Lead in School Drinking Water: Approaching a Public Health Issue from an Occupational Hygiene Perspective

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Outline

• Lead and health
• Lead in school drinking water
• Applying a hygiene model to mitigation
• Summary
Lead and Exposure

• Removal of lead from gasoline & lead paints has resulted in decreased exposure
  – Median blood lead levels decreased from 15 µg/dL in 1980 to 1.9 µg/dL in 1999 (among US children 1-5 years of age)

• BUT residual, low level exposure sources have not been adequately addressed
Low Level Exposure and Health

- Effects seen even at levels previously considered “safe”

- Blood lead levels < 10 µg/dL associated with cognitive changes and neuropsychiatric disorders in children

- Early exposures associated with social & economic costs
  - Annual loss of $43.4 billion in lifetime earnings due to lead-induced IQ deficits estimated in the US (based on mean blood lead level of 2.4 µg/dL among 5-year old children)
School Drinking Water Is A Source

• Testing of Ontario schools in 1997 found:
  – 28 % of “first draw” samples > 10 µg/L Canadian drinking water guideline (n= 3,669)
  – 9 % of “30 second flush” samples > 10 µg/L (n= 3,479)

• Small incremental increases in exposure can be problematic
  – Some children already have a high lead body burden from exposure to other lead sources
How does lead get into water?

• Leaching from lead-containing plumbing is the most common route

• The degree of leaching depends on 3 key factors:
  1. Distribution system & building plumbing
  2. Water chemistry
  3. Water usage patterns
1. Plumbing

• 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
### 2. Water Chemistry

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

- Longer contact times = more leaching

- Water outlets in schools are used intermittently
  - Lead levels can increase during non-use periods (weekends & holidays)
  - Morning “first draw” typically have highest lead levels
  - Levels at lunch-time can reach morning levels
Why Schools in Particular?

• Water usage patterns
  – Intermittent use

• Types of outlets
  – Drinking fountains: narrower pipes, more solders
  – Water coolers: require long contact times for cooling purposes
What is Being Done?

• No national regulations around testing or monitoring in schools
  – Health Canada’s corrosion control guidelines provide guidance on sampling, interpretation & mitigation

• Ontario is the only province that requires annual testing by schools & day cares
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>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>Replacing lead-containing plumbing</td>
</tr>
<tr>
<td></td>
<td>Altering water chemistry (at water treatment level)</td>
</tr>
<tr>
<td>Administrative</td>
<td>Regular flushing of plumbing system in building</td>
</tr>
<tr>
<td></td>
<td>Use of only cold-water taps</td>
</tr>
<tr>
<td></td>
<td>Use of alternative drinking water</td>
</tr>
<tr>
<td>Personal Protective</td>
<td>Water filtration</td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
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</tbody>
</table>
In-Practice

• Replacement of plumbing is expensive, but may save $ in the long run

• Flushing is more commonly implemented
  – Considered a less costly option
  – Must be done every morning; need to consider staff cost and time, and water wastage
  – Recommended times vary depending on building size, plumbing, type of outlets
Summary

• Low level lead exposures are associated with health effects in children

• Residual sources, including school drinking water, need to be addressed

• Lead concentrations in water depend on plumbing, water chemistry and water usage patterns

• Mitigation strategies can be prioritized into the “hierarchy of controls” used in the occupational hygiene realm
Thank You

Questions?
Comments?

www.ncceh.ca | www.ccnse.ca
References


