INTERPRETING AND MANAGING LOW BLOOD LEAD LEVELS:
Supplemental Information for Clinicians

PEHSU Pediatric Environmental Health Specialty Units

Note that federal, state, and local strategies for preventing and screening pediatric lead poisoning vary. Primary prevention of lead exposure is essential, but secondary prevention (screening and early detection) also has an important role. This guidance is intended to help clinicians respond to lower BLL results once a blood sample has been collected.

The National PEHSU has released a factsheet for clinicians addressing "*Recommendations on Medical Management of Childhood Lead Exposure and Poisoning*" (April 2013, located at http://www.aoec.org/pehsu/documents/medical-mgmnt-childhood-lead-exposure-June-2013.pdf). This intent of this local NW PEHSU factsheet is to supplement the national factsheet, providing additional detail and discussion.

Blood lead level (BLL) and children's health

In order to identify children with excessive lead exposure, the CDC recommends using a national reference value based on the 97.5th percentile of BLL distribution in children 1-5 years old. As of 2012, this equates to a BLL of 5 µg/dL. Children with BLLs of 5 µg/dL and above are in the top 2.5% of lead exposure. This reference value will be recalculated by the CDC every 4 years.

Unfortunately, there is no safe level of lead exposure for children, and even lower ranges of BLLs (below 5-10 µg/dL) are known to be a risk factor for impaired cognitive and behavioral outcomes in children[i]. Current and consistent evidence suggests that the reduction in children's IQ scores (per unit increase in BLL) is greater in the range of BLLs that are 0 to 10 µg/dL than it is for BLLs > 10 µg/dL[ii]. New findings also suggest that the adverse health effects of low BLLs extend beyond cognitive function to include cardiovascular, immunological, and endocrine effects.

However, a single blood lead level in this range for any individual child is not predictive of effects for that child. It is one of multiple risk factors. Cognitive effects related to lead may be mitigated by a healthy home psychosocial environment and genetic inheritance[iii].

Blood lead interpretation considerations

- Initial BLLs can be measured from venous or capillary blood samples. Providers should have children wash hands with soap and water prior to obtaining a capillary sample to minimize fingerstick contamination issues.

- It is generally recommended that an initial capillary BLL > 4 µg/dL be confirmed with a venous sample within 1-4 weeks, because laboratory and sample collection methods can influence the results. Formal reporting and confirmation requirements may vary by state[iv].

- Limits of lead detection vary by analytical method and laboratory. Most laboratories performing BLL testing can achieve an error range within +/- 2 µg/dL. However, the current allowable error range for a lab to be in compliance with proficiency testing is +/- 4 mcg/dL or +/- 10%, whichever is greater[v]. There is ongoing discussion that this error range should be reduced to better reflect modern lead reference ranges and lab capabilities.
    - When the most sophisticated machines (inductively coupled plasma method - ICP MS) are used the limit of detection is typically 1 µg/dL or less (e.g. 0.1 µg/dL)[vi].
    - Many sites do not have these and instead use graphite furnace atomic absorption spectrophotometry (GFAAS) or flame atomic absorption spectrometry (FAAS), which have limits of detection of < 1-2 µg/dL or ~10 µg/dL, respectively[vii].
    - The error range for the handheld LeadCheck II instruments (a CLIA-waived instrument using a capillary sample) is +/- 3 mcg/dL.

- Ingested lead distributes first into the red blood cells, and then re-distributes into soft tissues (25%) and bone (70%). For children with baseline lower levels of lead exposure, after an acute exposure, the blood level will fall rapidly (weeks). A large decrease from the first to second lead level may reflect an acute exposure followed by body equilibration, or may result from laboratory or fingerstick contamination issues.

Identifying sources of lead exposure

The first priority is to identify sources and prevent ongoing exposure. Lead paint and contaminated dust/soil are sources responsible for the majority of BLLs above the reference value in U.S. children, but there is increasing evidence of exposure through other sources. It is important to question families about the child's home environment as well as other potential exposure sources. Talk to parents about exposure pathways (floor to hand to mouth) and important sites of exposure (windowsills). Some pertinent questions include:

- Does the child live in a home or regularly visit 1) a building (*e.g. school, daycare*) built before 1950, or 2) a building built before 1978 with recent or ongoing painting, repair, and/or remodeling?
- Could the soil where the child lives or plays be contaminated with lead (*e.g. neighborhood with older housing, current or historical mining, smelting, or agriculture)*?
    - Could the child's drinking water be contaminated (*e.g. from indoor plumbing*)?
        - Consider testing water sources, such as kitchen tap water, for lead contamination. Most NSF certified faucet mounted water filters remove lead - see PEHSU factsheet on lead removal from drinking water.
- Does the family have older or antique furniture with lead-based paint? Older children's toys? Newer imported toys?
- Does the child spend time with anyone who has a job or hobby where they may work with lead in the home or bring lead dust home on shoes and clothing (*e.g. painting, remodeling, auto radiators, ship repair, soldering, making sinkers or bullets, going to shooting ranges, welding, mining, stained glass, pottery, jewelry, antiques, or imported toys*)?
- Does the family use pottery or ceramics made in other countries (especially Mexico and China), lead crystal or pewter, or vintage dishes for cooking, storing, or serving food or drink?
        - Restrictions on lead in dishes were implemented in late 1980s and strengthened in early 1990s—since then US made dishes are without lead.
- Are imported spices used or home spices brought from other countries?
- Has the child ever used imported cosmetics or taken any traditional home remedies (*e.g. Azarcon, Alarcon, Greta, Rueda, Pay-loo-ah, Kohl*)?
- Has the child been adopted from, lived in, or visited another country?
- For children < 12 months, consider mother as the source for transmission prenatally and through human milk. Are there maternal risks for lead exposure (see CDC Guidelines for Pregnant and Lactating Mothers)?

Although a specific source may not be identified, the medical provider can still provide information and counseling to the family on common sources of exposure and how to avoid them (*e.g. use a doormat and take off shoes when entering the home, wash children's and adults' hands often, do not allow children to chew on painted wooden toys or furniture or windowsills).*

If a lead paint hazard is identified (e.g. paint prior to 1978), some practical lower cost approaches include simply keeping it in good condition, cleaning up dust often (wet wiping and using vacuums with HEPA filters), painting over suspect paint, or placing a barrier over the area to keep it out of reach from children.

A home inspection and risk assessment may be the best approach to identify and characterize lead hazards in the home. Such inspections typically cost $400 - $1000 and individual dust wipe samples cost about $35 each. Trained lead professionals can use EPA approved test kits (http://epa.gov/lead/pubs/testkit.htm); these test kits are not generally recommended for consumer use. Proper and safe remediation is important to avoid actually increasing the risk for a child's exposure. Information on proper remediation and repair is available from the EPA at http://epa.gov/lead/pubs/leadinfo.htm#remodeling.

Also, note that federal law requires that home sellers and landlords must disclose a lead hazard at the time of sale or before a rental lease takes effect[vii].

Additional considerations

- For infants with initial BLLs > 4 mcg/dL, recheck earlier than the standard 1-3 months and include iron status testing. Their increasing mobility increases their risk of exposure.
- Consider testing other members of the household/family, as this may aid identification of lead sources.
- Chelation therapy is *not* recommended for BLL's < 45 µg/dL except in special circumstances. Consult the PEHSU for chelation questions. The FDA recently released a statement warning of the dangers of off-label use of chelation therapies: http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm229358.htm

Resources for advice on identifying and reducing potential exposure sources

Call the local health department for assistance in evaluating the home environment for lead and check with your state or local housing agencies for resources to remediate lead-based pain hazards.

Region X State-specific lead programs

- Alaska Lead Surveillance Program: http://www.epi.hss.state.ak.us/eh/lead/default.htm
- Idaho Department of Health and Welfare lead education:http://healthandwelfare.idaho.gov/Health/EnvironmentalHealth/IndoorEnvironment/Lead/tabid/941/Default.aspx
- Oregon lead poisoning prevention: http://www.oregon.gov/DHS/ph/lead/index.shtml
- Washington State Childhood Lead Poisoning Prevention program: http://www.doh.wa.gov/ehp/lead/default.htm

National programs

- CDC factsheet on new reference level: http://www.cdc.gov/nceh/lead/ACCLPP/Lead_Levels_in_Children_Fact_Sheet.pdf
- CDC tips for reducing lead exposure: http://www.cdc.gov/nceh/lead/tips.htm
- EPA information on childhood lead exposure and lead in general: http://www.epa.gov/lead/index.html and http://www.epa.gov/iaq/lead.html
- National Center for Healthy Housing (NCHH) consumer factsheet: http://www.nchh.org/Portals/0/Contents/Consumer BLL Fact Sheet 8-7-12.pdf

For additional questions or guidance, contact the NW PEHSU. The University of Washington based Pediatric Environmental Health Specialty Unit (PEHSU) serves medical and public health professionals in Alaska, Washington, Idaho, and Oregon. For more information contact us at 206-221-8671 or pehsu@uw.edu or visit our website http://www.depts.washington.edu/pehsu.

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[i] ACCLPP. Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention. Report of the Advisory Committee on Childhood Lead Poisoning Prevention of the Centers for Disease Control and Prevention. January 4, 2012

[ii] ACCLPP 2012; Lanphear BP, Dietrich K, Auinger P, Cox C. Cognitive deficits associated with blood lead concentrations <10 mg/dL in US children and adolescents. *Public Health Report*. 2000; 115:521–529; Lanphear BP, Hornung R, Khoury J, et al. Low-level environmental lead exposure and children's intellectual function: an international pooled analysis. *Environmental Health Perspectives*. 2005; 113(7):894–899.

[iii] Moodie S, Ialongo N, Lopez P, et al. The conjoint influence of home enriched environment and lead exposure on children's cognition and behaviour in a Mexican lead smelter community. *Neurotoxicology*. 2012. Advance of print. http://dx.doi.org/10.1016/j.neuro.2012.10.004; Guilarte TR, Toscano CD, McGlothan JL, Weaver SA. Environmental enrichment reverses cognitive and molecular deficits induced by developmental lead exposure. *Annals of Neurology*. 2003; 53(1): 50-56

[iv] In Washington state, WAC 246-101 requires laboratories to report all blood lead test results to the Washington State Department of Health. All "elevated" blood lead levels, currently defined by the state as ≥10µg/dL in youths <15 years old and as ≥25µg/dL in people ≥15 years old, must be reported within 2 days. All other test results must be reported within 1 month.
(http://www.doh.wa.gov/PublicHealthandHealthcareProviders/HealthcareProfessionsandFacilities/ProfessionalResources/BloodLeadTestingandReporting/BloodLeadTestReporting, 9/19/12)

[v] Per current regulation, *Clinical Laboratory Improvement Amendments (CLIA) of 1988*. A useful discussion of lab limits can be found in: Advisory Committee on Childhood Lead Poisoning Prevention. Meeting Minutes, November 16-18, 2010. Atlanta, Georgia. Pages 19-25.

[vi] WHO. Brief guide to analytical methods for measuring lead in blood. 2011. Page 3.
(http://www.who.int/ipcs/assessment/public_health/lead_blood.pdf, 9/19/12)

[vii] EPA. Residential Lead-Based Paint Disclosure Program, Section 1018 of Title X (http://epa.gov/lead/pubs/leadbase.htm, 9/19/12)