Chapter 5
Medical Management for Children with Lead Poisoning

Contents

Introduction

Clinicians have an important role in preventing lead exposure and managing lead-exposed children. This role is described in Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention (CDC, 2012, January 4), and includes:

Blood lead tests

A blood lead test is direct measurement of the concentration of lead in blood. Venous blood is the preferred specimen for analysis due to the low likelihood of contamination. Since venipuncture can be difficult in children, capillary blood from a fingerstick is acceptable for blood lead screening. Personnel using this method should be thoroughly trained in proper collection procedures. The recommended procedure for the collection of blood lead specimens by fingerstick is available from the Wisconsin State Laboratory of Hygiene (January 2024). An abbreviated fingerstick collection procedure is also available. Supplies for obtaining capillary blood specimens can be ordered from the Wisconsin State Laboratory of Hygiene (WSLH) on-line or by calling 800-862-1088.

Elevated blood lead results obtained from a capillary specimen should be confirmed using venous blood. See Table 5.1 for the recommended schedule for obtaining a confirmatory venous sample (CDC, 2022) and refer to the definitions in Chapter 1: Consolidated Contracts, Standards, and Definitions for more information on CDC's blood lead reference value. The higher the blood lead level (BLL), the sooner the confirmatory test should be done. For example, CDC recommends that BLLs from 10–44 µg/dL be confirmed within one week to one month. Children with BLLs closer to 44 µg/dL should receive a confirmatory test in approximately one week.

In the event that it is not possible to obtain a confirmatory venous sample from the child, a second capillary sample drawn within 12 weeks of the initial screening test can be considered a confirmatory test. This is consistent with the standard surveillance definitions used by the CDC to classify confirmed and unconfirmed elevated BLLs. If the second capillary test result is elevated, all follow-up tests should be performed as venous samples.

Other tests

There is no medical rationale for using any of the following methods to diagnose exposure to lead; testing of neurophysiologic function; evaluation of renal function (except during chelation with Calcium Disodium Versenate ($CaNa_2$ EDTA); testing of hair, teeth, packed red cells, saliva or fingernails for lead; and radiographic imaging of long bones, nor is provocative chelation prior to measurement of lead in urine testing recommended (CDC, 2012).

Lead poisoning diagnosis

A diagnosis of lead poisoning is made based on a venous blood lead test. When a child has a capillary blood lead test ≥3.5 µg/dL (or the current BLRV), a diagnostic venous blood lead test should be obtained to ensure accuracy. See Table 5.1 or CDC's website for the recommended schedule for obtaining a confirmatory venous sample (CDC, 2021). In general, the higher the blood lead level (BLL), the sooner the confirmatory test should be done.

Table 5.1 Recommended schedule for obtaining a confirmatory venous sample (CDC, 2021)

Blood lead level (µg/dL)	Time to confirmation testing
≥ 3.5–9	Within 3 months*
10–19	Within 1 month*
20–44	Within 2 weeks*
≥45	Within 48 hours*

*The higher the BLL on the initial screening capillary test, the more urgent the need for confirmatory testing using a venous sample.
Source: Centers for Disease Control and Prevention

Follow-up blood lead tests

When lead poisoning is diagnosed, follow-up tests should be performed with venous blood samples to monitor the child's BLL and to evaluate the effectiveness of interventions. The scheduling of follow-up tests depends on the diagnostic BLL (see Table 5.2). Even in the best laboratories, variations in test results of ±2 µg/dL are normal and are well within the acceptable lab error. Multiple blood lead tests are needed over time to monitor the trend in a child's actual BLLs. Blood lead levels that increase may be indicative of an unrecognized source of exposure, inappropriate abatement activities, failure to mitigate the identified hazard, or the redistribution of lead stores within the child's body. The follow-up schedule is provided on the next page.

Table 5.2 Schedule for follow-up blood lead testing* (CDC, 2012)

Venous blood lead level (µg/dL)	Early follow-up testing (2 - 4 tests after identification)	Later follow-up testing after blood lead level declining
≥ 3.5–9	3 months **	6 – 9 months
10–19	1 – 3 months **	3 – 6 months
20–44	2 weeks – 1 month	1 – 3 months
≥ 45	As soon as possible	As soon as possible

* Seasonal variation of BLLs exists and may be more apparent in colder climate areas. Greater exposure in the summer months may necessitate more frequent follow-ups.
** Some case managers or health care providers may choose to repeat blood lead tests on all new patients within a month to ensure that their BLL is not rising more quickly than anticipated.

Source: Centers for Disease Control and Prevention

Clinical assessment of children with lead poisoning

Review CDC's Recommended Actions Based on Confirmed Blood Lead Level for a summary of recommendations for follow-up and case management for children. The Wisconsin Poison Center and Children's Wisconsin also have a Lead Poisoning Guideline for physicians to follow. Request a copy by sending an email to the Poison Center or the CLPPP general email DHSLeadPoisoningPrevention@dhs.wisconsin.gov.

Today, most children with lead poisoning have no symptoms. The detrimental effects of BLLs below 45 µg/dL are often subclinical and may include neurodevelopmental impairment often apparent only at a later age. It is critical that the primary care provider (PCP) and case manager not equate the absence of clinical symptoms, physical abnormalities, or abnormal laboratory results with an absence of toxicity.

Erythrocyte protoporphyrin (EP) or zinc protoporphyrin (ZPP)

Protoporphyrin is a precursor of heme, the oxygen-carrying component of red blood cells (erythrocytes). Small amounts of protoporphyrin are normally present in erythrocytes, hence the term erythrocyte protoporphyrin (EP). Pathological conditions that impair heme synthesis therefore cause elevations in EP concentrations. The result of an individual EP test reflects the average effect on heme synthesis over 90–120 days, because that is the life-span of erythrocytes in the blood stream. Lead poisoning can fluctuate over a shorter period of time, which makes the EP tests an ideal partner with blood lead testing (Stanton, 2000).

The terminology associated with EP test results can be confusing. You may see an EP result referred to as erythrocyte protoporphyrin (EP), zinc protoporphyrin (ZPP), or free erythrocyte protoporphyrin (FEP). Technically these terms refer to different variations of protoporphyrin.

Reporting units
EP or ZPP test results are most commonly reported as:

- μmol/mol Heme: molar ratio of pEP or ZPP to heme
- μg /dL whole blood: micrograms per deciliter of whole blood concentration units of EP or ZPP

When reported in μg/dL (or mcg/dL) reporting units, EP and ZPP results are approximately equivalent. A value exceeding 35 μg/dL is widely accepted as indicative of pathology. Results exceeding 70 μmol/mol are accepted as indicative of pathology. An EP or ZPP level higher than the threshold value does not indicate the reason for the elevation; further tests for iron deficiency and/or lead poisoning must be performed (Stanton, 2000).

Usefulness of erythrocyte protoporphyrin testing
Lead in the blood begins to cause an increase in EP at levels of 15–20 μg/dL. As the lead level rises, the EP level rises exponentially. Paired results of EP and BLL can provide information on the effect, extent, and duration of lead exposure. An elevated BLL along with a normal or near-normal EP may indicate that the lead exposure has been recent and/or short term. An elevated EP level with a minimal increase in BLL may indicate a higher past lead exposure and a continuing body burden of lead. Elevation of both EP and BLL may indicate prolonged and ongoing lead exposure. In general, an EP test should routinely be obtained on any child with a diagnostic BLL $\geq$20 μg/dL, and paired with any follow-up BLLs that are drawn (Stanton, 2000).

Iron deficiency
Iron deficiency often co-exists with lead poisoning and can enhance lead absorption. Research indicates that iron deficiency in young children can enhance the effects of lead poisoning on the central nervous system as well as be an independent neurotoxin (ATSDR, 2020).

Pica
Pica is a pattern of deliberate ingestion of nonfood items. Harmful items commonly associated with pica include chalk, newsprint, ice, pencil erasers, paint chips, dirt, clay, and pottery. Lead poisoning can result if the child consumes substances that are contaminated with lead, such as lead-contaminated soil or paint chips, and can be associated with anemia and iron or zinc deficiencies. Abdominal radiographs may be useful in determining whether children have ingested lead-contaminated non-food items. Radiographs may be useful when children have an unexpected acute rise in blood lead or are not responding to exposure reduction or chelation.

Chelation therapy
Chelation is the use of special drugs that bind to metals in the blood to form complex structures which are then excreted in urine. The CDC recommends chelation therapy for children with a venous BLL $\geq$45 μg/dL.

Chelation therapy is not a substitute for effective and rapid environmental interventions and should only be used as part of an integrated environmental and medical approach to treating children with lead poisoning. Children receiving chelation therapy for treatment of lead poisoning require special care and consideration by a health care team. Primary care providers should consult with an expert in lead chelation therapy prior to initiating chelation therapy. The PCP can contact the Wisconsin Poison Center at 1-800-222-1222 for information on treatment. Public health nurses should be in communication with the child's physician regularly to discuss the plan of care, follow-up, and to assure that the child is in a lead-safe environment after chelation is complete or while receiving chelation as an outpatient.

Several chelating agents can be used in the treatment of lead poisoning. These drugs are capable of binding (or chelating) lead and depleting the soft and hard (skeletal) tissues of lead, thus reducing acute toxicity. All drugs have potential side effects and must be used with caution. The American Academy of Pediatrics Committee on Drugs published *"Treatment Guidelines for Lead Exposure in Children,"* which contains a good summary of chelation with the most commonly used agents.

A commonly used oral chelating agent is succimer (Chemet). Research found that chelation therapy with succimer lowered average BLLs for about six months but resulted in no benefits in cognitive, behavioral, and neuromotor endpoints (ATSDR, 2000).

Family education

Families whose children are receiving chelation therapy need adequate information to ensure a successful outcome. This education should address the following topics:

- The need for and importance of a lead-safe environment during and after chelation. It is often difficult for families to secure a lead-safe place at the same time the child is hospitalized or starting on a new medicine. However, it is one of the most important tasks for them to undertake during this time.
- The name of the drug, dose, route of administration, schedule, and side effects of the chelating agent being used. This is especially important if the parent is responsible for administering an oral chelating drug to the child.
- The importance of follow-up blood lead and EP testing (see below).

After chelation

Post-chelation venous blood lead and EP levels should be obtained every few weeks for several months. Within a month or two after chelation is completed, the BLL may rebound to around 70 percent of the pre-chelation level as lead is released from the bone and re-enters the bloodstream. If the BLL rebounds to 45 µg/dL or greater, chelation may need to be repeated. The EP level, in combination with a BLL, can be useful in differentiating between post-chelation blood lead rebound and ongoing exposure to lead. The EP level should continue to decrease after chelation unless there is a new exposure. An increase in both the BLL and EP level after chelation is an indication of re-exposure to lead. Further investigation should be done in this situation to identify the ongoing, or new, source of lead exposure.

Unapproved "chelation" products
The U.S Food and Drug Administration advises consumers to be wary of so-called "chelation" products that are marketed over the counter (OTC) to prevent or treat diseases. Companies are marketing unapproved OTC chelation products to patients with serious and incurable diseases, including autism spectrum disorders and heart (cardiovascular) conditions. For more information please visit the FDA's website on unapproved chelation products.

Monitoring a child's neurodevelopmental progress

Long-term follow-up of lead-poisoned children requires attention to the developmental and neurobehavioral effects of lead poisoning. Neurodevelopmental monitoring should continue long after a child is initially diagnosed with lead poisoning, as many deficits will not manifest themselves until after a child starts school. Additional information on childhood milestones can be found on CDC's Developmental Milestones page or visit Children's Health Alliance for additional information on developmental screening.