Risk Management for Lead

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“Environmental lead exposure reduction has been shown to be a cost-effective public health measure...Therefore, there is a need for continued efforts to reduce [all] environmental lead exposures in Canada.” - Health Canada (March 2012) Blood Lead Action Levels
How does lead exposure affect us?

Lead is a neurotoxin
- Nervous system development
- IQ deficits
- Antisocial Behaviour
- Cardiovascular
- Auditory and visual function
- Renal effects
- Reproductive effects
- Age-related cognitive decline

Image: http://www.scienceclarified.com/Al-As/Anatomy.html
What are the main sources of lead?

- Natural sources include bedrock, sediments, surface and ground water
- Anthropogenic sources include smelter operations, smoking, firing ranges, lead pipes delivering water
  - NPRI (2009 est.) air: 260 tons, land: 160 tons, water: 16 tons
What is the estimated intake from different sources?

WHO tolerable weekly allowance: 25 µg/kg/bw
- (Acceptable daily intake of 3.5 µg/kg/bw) NOAEL, (withdrawn)

*Ref. HC 1992, using 0.06 µg/m³, various, 4.8 µg/L and 140 µg for air, food, water and dust, respectively for child 13.6 kg and adult 70 kg.
Where does lead accumulate in the human body?

- Uptake (similar to Ca)
- Release during periods of bone turnover—pregnancy, menopause, osteoporosis
- Biological half-life
  - Blood ~25 days
  - Tissue ~40 days
  - Bones ~20 years
Lead levels in the Canadian Population are decreasing

- Canadian lead levels based on CHMS, 6-79 yrs is 1.34 µg/dL (Geometric Mean)
- Highest in oldest Canadians (60-79 yrs)

CHMS 07-09, 95th percentile

6-11 yrs: 1.95 (1.65, 2.25)
12-19 yrs: 1.64 (1.47, 1.82)
20-39 yrs: 3.12 (2.75, 3.49)
40-59 yrs: 3.87 (3.16, 4.57)
60-79 yrs: 5.19 (4.20, 6.18)
What are the guidelines for Lead?

• Current Canadian (Whole) Blood Lead Intervention Level of 10 µg/dL
• Other guidelines—CDC, WHO 10 µg/dL, are under downward revision

• CDC – 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
Impacts of lead shown at low levels

<table>
<thead>
<tr>
<th>Blood Lead Level (µg/dL)</th>
<th>IQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4 – 10</td>
<td>3.9 ↓</td>
</tr>
<tr>
<td>10 – 20</td>
<td>1.9 ↓</td>
</tr>
<tr>
<td>20 – 30</td>
<td>1.1 ↓</td>
</tr>
</tbody>
</table>

Findings: lead-associated IQ deficit greater per µg/dL for BLL <7.5 than ≥7.5 µg/dL

Lanphear et al., 2005
No “safe” level of lead exposure has been identified

- Evidence suggests a dose-related continuum of effects
- No apparent threshold
- Underscores importance of primary prevention
What are the proposed Risk Management Strategies for Lead?

- For all sources: existing risk management guidelines and regulations
- For water in particular:
  - Guidelines for Canadian Drinking Water Quality (10 µg/L)
  - Guidance for controlling corrosion in drinking water distribution systems
Leaching from lead-containing plumbing is the most common route

- The degree of leaching depends on 3 key factors:
  - Distribution system & building plumbing, type and age of system
  - Water usage patterns
  - Water chemistry
Type of distribution system

- Lead-containing plumbing
  - Lead pipes, tin-lead solder, brass fittings

- Age of buildings
  - May have more lead plumbing = higher leaching
  - Pipes may have more buildup = less leaching

- Other factors
  - Pipe length
  - Pipe diameter
Usage Patterns can influence lead content

- Longer contact times $\rightarrow$ more leaching

- Intermittent use
  
  “First draw” typically highest lead levels
## Water Chemistry

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>EFFECT ON LEACHING</th>
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<tbody>
<tr>
<td>Low pH</td>
<td>↑</td>
</tr>
<tr>
<td>Low alkalinity</td>
<td>↑</td>
</tr>
<tr>
<td>Soft Water</td>
<td>↑</td>
</tr>
<tr>
<td>Corrosion inhibitors</td>
<td>↓</td>
</tr>
<tr>
<td>Cold water</td>
<td>↓</td>
</tr>
</tbody>
</table>

adapted from Barn and Kosatsky, (2011)
Corrosion Control Measures

- Guidelines for residential and non-residential (Health Canada)
  - Sampling
  - Action levels
  - Public education
- Raising pH to $>7.5$ and $9.5$ (8-9 WHO)
- Optimal alkalinity ranges 30 to 75 mg/L as Calcium Carbonate
Lead can be a problem in Schools

- Aging infrastructure, costly to replace
- Types of outlets
  - Drinking fountains: narrower pipes, more soldered joints
  - Water coolers: require long contact times for cooling purposes
- Intermittent use
- Impact to vulnerable group
Lead exposure in school drinking water

- School in BC
  - Trigger was salmon eggs dying in classroom tank
- Initiated testing for lead and copper
  - Fountains and taps tested
  - High levels of lead (and copper) found
The Hierarchy of Controls

**Engineering:** Isolate or remove the contaminant

**Administrative:** Change procedures to reduce exposure to contaminant

**PPE:** Final barrier between contaminant and individual
## Mitigation strategies

<table>
<thead>
<tr>
<th>Level</th>
<th>Approach</th>
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<tbody>
<tr>
<td>Engineering</td>
<td>- Replacing lead-containing plumbing</td>
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<tr>
<td></td>
<td>- Altering water chemistry (at water treatment level)</td>
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<tr>
<td>Administrative</td>
<td>- Regular flushing of plumbing system in building</td>
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<td></td>
<td>- Use of only cold-water taps</td>
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<td></td>
<td>- Use of alternative drinking water source</td>
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<td></td>
<td>- Public education</td>
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<tr>
<td>Personal Protective Equipment</td>
<td>- Water filtration, Point of Use</td>
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Summary

- No threshold level identified with respect to health effects
- Lead accumulated in the body, intergenerational impacts
- Low levels of lead have shown health impacts including IQ deficit
- Blood Lead Intervention level being revisited
Summary

- Risk management includes water-characterization, corrosion control, infrastructure replacement, administrative controls, public education
- Difficult to identify source in individual cases, exposure to lead from all sources should be reduced
Thank you

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Primary references


