HEALTH EFFECTS OF LEAD ON CHILDREN

Workshop on Understanding Lead Poisoning in Baltimore
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This multi system toxin has no purpose in the body.

Absorbed through lungs and GI tract, enters blood, distributes to soft tissues and bone (t ½ in adult bone = 27 years. It is excreted primarily through gut and kidney.

Effects may depend on age of exposure, co-exposures to other toxins, nutritional status and genotype.

On molecular level proposed toxicity mechanisms involve fundamental biochemical processes:
- Inhibits or mimics actions of calcium
- Interacts with various proteins
- Potential generator of oxidative stress
DEFINING LEAD POISONING OVER THE YEARS

Beginning: Just Galena

Ancient times
“Lead makes mind give way”

1700s: Ben Franklin

1892: Brisbane
White lead paint causing severe neurological disease in children

1911: England
Sir Thomas Oliver: Effects on kidneys, blood production, miscarriage

1943: Randolph Byers
Children “recovered” from lead poisoning had ongoing learning problems

1950s: Geologist Clair Patterson
Connects earth lead levels to Industrialization

ACUTE POISONING

CHRONIC POISONING
HISTORICAL LEAD LEVELS OF CONCERN AND SYMPTOMS AT THOSE LEVELS

NHANES 1976-1980: Mean BLL: 12.8 µg/dL

“Low” levels showing evidence of multiple organ system effects

NHANES 2007-2010: Mean BLL: 1.3 µg/dL

Level ≥5 µg/dL to identify children within the 97.5th %ile as trigger to guide interventions

Frank anemia, Nephropathy, Encephalopathy

Colic

Hemoglobin Synthesis

### Table 2: Effects of Low-Level Lead Exposure on Academic and Intellectual Abilities, Puberty, Kidney Function, Postnatal Growth, Hearing, and Other Health Endpoints

<table>
<thead>
<tr>
<th>Blood Lead Concentration</th>
<th>Evidence Level</th>
<th>Health Effect</th>
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<tbody>
<tr>
<td>&lt;5 μg/dL</td>
<td>Sufficient</td>
<td>Decreased academic achievement</td>
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<td>Lower IQ scores</td>
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<td></td>
<td></td>
<td>Attention-related behavior problems</td>
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<td></td>
<td></td>
<td>Antisocial behaviors</td>
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<tr>
<td>Limited</td>
<td></td>
<td>Delayed puberty</td>
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<tr>
<td></td>
<td></td>
<td>Decreased kidney function in children ≥12 y of age</td>
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<tr>
<td>&lt;10 μg/dL</td>
<td>Sufficient</td>
<td>Delayed puberty</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced postnatal growth</td>
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<tr>
<td></td>
<td></td>
<td>Decreased hearing</td>
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<tr>
<td>Limited</td>
<td></td>
<td>Hypersensitivity by skin prick test</td>
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<tr>
<td></td>
<td></td>
<td>Asthma and eczema</td>
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<tr>
<td></td>
<td></td>
<td>Cardiovascular effects</td>
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<tr>
<td></td>
<td>Limited</td>
<td>Kidney function &lt;12 y of age</td>
</tr>
</tbody>
</table>

From the US Department of Health and Human Services, National Institute of Environmental Health Sciences, 2012.

DOSE EFFECT: IQ LOSS PROPORTIONALLY GREATER AT LOWER LEAD-LEVELS

95% CIs shaded
Concurrent blood lead levels, adjusted for HOME score, maternal education, maternal IQ, and birth weight.

Data from 1333 children who participated in seven international population – based longitudinal cohort studies, followed from birth or infancy until 5-10 years of age.

NON-LINEAR DOSE EFFECT FOR READING FAILURE RATE

Black curve shows adjusted reading failure rate at mean value of covariates

- >58K public school Chicago 3rd graders
- Adjusted for poverty, race/ethnicity, gender, maternal ed, very low birth weight or pre-term birth

Figure 1 Adjusted and observed reading failure rates by B-Pb.
LEAD EFFECTS ON THE KIDNEY

Study of 769 adolescents aged 12-20 years (NHANES 1988-1994)

Median lead level was 1.5 µg/dL

Median Cystatin C-estimated GFR was 112.9

Source: Fadrowski et al. Arch Intern Med 2012 Jan 11; 170(1)75-82
CONCLUSIONS ABOUT HEALTH EFFECTS OF LEAD IN CHILDREN

- Lead levels and consequential effects have decreased over the past 40 years due to successful public health measures.

- There is no acceptable lead level in children.

- Accumulating data shows levels below 10µg/dL adversely affect many organ systems.

- Health effects of lead are irreversible and there is no effective treatment so we need primary prevention that focuses on reducing exposures before a child is identified as having an elevated lead level.