Review Article

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Lead Exposure in Children: Prevention, Detection and Management

Islam MR[1], Islam MR[2], Matin A[3], Khatoon S[4], Khan R[5], Karim AKMR[6], Mowla MG[7]

Abstract

Lead has long been recognized as a harmful environmental pollutant. According to the Centres for Disease Control and Prevention (CDC), an elevated blood lead level (BLL) is defined as 10 µg/dL or more. A 1 µg/dL increase in BLLs was associated with a 3.32 point decline in cognitive functioning in children ages six months to three years and a 2.47 point decline in children ages three to five years-old. Blood lead level (BLL) 70 µg/dL in children should be considered a medical emergency. In Bangladesh, an estimated 6.9 million children 5-14 years-old are engaged in 200 hazardous and risky physical labours all of which are likely sources of lead poisoning. Automobiles that burn leaded gasoline are major source of lead in air, dust, and soil. High levels of lead in the air are associated with elevated blood lead (Pb) levels in human. Primary prevention of lead ingestion through the provision of anticipatory guidance is a major role of paediatricians. It is through education about common sources of lead, such as paint and dust. Public health efforts to prevent lead exposure through the removal of environmental lead hazards continue to be a most effective measure. Lead poisoning and its sequelae can be prevented by blood lead screening called secondary prevention followed, when appropriate, by education and case management, as well as by environmental abatement to prevent lead exposure in siblings and playmates. Individualize case management, which begins at a BLL of ?20 ?g /dL. Chelating therapy may be considered, but is not recommended routinely at BLLs <45 ?g/dL.

Key words: Lead exposure, lead poisoning,

Introduction

Lead has long been recognized as a harmful environmental pollutant. In late 1991, the Secretary of the Department of Health and Human Services referred to lead as the number one environmental threat to the health of children in the United States[1]. According to the Centres for Disease Control and Prevention (CDC), an elevated blood lead level (BLL) is defined as 10 µg/dL or more[2]. In children, BLLs as low as 10 µg/dL, or even lower, have been associated with developmental delays, deficits in behavioural functioning , decreased stature , diminished hearing acuity , and difficulty learning[3-7]. A 1 µg/dL increase in BLLs was associated with a 3.32 point decline in cognitive functioning in children ages six months to three years and a 2.47 point decline in children ages three to five years-old[8]. Blood lead level (BLL) 70 µg/dL in children should be considered a medical emergency. This level of lead can cause serious health issues, such as seizures, coma, and death[9]. In the CDC's 1991 revised document[2], universal screening of infants and young children in areas where lead exposure is still common was recommended. In Bangladesh, an estimated 6.9 million children 5-14 years-old (12.9% of the total labour force) are engaged in physical labour. They are exposed to more than 200 hazardous and risky conditions, including welding, car repair, lead melting, ship breaking, and pottery glazing, all of which are likely sources of lead poisoning[10]. Automobiles that burn leaded gasoline are major source of lead in air, dust, and soil[11]. High levels of lead in the air are associated with elevated blood lead (Pb) levels in human[12]. An elevated blood lead (Pb) level is defined as <10 µg/dL according to the guidelines of the Centres for Disease Control and Prevention (CDC)[13]. The World Health Organization has adopted a critical level of 10-15 µg/dL[14]. In children, Pb levels as low as 10 µg/dL have been associated with developmental delays, deficits in intellectual performance and neurobehavioral functioning, decreased stature, and diminished hearing acuity[15-19].

Primary prevention: abatement, assessment, and anticipatory guidance Primary prevention of lead ingestion through the provision of anticipatory guidance is

1. Dr. Md. Reazul Islam, Internee Doctor, Dhaka National Medical College & Hospital, Dhaka
2. Dr. Md. Rafiqul Islam, Associate Professor of Paediatrics, Shaheed Suhrawardy Medical College and Hospital
3. Dr. Abdul Matin, Assistant Professor of Paediatrics, Shaheed Suhrawardy Medical College and Hospital
4. Prof. Dr. Soofia Khatoon, Professor & Head of Paediatrics, Shaheed Suhrawardy Medical College and Hospital, Dhaka
5. Dr. Rita Khan, Medical Officer, National Institute of Chest Research & Hospital. Mohakhali, Dhaka
6. Dr. A.K.M. Rezaul Karim, MBBS, MD. Assistant Professor of Paediatrics, OSD; DGHS. Dhaka
7. Dr. Md. Golam Mowla MBBS,DCH. Junior Consultant Paediatrics, Shaheed Suhrawardy Medical College and Hospital, Dhaka.

Correspondence
Dr. Md. Rafiqul Islam MBBS, DCH, M. Phil (Int. Health) Associate Professor of Pediatrics, Shaheed Suhrawardy Medical College and Hospital, Dhaka

a major role of pediatricians. It is through education about common sources of lead, such as paint and dust, and less common sources, such as water or contaminated soil, those parents can take measures to minimize their child's exposure to lead. Also, discussions about nutrition and the importance of dietary iron may help prevent elevated BLLs. Educational brochures are available from the American Academy of Pediatrics (AAP) to assist in preventive education. Public health efforts to prevent lead exposure through the removal of environmental lead hazards continue to be a most effective measure. The child's residence and site of routine care are most important, because high lead exposures occur most frequently where children spend the majority of their time.

Secondary prevention through lead screening

Lead poisoning and its sequelae can be prevented by blood lead screening followed, when appropriate, by education and case management, as well as by environmental abatement to prevent lead exposure in siblings and playmates. The standard procedure to determine BLLs requires a blood sample that has been collected properly by venipuncture and analyzed accurately[1]. When feasible, venous blood samples should be used for initial screening. A capillary (finger stick) blood sample may be a practical screening alternative. When collected properly, the capillary specimen can approach the venous blood sample in accuracy[19]. A poorly collected finger stick sample is contaminated easily by environmental lead, thereby increasing the false-positive rate. Finger stick values >10 g/dL should be confirmed with a venous blood sample. The laboratory technique used to measure BLLs must have a high degree of accuracy. Use of a laboratory that participates in a proficiency testing program is necessary to prevent the misidentification both false-negative and false-positive findings of lead exposure[19,20]. Laboratories participating in a proficiency program can be determined by calling the CDC. The CDC blood lead proficiency program allows an error of ±4 g/dL[21]. A recently developed portable machine that reliably measures BLLs may provide a means of rapid, accurate screening[22]. The measurement of erythrocyte protoporphyrin, used formerly as the primary lead screening tool, is insensitive for BLLs <35 g/dL and should not be used.

Management of Elevated BLLs

The toxicity of lead is a function of the dose, the duration of exposure, and the developmental and nutritional vulnerability of the child. It is the role of the pediatrician to give realistic reassurance that early detection and source control in children found to have high BLLs can minimize the consequences for the child. The first step is to perform a confirmatory venous BLL. This should be performed immediately if the screening result is >70 g/dL; within 48 hours if the result is between 45 and 69 g/dL; within 1 week if the result is 20 to 44 g/dL; and within 1 month if the result is 10 to 19 g/dL. In children with BLLs of 10 to 14 g/dL, a point source of lead exposure is usually not found. Therefore, general education on measures to reduce lead exposure may be useful to parents. If the confirmatory BLL still is between 10 and 14 g/dL, BLL testing should be repeated within 3 months[13]. For children with BLLs of 15 to 19 g/dL, the pediatrician should take a careful environmental history. The history should be tailored to the family characteristics and the pediatrician's practice setting; potential questions include those about housing and child care facilities, use of folk remedies and imported pottery, lead testing results among siblings and playmates, and personal habits like hand-washing, hobbies, or occupations that may involve lead. Parents should receive guidance about interventions to reduce BLLs, including environmental hazard reduction as well as optimal nutrition. Nutritional interventions including iron and calcium supplementation, a reduced-fat diet, and frequent meals should be considered because all are associated with reduced gastrointestinal absorption of ingested lead[13]. If the confirmatory BLL is still between 15 and 19 g/ dL, BLL testing should be repeated within 2 months.

Conclusion

Individualized case management, which includes a detailed medical history, nutritional assessment, physical examination, environmental investigation, and hazard reduction, begins at a BLL of 20 g /dL. Chelation therapy may be considered, but is not recommended routinely at BLLs <45 g/dL.

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