Health Effects of Lead Exposure

Susan Buchanan, MD, MPH
Director
Pediatric Environmental Health
Specialty Units (PEHSU) Region V
Health Effects of Lead Toxicity

Susan Buchanan, MD, MPH
Great Lakes Center for Children’s Environmental Health
University of Illinois at Chicago School of Public Health
The findings and conclusions in this presentation have not been formally disseminated by the Agency for Toxic Substances and Disease Registry and should not be construed to represent an agency determination or policy.

Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing partial funding to ATSDR under Inter-Agency Agreement number DW-75-95877701. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.

Dr. Helen Binns, Dr. Daniel Hryhorczuk

Acknowledgement/Disclosure
Children are a High Risk Population for Environmental Exposures

- Developing brain
- Higher absorbed dose
- Different diets
- Longer life span
- High risk behaviors
1895
Health effects reported

1900

1909
France, Germany, and Belgium ban white-lead paint

1920

1923
U.S. leaded-gas sale begins

1940

1970
Clean Air Act-catalytic converter required

1960

1971
Lead Poisoning Prevention Act

1976
Leaded gas phase-out begins

1980

1978
U.S. interior paint < 0.06% by weight

Markowitz, AJPH 2000;90:35-46
Lead in Paint and Gasoline

More than 80% of U.S. housing built before 1978 contains lead paint

Soil levels continue to be high
Lead in Drinking Water

"Tap water once contributed to as much as 10-20% of total Pb exposure in the US."

No known reports of community mean BLL over "level of concern" due to contaminated drinking water (Pb in plumbing)

National Toxicology Program Monograph on Health Effects of Low-Level Lead 2012
Up to 20% of BLL may be due to lead in tap water [US EPA 1993]

For bottle-fed infants may be > 50% [US EPA]

Association between lead in tap water and BLL (OR 4.7, CI 2.1-10.2) [Levallois 2014] and p< 0.05 [Lanphear 1998]

Correlation coefficient for lead in tap water and BLL: R^2 = 0.43 [Fertmann 2004]

The contribution of tap water to BLL
Common Lead Sources

- Deteriorated leaded paint, dust
- Lead contaminated soil
- Occupational sources (take-home)
- Folk remedies (greta, azarcon)
- Food & food containers (including lead-glazed ceramics)
- Lead-contaminated drinking water
- Other (fishing sinkers, lead shot)
- Painted toys and furniture made before 1976
- Painted toys from outside the U.S.
## Historic Overview

<table>
<thead>
<tr>
<th>CDC Level of Concern</th>
<th>Lead in Blood (µg/dL)</th>
<th>Adverse Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>100</td>
<td>Death</td>
</tr>
<tr>
<td>1985</td>
<td>70</td>
<td>Encephalopathy</td>
</tr>
<tr>
<td>1991</td>
<td>40</td>
<td>Abdominal pain</td>
</tr>
<tr>
<td>2012</td>
<td>30</td>
<td>Anemia</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>Reduced IQ</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Behavior problems</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
Mean Blood Lead Levels in US Children (1-19 yo)

- 1978-1980: 16 ug/dL
- 1999-2000: 10 ug/dL
- 2001-2004: 8 ug/dL
- 2005-2008: 6 ug/dL
- 2009-2012: 4 ug/dL

88% ≥10 μg/dL

1.6% ≥10 μg/dL

Mean 0.816

Flint lead Levels ≥ 5μg/dL
Pre: 2.4%
Post: 4.9%

5 ug/dL

6 ug/dL

Source: The National Health and Nutrition Examination Survey
76-80 data: http://www.ncbi.nlm.nih.gov/pubmed/6333758
91-94 data: http://www.cdc.gov/mmwr/preview/mmwrhtml/00048339.htm
88-91 data: http://www.cdc.gov/mmwr/preview/mmwrhtml/00032080.htm
Workers are removed when blood lead is 50-60ug/dl

Return to work when blood lead decreases to 40ug/dl
Health Effects - **Overt** Signs and Symptoms of Lead Poisoning

- **Low**
  - Usually NONE

- **Moderate**
  - Constipation
  - Abdominal pain
  - Poor appetite
  - Anemia
    - (~40 μg/dL)

- **High**
  - Vomiting
  - Irritability
  - Lethargy
  - Seizures
Low-Level Environmental Lead Exposure and Children’s Intellectual Function: An International Pooled Analysis

- Pooled analysis, 7 studies, N= 1,333

Increase in lead:
- from 2.4 to 10 µg/dL → ▼ 3.9 IQ points
- from 10 to 20 µg/dL → ▼ 1.9 (95% CI, 1.2-2.6)
- from 20 to 30 µg/dL → ▼ 1.1 (95% CI, 0.7-1.5)

172 inner city children (101 with peak blood lead <10 µg/dL)

-7.4 points IQ for lifetime avg BLL ↑ from 1 to 10 µg/dL

Reduced intellectual development in children with prenatal lead exposure

- Study from Mexico, 150 children
- Geometric mean BLL in pregnancy, 8.0 µg/dL
- Maternal blood lead at 28 wks gestation, significantly assoc with child IQ at age 6-10 yrs

Schnaas; *Env Health Perspect* 2006;114:791-7
Result of a 5 point reduction in average IQ

Expected

Shifted by 5 IQ points
Bone Lead Levels and Delinquent Behavior

Herbert L. Needleman, MD; Julie A. Riess, PhD; Michael J. Tobin, PhD; Gretchen E. Biesack; Joel B. Greenhouse, PhD

- Bone lead and CBCL scores in 7 and 11 yr old boys
- Higher lead associated with delinquency, aggression, inattention, social problems

Lead Neurotoxicity: Behavior
At mean blood lead levels < 5ug/dl

Sufficient evidence for:

- Attention-related problems
- Greater incidence of problem behaviors
- Decreased cognitive performance