PEHSU Pediatric Environmental Health Specialty Units

Recommendations on Management of Childhood Lead Exposure

A Resource for Clinicians

Summary of Key Points

- There is no safe level of lead in the blood.
- The ultimate goal is removal of the lead source before exposure (primary prevention).
- "Screening" is a risk assessment conducted via questionnaire; "testing" is performed via blood test (either venous or capillary).
- Screening is recommended for all children at 6, 9, 12, 18, and 24 months, and 3, 4, 5, and 6 years of age.
- Testing is required at 12 and 24 months for children on Medicaid and/or in high-risk areas or risk factors requiring universal blood tests as defined by state health departments.
- Test all children in the same household if there is an elevated blood lead level (BLL) for one of the children.
- Lead exposure can be viewed as a lifelong exposure, even after BLL decline.

Lead exposure continues to be a significant public health concern in the United States. While primary prevention is the optimal approach to addressing this important health issue, the identification of lead-exposed children occurs through screening and testing. This fact sheet is intended for use by health care providers to provide guidance on the prevention, diagnosis, and management of childhood lead exposure.

Prevention and Risk Reduction Communication

- The prevention of lead toxicity in children remains a major public health concern, especially for children already at high risk for poor health outcomes.
- The removal of lead sources before exposure occurs should be the focus of lead exposure prevention efforts.
- Follow *Bright Futures Guidelines,* 4th Edition anticipatory guidance to identify families and patients who could be at risk. This includes advising families to identify lead hazards before moving into a home.
- Discuss potential sources of lead with families, as well as common child behaviors that can increase risk, to raise their awareness. Potential sources include (but are not limited to) lead paint, soil, imported cookware, water, nutritional supplements, folk medicines, imported food (including spices), cosmetics, toys, ceramic dishware, and cultural/religious powders. Healthcare providers should keep in mind that cultural/religious powders and cosmetics, such as kajal or khol, may contain lead and be more prevalent among certain South Asian or Middle Eastern populations.

- In addition to common hand-to-mouth behaviors in young children, special attention should be given to children and adolescents with pica.

Lead Exposure and Risk Factors

- The ultimate key to prevention and treatment is removal of the source. If a child's blood lead level (BLL) is elevated (see below), hospitalization may be necessary until the source is identified. Families should be counseled about potential sources. If the source is still not identified, referral to local services for in-home assessments may be necessary.
- A child's BLL depends on his/her environment, habits, parental occupations, and nutritional status. Each of these can influence lead exposure and absorption. Therefore, in a household with multiple children, not all children will have the same lead exposure. Be aware that when families move, lead exposure risk may vary.
- Any detectable blood lead levels, even below 5 µg/dL, are associated with subclinical effects such as inattention and hyperactivity, as well as decreased cognitive function on a population level. Clinically evident effects such as anemia, abdominal pain, nephropathy, and encephalopathy can be seen at levels >40 µg/dL. Levels above 100 µg/dL may result in fatal seizures and cerebral edema.
- Lead exposure can be viewed as a lifelong body burden, even after a decline in the BLL. For instance, bone acts as a reservoir for lead over an individual's lifetime. Childhood lead exposure has potential consequences for adult and prenatal health, and is linked to hypertension, renal insufficiency, and increased cardiovascular-related mortality.
- Since lead shares common absorptive mechanisms with iron, calcium, magnesium, and zinc, nutritional deficiencies in these minerals promote lead absorption. Acting synergistically with lead, deficiencies in these minerals can increase lead absorption and lead-related neurotoxicity.
- Provide anticipatory guidance on common sources of environmental lead exposure: leaded
- paint and dust in homes built prior to 1978, lead in drinking water (see bullet below), lead in soil (usually legacy contamination from leaded gasoline, but possibly from previous exterior home renovations), take-home exposures related to adult occupations, imported food, spices, cosmetics, jewelry, folk remedies, toys, and cookware.
- Although less common than lead from paint and dust, lead may arise in drinking water from water mains, service lines, or plumbing within individual buildings. EPA sets standards for drinking water; municipalities can provide further information on local water quality and filtration.
- Additionally, there are hobbies and occupations that are associated with lead "take-home"
- exposure (i.e., lead-containing dust contaminating work clothes worn home after work), including (not a comprehensive list): construction, welding, metal work/recycling and those involving boatyards, firearms, and art materials (especially those who work with metals). Contact your local health department for specific screening and testing recommendations for your area.

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Lead Screening & Testing

- Bright Futures Guidelines recommend that all children should be screened—at well-child exams and as appropriate—with a questionnaire to assess for lead hazards and possible exposures. A positive screen informs the risk for lead hazards in the home and an opportunity for primary prevention. Those who are found to have lead hazards in their environment should receive a blood lead test.
- Children should have blood lead testing at 12 and 24 months. Screening with a questionnaire should not take the place of testing (called "screening by blood test" by CDC and state statutes) of children at 12 and 24 months who are on Medicaid or in high-risk areas requiring universal blood tests as defined by state health departments. Lead testing can be performed with a capillary specimen obtained by a finger prick with blood blotted onto a testing paper. Testing in this manner requires that the skin surface be carefully cleaned. Elevated capillary BLL should have repeat testing by venipuncture to confirm the BLL.
- In cases where the capillary specimen demonstrates an elevated BLL but the follow-up venipuncture does not, it is important to recognize that the child may live in a lead-contaminated environment that resulted in contamination of the fingertip. Work with the family to Identify and eliminate potential sources of lead in these cases.
- Where feasible, perform lead testing by venipuncture. Test all children in the same household if there is an elevated BLL.
- Children at high risk for lead exposure include those who are low income, recent immigrants, international adoptees, children of immigrants, those with oral behaviors (or pica), those living in housing built before 1978 (when lead in residential paint was banned), but particularly in those built before 1950.

Iron Deficiency Screening

- Iron deficiency enhances absorption of ingested lead.
- Hemoglobin is a lagging indicator of iron deficiency, and only 40% of children with anemia are iron deficient.
- Lead-exposed children should be screened for iron-deficiency anemia.
- Evidence suggests consuming regular, iron-rich, nutritious meals provides the most benefit for children. This should be considered before recommending nutritional supplementation to parents.

Medical Management

Lead Level <5 µg/dL

1. The limit of detection for lead can vary by lab and is typically between 1 and 3.3 µg/dL.
2. Review laboratory results with the family. For reference, the geometric mean blood lead level for children 1-5 years old in the United States is less than 1 µg/dL. Emphasize with the family the dangers of lead and the need for vigilance.
3. Repeat the blood lead level (BLL) in 6-12 months if the child is at high risk or if the environmental risk changes during the timeframe. Ensure lead testing is done at 1 and 2 years of age and thereafter, based on local and state guidelines.

4. For children tested at age <12 months, consider retesting in 3-6 months, as lead exposure may increase as mobility increases. Consider lead-contaminated tap water used daily for infant formula as a possible significant source that may be missed in later assessments of BLL.
5. Perform routine health maintenance including assessment of nutrition, physical and mental development, as well as iron deficiency risk factors as per the recommendations in the American Academy of Pediatrics' (AAP) Bright Futures Guidelines.
6. Provide preliminary advice about reducing/eliminating exposures (e.g., wash children's hands/toys frequently; damp-mop floors, windows and windowsills; leave shoes at the home's threshold; place duct-tape or contact paper over chipping/peeling paint; avoid renovations that may create a dust hazard).

Lead Level 5-14 µg/dL

1. Perform steps as described above for levels < 5 µg/dL.
2. Re-test venous BLL within 1-3 months to ensure the lead level is not rising. If it is stable or decreasing, retest the BLL in 3 months. Refer patient to local health authorities if services are available. Most states require elevated BLL be reported to the state health department. Contact the CDC at 800-CDC-INFO (800-232-4636), the National Lead Information Center at 800-424-LEAD (5323), or the national PEHSU network (pehsu@aap.org) for resources. regarding lead-poisoning prevention and local childhood lead-poisoning prevention programs.
3. Take a careful environmental history to identify potential sources of exposure (see #6 above). Consider young siblings and other children who may be exposed. If lead paint in older homes is the exposure concern, advise that lead paint abatement is the best solution, and refer the family to local health department for resources and information.
4. Provide nutritional counseling related to calcium, vitamin D, and iron. In addition, recommend having fruit at every meal, as iron absorption quadruples when taken with vitamin C-containing foods. Encourage the consumption of iron-enriched foods (e.g., cereals, meats). Some children may be eligible for Special Supplemental Nutrition Program for Women, Infants and Child (WIC) or other nutritional resources.
5. Ensure iron sufficiency with adequate laboratory testing (complete blood count (CBC), ferritin, and reticulocyte count) and treatment per AAP guidelines. Consider starting a multivitamin with iron or iron supplementation as indicated.
6. Perform structured developmental screening evaluations at child health maintenance visits per recommendations in Bright Futures Guidelines, and, if indicated, refer to therapeutic and special educational programs (e.g., Early Intervention Program (EIP), a CORE evaluation and Individualized Education Plan (IEP)), as lead's effect on development may manifest over years.

Lead Level 15-44 µg/dL

1. Perform steps listed above for levels 5-14 µg/dL. Report results to state/local health authorities.
2. Determine if there are any symptoms, which may be subtle and can include anorexia and abdominal discomfort.

3. Confirm BLL with venous sample within 1 to 2 weeks, or more rapidly for higher levels.
4. Work with the family to identify and remove potential lead sources. Refer to local health department to conduct home investigation to assess for the lead source, if available. If not available, consult with a regional Pediatric Environmental Health Specialty Unit (PESHU) regarding other options.
5. Additional, specific evaluation of the child, such as an abdominal x-ray, should be considered based on the environmental investigation and history (e.g., pica for paint chips, mouthing behaviors). Gastrointestinal decontamination may be considered if radio-opaque foreign bodies consistent with ingested lead are visualized on x-ray. Any treatment for BLL in this range should be done in consultation with an expert.
6. Contact your regional PEHSU or Poison Control Center (PCC) for guidance; see resources on back for contact information.

Lead Level >44 µg/dL

1. Follow above guidance for BLL 15-44 µg/dL. Report results to state and local health authorities.
2. Confirm the BLL with repeat venous lead level within 48 hours or more rapidly for higher levels.
3. Obtain a complete blood count, electrolytes, blood urea nitrogen, creatinine, liver transaminase enzyme levels, and urinalysis in anticipation of chelation therapy.
4. Abdominal X-ray should be done to look for radio-opaque foreign bodies suggestive of recent ingestion, as this may change management. Consider gastrointestinal decontamination if radio-opaque foreign bodies consistent with ingested lead are visualized on x-ray.
5. Emergently admit all symptomatic children to a hospital; if there is evidence of significant central nervous system pathology, consider pediatric intensive care unit admission. If asymptomatic, consider hospitalization and/or chelation therapy (managed with the assistance of an experienced provider). Chelation in the context of ongoing exposure is ineffective and may result in increasing lead levels in the central nervous system. Factors that may influence management include the status of the home with respect to lead hazards, ability to isolate the lead source, family social situation, and chronicity of the exposure. An elevated blood zinc-chelated protoporphyrin level (ZPP) can confirm either an iron-deficiency anemia as a comorbidity in the lead-poisoned child or, if there is no iron deficiency present, a more chronic lead exposure. Contact your regional PEHSU or Poison Control Center (PCC) (1-800-222-1222) for assistance.
6. Prior to initiating chelation therapy for outpatient therapy, it is critical that the home environment is inspected, temporary mitigation measures applied, and preferably demonstration of stable or down trending lead levels indicating the primary of lead exposure has been removed prior to starting chelation therapy. There is a risk of worsening lead exposure if chelation therapy continues in a residence with persistent lead hazards. It is expected, after a course of chelation therapy, that the blood lead level will rebound as the lead re-equilibrates. After chelation is completed, continue to follow the child until the BLL declines steadily; consider re-exposure if the BLL remains stable or rebounds above pre-chelation levels.

About PEHSU

The Pediatric Environmental Health Specialty Units (PEHSUs) are a source of medical information and guidance on prevention, diagnosis, management, and treatment of environmental conditions that influence reproductive and children's health. PEHSUs work with health care professionals, parents, schools, community groups, as well as federal, state, and local agencies to address reproductive and children's environmental health issues where families live, learn, play, and congregate. For more information on PEHSUs and available resources, please visit: www.pehsu.net.

For additional resources and information on reproductive and children's environmental health topics that offer continuing education for health professionals, visit: https://www.pehsu.net/nationalclassroom.html

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