদি উৎস সনাক্ত করা যায়, উৎস অপসারণের পরামর্শ দিন যেমন রঙিন মাটির খেলনা না দেয়া, পুনর্ব্যবহৃত অ্যালুমিনিয়াম এর তৈরী রান্নার পাত্র এড়িয়ে চলা, বাড়ির আশেপাশের দূষিত মাটি প্রতিস্থাপন ইত্যাদি (সীসা দূষণের ফ্লিপচার্ট পড়ুন এবং রোগী ও রোগীর পরিবার কে দেখান)
- রোগী ও রোগীর পরিবারকে সীসার ক্ষতিকর প্রভাব সম্পর্কে জানান এবং সীসা এড়িয়ে চলার পরামর্শ দিন (সীসা দূষণের ফ্লিপচার্ট পড়ুন এবং রোগী ও রোগীর পরিবার কে দেখান)
- ভাল পুষ্টি গ্রহণ বিশেষ করে আয়রন, ক্যালসিয়াম, ভিটামিন সি এবং ডি (সীসা দূষণ ক্লিনিক্যাল ম্যানেজমেন্ট গাইডলাইন - অধ্যায় ৬ পড়ুন) পর্যাপ্ত পরিমাণে গ্রহণের বিষয়ে পরামর্শ দিন।
- প্রয়োজনে আয়রন, ফলিক এসিড, ক্যালসিয়াম ইত্যাদি পুষ্টি সম্পূরক হিসেবে দিতে হবে। (সীসা দূষণ ক্লিনিক্যাল ম্যানেজমেন্ট গাইডলাইন - অধ্যায় ৬ পড়ুন)

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Development of Clinical Management Guideline on Lead Poisoning in Bangladesh

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