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AT A GLANCE

Clinical Evaluation for Lead Exposure: A Simplified Approach

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Introduction

This document is for physicians and other licenced primary care providers (e.g. nurse practitioners) who require more information on identifying and managing known or potentially clinically relevant metals exposure in the community setting. This is a brief guide, and not intended to be comprehensive. It should not supersede specialist or urgent care referral, where clinical judgement dictates.

Public Health Ontario (PHO) has also developed documents for cadmium exposure and mercury exposure.

Step 1: Enquire About Relevant Exposures

An **exposure history** should capture potential sources in the home, community, and at the workplace.

- Most individuals are exposed to small amounts of lead in food, water, dust, soil, and air, all of which is of little or no clinical significance.
- The most common sources of potentially clinically significant community exposures are from lead-based indoor paint in older homes (greater risk associated with homes built prior to around 1950), imported consumer products (such as spices or herbal medicines), or certain hobbies.[1]
- Occupational exposures occur in various settings, but most commonly in police officers (e.g., related to target shooting), welders/metallurgical workers, industrial machinery and building equipment workers, metal processing, or battery recycling workers.[2]

Step 2: Assess for Expected Clinical Outcomes

Lead toxicity occurs at levels much higher than background population levels (i.e., blood lead levels greater than 1.9 µmol/L) and manifests in multiple target organs and systems, including the central and peripheral nervous systems, cardiovascular, gastrointestinal, musculoskeletal, hematologic, renal, and reproductive systems. Individual and population level effects related to lead toxicity occur in a dose-dependent manner (Table 1). Exposures below these levels but above laboratory reference ranges can result in non-specific effects on children's development, and cardiovascular and reproductive systems.

The most common complaints in acute toxicity include:

- Abdominal colic
- Malaise and fatigue
- Arthralgias and myalgias
- Headaches and tinnitus
- Peripheral neuropathy

Step 3: Determine What Testing Should be Performed

Blood lead concentration or level (BLL) is the most appropriate biomarker for lead exposure.

- Bone lead levels represent lead body burden but their use is largely confined to research studies.
- Hair testing has not been proven to be a valid clinical biomarker for individual lead exposure.[3]
- Testing after administration of a chelating agent (provoked testing) is not scientifically validated and does not give interpretable results.[4] In these circumstances, a blood lead level should be ordered no sooner than 3–5 days after chelation.[4]

Step 4: Interpreting Results

Reported laboratory reference ranges represent population averages, and are significantly lower (i.e., by more than an order of magnitude) than levels at which toxic effects may occur. Dose-response relationships are outlined in Table 1.

- Levels above population norms but below the level of clinical toxic effects are best addressed through identification and cessation of exposure.
- Chelation may be indicated in cases where the level is greater than 2.4 µmol/L and clinical symptoms are present, but should only be done in consultation with an occupational medicine or toxicology specialist (Table 2).[5] Chelation is not recommended with ongoing exposure.
- Table 2 provides guidance for management based on BLL for the general population.
- If a worker has an elevated blood lead level that could be work-related, the Ontario Ministry of Labour, Immigration, Training and Skills Development Codes for Medical Surveillance for Designated Substances of lead may be applicable.[6]

Lead Concentrations Associated with Individual and Population Level Effects

Note, the 95th percentile BLL in Canadians aged 60–79 in 2018–2019 was 0.15 µmol/L (3.1 µg/dL) based on the nationally representative Canadian Health Measures Survey.[10]

Table 1: Blood Lead Dose-Response[1,5,7-10]

Blood Lead Concentration (µmol/L)	Blood Lead Concentration (µg/dL)	Clinical Effect – Individual Level	Clinical Effect – Population Level
0.15	3.1	95th percentile BLL in Canadians aged 60–79 in 2018–2019	N/A
≤0.24	<5	Not detectable	Possible increased risk of spontaneous abortion, postnatal developmental delay, decreased IQ in children

Blood Lead Concentration (µmol/L)	Blood Lead Concentration (µg/dL)	Clinical Effect – Individual Level	Clinical Effect – Population Level
>0.24–0.48	5–9	Not detectable	Decreased growth and hearing in children; increased risk of hypertension and subclinical decreased eGFR in adults, increased incidence of essential tremor; effects on sperm, semen
>0.48–0.97	10–19	Subclinical heme synthesis disruption (elevated zinc protoporphyrin). Decreased nerve conduction velocity	Increased effects on male and female reproductive system, and decreased fertility in men
>0.97–1.9	20–39	Sensory and motor nerve impairment, increased risk of spontaneous abortion	No data
>1.9–2.4	40–50	Frank clinical symptoms manifest (abdominal colic, arthralgias and myalgias, tinnitus, headaches, malaise, peripheral neuropathy), anemia	No data
>4.8	>100	Nephropathy, increased risk for encephalopathy, death in extreme cases	No data

Table 2: Blood Lead Level and Suggested Action[5,7,8]

Blood Lead Concentration (µmol/L)	Blood Lead Concentration (µg/dL)	Suggested Management
>0.24	>5	• Identify and eliminate source of exposure • In children, or in pregnancy and lactation, correct calcium/iron deficiency if present[5] • Repeat levels in 3 months to evaluate effectiveness of intervention(s)[5]
>0.48	>10	• Above, and • If home or community exposure is suspected, contact public health for assistance in identifying/ eliminating source of exposure

Blood Lead Concentration (µmol/L)	Blood Lead Concentration (µg/dL)	Suggested Management
>1.9	>40	• Above, and • Consider referral for specialist assessment (Ontario Poison Centre or occupational medicine specialist)[7] • Repeat BLL in 4 weeks[5]
≥2.4	≥50	• Above, and • Obtain CBC and creatinine level • Refer for specialist assessment (Ontario Poison Centre or occupational medicine specialist)[7]

If there are no apparent occupational or environmental exposures present on comprehensive exposure history, and levels are below 0.48 µmol/L (10 µg/dL), an actionable source is unlikely to be identified.[11] The half-life in the blood is approximately 30 days,[1] however, where chronic exposure has occurred it may take considerably longer for blood lead levels to decline by 50% due to release of lead from soft tissue and bone.[1] Nonetheless, if any intervention to reduce exposure has been attempted then repeat levels at 3 month intervals for monitoring would be reasonable.[5]

Particularly because of the increased susceptibility in children and developing fetuses to the neurodevelopmental effects of lead, testing of other residents in the home may be needed to determine if a shared source is present if an adult presents with elevated BLL. If other individuals have confirmed elevations, the local public health unit could be contacted to consider an investigation of the home to identify possible sources.

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