

## HealthCare Provider Information

### Children ( $\leq 17$ yrs) With Elevated Blood Lead Levels (EBLLs)

### Medical Evaluation and Recommendations

This document is intended to provide evidence-based guidance for healthcare providers caring for children ( $\leq 17$  years of age) with confirmed EBLLs.

**Confirmed EBLL: Venous blood lead level  $\geq 5$   $\mu\text{g}/\text{dL}$ .**

**Any capillary level  $\geq 5$   $\mu\text{g}/\text{dL}$  MUST be confirmed with a venous level.**

**Blood lead levels  $\geq 5$   $\mu\text{g}/\text{dL}$ : provide source identification and risk reduction education.**

#### GENERAL RECOMMENDATIONS:

**All children with a current or past EBLL need to have this listed in their permanent medical problem list** (even if EBLL has resolved, these children need surveillance for problems that may develop later) (4).

#### PHYSICAL EXAM:

All children with venous EBLL  $\geq 20$   $\mu\text{g}/\text{dL}$  must have a complete physical exam.

For levels between 5-19  $\mu\text{g}/\text{dL}$  a physical exam is recommended.

**Following are areas of the physical exam that deserve special attention.**

<b><i>Hearing/speech:</i></b>	Auditory function in children can be impaired, even at blood lead levels $< 10$ $\mu\text{g}/\text{dL}$ (5). Speech delays can also occur (4).
<b><i>HEENT:</i></b>	Lead lines on gingival tissue (rarely seen today unless severe prolonged exposure) (4).
<b><i>Growth:</i></b>	Several studies have shown a negative correlation between blood lead level and stature. NHANES III found a significant negative association between blood lead concentration and stature and head circumference in children ages 1-7 years. Regression models predicted reductions of 1.57 cm in stature and 0.52 cm in head circumference for each 10 $\mu\text{g}/\text{dL}$ increase in blood lead concentrations (2).
<b><i>Neurodevelopment:</i></b>	Lead exposure can: <ul style="list-style-type: none"> <li>• Decrease IQ, even at levels <math>\geq 10</math> <math>\mu\text{g}/\text{dL}</math> (3).</li> <li>• Increase behaviors such as distractibility, impulsivity, aggression, short attention span, poor organization, lack of persistence, daydreaming (4).</li> </ul>
<b><i>Neurologic:</i></b>	Findings suggestive of acute encephelopathy (rarely seen with BLL $< 70$ $\mu\text{g}/\text{dL}$ ).
<b><i>Referral for formal neurodevelopmental testing:</i></b>	Formal neurodevelopmental testing is recommended if any abnormalities found on developmental screening or concern about other neurodevelopmental risk factors (e.g. teen-age mother, poor parenting skills, inadequate cognitive or emotional stimulation, child abuse, poverty, genetic disorder, and poor nutrition). Although chelation therapy has not been shown to be effective at reversing neurodevelopmental deficits due to lead poisoning, it is possible that early intervention/stimulation programs may be helpful (4).

<b>Developmental surveillance:</b>	<p><b>Developmental surveillance is recommended for all children with EBLs or prior EBLs.</b> The period of increased risk for the expression of lead-associated neurodevelopmental problems continues after lead exposure has been remediated and BLLs reduced. Any child that has <b>ever</b> had an EBL should have on-going neurodevelopmental monitoring with special attention during critical transition points:</p> <ul style="list-style-type: none"> <li>• <b>First grade:</b> Children begin acquiring academic skills.</li> <li>• <b>Fourth grade:</b> They use these basic skills to learn new material.</li> <li>• <b>Sixth or seventh grade:</b> They need higher order planning and organizational skills (4).</li> </ul>
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<b>Sexual development:</b>	A cross-sectional study found that African American and Mexican American girls with BLL of 3 µg/dL had delayed pubertal development compared with girls with BLL of 1 µg/dL (7).
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**LABS:**

**How long should it take for an EBL to decrease to < 10 µg/dL?**

Time (# of months required to achieve a blood lead level < 10 µg/dL) = 0.845 x peak lead level.

A retrospective analysis of children with venous blood lead levels 10-29 µg/dL, receiving case management, but not receiving chelation found a linear relationship between mean time for blood lead to decline to <10 µg/dL and peak blood lead level (6). NB: After chronic lead exposure, increased metabolic activity (e.g. broken bones, growth spurts, pregnancy) can result in increased BLL due to mobilization of lead stored in body tissues.

<b>Hgb/hct:</b>	All children should be assessed for anemia regardless of their lead exposure (4). Lead can cause anemia from: (a) Acute high lead exposure causing hemolytic anemia (b) Chronic lead exposure interferes with heme synthesis and decreases RBC lifespan. Frank anemia is not an early manifestation of lead exposure and is evident only when BLL is significantly elevated for prolonged periods (1).
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<b>Peripheral smear:</b>	Not recommended (findings are non-specific) (4).
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<b>Iron studies:</b>	Children with EBL often have associated iron deficiency. Serum ferritin is the best measure of iron status in children.
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<b>Kidney function:</b>	No evidence to support routine evaluation of renal function in children with asymptomatic EBLs, but if chelation to be used test kidney function prior and during treatment (4).
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<b>Hair/fingernail/tooth lead measurements:</b>	Not recommended (not a reliable method of estimating body burden of lead) (1,4).
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<b>ZPP (zinc protoporphyrin):</b>	[aka erythrocyte porphyrin (EP) or free erythrocyte protoporphyrin (FEP) ]. A measure of past lead exposure. Not sensitive for lead levels < 25 µg/dL. May be used for evaluating children with BLL ≥ 25 µg/dL without a steady decline despite medical or environmental interventions. These measurements may help differentiate EBL due to ongoing exposure versus rebound after treatment. Iron deficiency can also cause an elevated EP. EP >150 is almost always due to lead. EP 35-150 may be due to lead or iron deficiency (1,4).
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**IMAGING STUDIES:**

<b>Abdominal X-ray:</b>	Obtain if acute ingestion of objects that may contain lead (e.g. lead sinkers, curtain weights, jewelry, paint chips) or if prolonged EBL and unable to identify source of exposure (1,4).
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<b>X-ray of long bones:</b>	“Lead lines” due to growth arrest indicate chronic exposure (not present unless BLL >50 µg/dL). Rarely provide information for case management (4).
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<b><i>X-ray fluorescence of long bones:</i></b>	Use of radioactive source to provide noninvasive estimation of lead in bone. Currently used only for research.
<b>NUTRITION:</b>	
<b>All children with EBLs are at risk for poor nutrition.</b>	
<b><i>Iron:</i></b>	Children with EBLs may be at risk for iron deficiency due to behavioral, nutritional, and socioeconomic factors. An iron rich diet may decrease lead absorption. Encourage adequate iron intake by introducing iron-fortified cereals and pureed meats at appropriate developmental stages. Iron supplementation recommended when iron deficiency anemia is documented (4).
<b><i>Calcium:</i></b>	Dietary calcium competitively inhibits lead absorption (adequate intake 0-6 months 210 mg/day; 7-12 months 270 mg/day; 1-3 years 500 mg/day; 4-8 years 800 mg/day). No clinical evidence that supplementation beyond AI level in children with EBLs has a clinical effect on BLL, so calcium supplementation is not necessary if child is consuming adequate dietary calcium (4).
<b><i>Vitamin D:</i></b>	Lead impedes Vitamin D conversion into active form, 1, 25- dihydroxyvitamin D. Assure adequate Vitamin D and calcium in the diet (1,4).
<b><i>Zinc:</i></b>	Animal studies suggest high zinc inhibits absorption and retention of lead, but human studies have not shown a significant effect. Zinc supplementation is not recommended in children with EBLs (4). Chelation therapy can deplete zinc so if administering chelation therapy it is important to monitor and replace zinc.
<b><i>Vitamin C:</i></b>	To improve iron absorption in children 6 months of age and older, encourage two servings per day of foods rich Vitamin C (e.g., fruits, vegetables, or juice) (4).
<b><i>WIC</i></b>	If WIC enrolled notify local WIC program of EBL. Children with EBLs should be referred to WIC in order to assure nutritional counseling and access to healthy foods.
<b><i>Regular meals &amp; snacks:</i></b>	Encourage caregivers to provide regular meals & snacks. More lead may be absorbed in the fasting state (4).

References:

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2. Ballew, C, et al. Blood Lead Concentration and Children's Anthropometric Dimensions in The Third National Health and Nutrition Examination Survey (NHANES III), 1988-1994. The Journal of Pediatrics May 1999; 134(5):623-630.
3. Canfield RL, Hendrson CR, Cory-Slechta DA, et al. Intellectual Impairment in Children with Blood Lead Concentration below 10 Micrograms per Deciliter. N. Engl J Med 2003; 348: 1517-25.
4. Centers for Disease Control and Prevention. Managing Elevated Blood Lead Levels Among Young Children: Recommendations from the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta: CDC; 2002.
5. Osman, K. et al. Lead Exposure and Hearing Effects in Children in Katowice, Poland. Environmental Research 1999;80(1):1-8.
6. Roberts, J.R. et al. Time Required for Blood Lead Levels to Decline in Nonchelated Children. Clinical Toxicology;39(2):153-160.
7. Selevan SG, Rice DC, Hogen KA, et al. Blood Lead Concentration and Delayed Puberty in Girls. N. Engl J Med 2003;348:1527-35.

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# LEAD POISONING DISEASE REPORTING AND FOLLOW-UP GUIDELINES

The following information has been excerpted from the State of Oregon's Disease Reporting and Follow-up Guidelines. The full document can be found at [www.healthoregon.org/lead](http://www.healthoregon.org/lead).

## DESCRIPTION OF LEAD POISONING

For the purposes of these guidelines, persons with EBLs are considered to have lead poisoning. Lead poisoning can affect both children and adults, although the effects may vary markedly with age. It is convenient, albeit somewhat artificial, to divide lead poisoning into an acute disease that relates to current BLLs, and a chronic disease that relates to the cumulative effects of body lead burden. In both cases, the most prominent signs and symptoms are neurological. Bear in mind that persons with very high BLLs ( $\geq 70$   $\mu\text{g/dL}$  in children) should be treated as medical emergencies, regardless of overt symptomatology. Ingestion of a metallic object that may contain lead can result in an EBL within hours. Ingestion of any object that may contain lead should be treated as a medical emergency and treatment should include a blood lead test and abdominal x-ray.

## ACUTE DISEASE

Acute exposure to lead generally means exposure for a short time, but at high levels. Blood lead levels increase quickly after an acute exposure. The most common symptom of acute lead poisoning is colicky abdominal pain evolving over days to weeks. Constipation, diarrhea, and nonspecific complaints of irritability, fatigue, weakness and muscle pain may also occur. These symptoms are seldom caused by BLLs less than 50  $\mu\text{g/dL}$ . In more severe cases, warning signs of acute, serious brain swelling include vomiting, irritability, restlessness, tremors, and progressive drowsiness. These symptoms may herald the onset of seizures, coma, and possibly death. The BLLs associated with encephalopathy in children vary from study to study, but BLLs of 70-80  $\mu\text{g/dL}$  or greater appear to indicate a serious risk (ATSDR 2007).

## CHRONIC EFFECTS

Chronic lead exposure generally means exposure to low to moderate levels of lead over a long period of time. Recent studies suggest that lead absorption is harmful at any concentration and that no safe level of lead exposure exists (Canfield et al. 2003; Lanphear et al. 2000, 2005b; Schwartz 1994; U.S. CDC 1991). Relatively low blood lead levels rarely cause overt signs and symptoms, but such exposure can cause permanent damage—especially in young children—including decreased IQ, developmental delays and behavioral disturbances.

## CHELATION THERAPY

Chelating agents solubilize lead, depleting it from soft and hard tissue and thereby reducing its acute toxicity. While chelation therapy is considered a mainstay in the medical management of children with BLLs  $\geq 45$   $\mu\text{g/dL}$ , it should be used with caution. Treatment with chelating agents lowers BLLs, but does not improve scores on tests of cognition, behavior, or neuropsychological functions except in patients with extremely high BLLs. Primary care providers (PCP) should consult with the OHA Lead Poisoning Prevention Program or Oregon Poison Center prior to using chelating agents. In the short term, chelation can redistribute body lead, causing an increase in lead concentrations in soft tissue, including the brain. Some chelators may remove essential minerals, such as calcium, iron, zinc, copper and other trace minerals, as well as lead. There is general agreement that individuals with very high BLLs (in children  $\geq 45$   $\mu\text{g/dL}$ ; in adult  $\geq 100$   $\mu\text{g/dL}$ ) should be chelated. Patients with lower BLLs (children  $< 25$   $\mu\text{g/dL}$ ; adults  $< 65$   $\mu\text{g/dL}$ ) are usually not chelated unless symptomatic and/or unresponsive to removal from exposure. For patients with in-between BLLs, chelation may or may not be appropriate.

The table on the following page is to be used as guidance. Case managers and medical providers should consider individual patient characteristics and caregiver capabilities and adjust the frequency of follow-up tests accordingly.

Any screening BLL  $\geq 5$   $\mu\text{g/dL}$  must be confirmed with a venous sample. The higher the BLL on the screening test, the more urgent the need for confirmatory testing.

BLL (µg/dL)	Confirmation Testing (venous)	Follow-Up Testing (venous)	Case Management for BLLs in Children
5-9	As soon as possible, or within 7-14 days	3 months	<p><b>Clinician case management:</b></p> <ul style="list-style-type: none"> <li>• Perform confirmatory testing. Confirm recent known exposure as soon as possible.</li> <li>• Provide risk reduction education.</li> <li>• Provide nutritional education and refer to WIC as needed. If WIC enrolled, notify local WIC program of EBLL for nutritional assessment.</li> <li>• Ensure follow-up testing by established timeframe.</li> <li>• Include history of EBLL in list of child's permanent medical record.</li> <li>• See <a href="#">CDC guidelines</a> for more medical management recommendations.</li> </ul> <p><b>LPHA case management:</b></p> <ul style="list-style-type: none"> <li>• Contact caregiver regarding child's BLL.</li> <li>• Ensure case is confirmed with venous test <b>before</b> investigating, either with physician or parent.</li> <li>• Complete <a href="#">Elevated Blood Lead Investigation Questionnaire</a> over phone to explore possible exposure sources.</li> <li>• Complete on-site investigation to identify lead hazards. Follow procedures outlined in Section 7 of the <a href="#">Lead Poisoning Investigative Guidelines</a>. If on-site investigation is not practical or feasible (as determined on a case-by-case basis), a phone interview using the <a href="#">Elevated Blood Lead Investigation Questionnaire</a> may be acceptable.</li> <li>• Refer to housing remediation services if applicable and/or available.</li> <li>• Send environmental sampling results (and those performed by OHA) and follow-up recommendations in letter to family.</li> <li>• Send a copy of follow-up letter and questionnaire to clinician.</li> <li>• Refer family to WIC, social services, public assistance, Early Intervention or housing remediation services if applicable and/or available.</li> <li>• Ensure follow-up testing by established timeframe.</li> </ul>
10-19	As soon as possible, or within 7 days	3 months	<p><b>Clinician case management:</b> ALL OF THE ABOVE.</p> <p><b>LPHA case management:</b> ALL OF THE ABOVE.</p>
20-44	As soon as possible, or within 7 days	1 month	<p><b>Clinician case management:</b> ALL OF THE ABOVE, PLUS:</p> <ul style="list-style-type: none"> <li>• Children with BLLs <math>\geq 20</math> µg/dL should have a medical examination.</li> <li>• Conduct neurodevelopmental assessment.</li> </ul> <p><b>LPHA case management:</b> ALL OF THE ABOVE.</p>
45-59	As soon as possible, or within 2 days	Chelation* with subsequent follow-up.	<p><b>Clinician case management:</b> ALL OF THE ABOVE, PLUS:</p> <ul style="list-style-type: none"> <li>• Chelation therapy. Follow-up testing schedule determined by medical provider.</li> </ul> <p><b>LPHA case management:</b> ALL OF THE ABOVE.</p>
60-69	As soon as possible, or within 1 day	Chelation* with subsequent follow-up	<p><b>Clinician case management:</b> ALL OF THE ABOVE, PLUS:</p> <ul style="list-style-type: none"> <li>• Chelation therapy. Follow-up testing schedule determined by medical provider.</li> </ul> <p><b>LPHA case management:</b> ALL OF THE ABOVE.</p>
$\geq 70$	Immediately as an emergency lab test	Chelation* with subsequent follow-up	<p><b>Clinician case management:</b> ALL OF THE ABOVE, PLUS:</p> <ul style="list-style-type: none"> <li>• Hospitalize child for chelation therapy immediately. Follow-up testing schedule determined by medical provider. The child should not return to any environment that would expose him/her to lead.</li> </ul> <p><b>LPHA case management:</b> ALL OF THE ABOVE.</p>

\* **Exception to confirmatory testing schedule:** If recent known exposure (e.g. foreign body ingestion, recent remodeling) confirm as soon as possible for all blood lead levels.