Making Sense of Child Lead Exposure Data

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Overview

• What does elevated lead mean and how is it defined?

• Understanding the biology of exposure

• Children at greatest risk

• Illustrations

• Different metrics inform different types of decisions
Definition of Elevated Blood Lead Levels (EBLL)

• 5 micrograms per deciliter (mcg/dl)
  *is the CDC reference level defining EBLL

  *the top 2.5% of U.S. children 1-5 have EBLLs of 5mcg/dl or higher

There is no safe level of lead for a child
EBLL: What does it Mean?

• Value is calculated by the CDC and represents the 97.5th percentile of the National Health and Nutrition Examination Survey (NHANES)’s blood lead distribution in children 1-5

• Value is re-calculated every four years based on the two most recent years’ surveys.

• Will be re-evaluated in 2020.
EBLL: What does it mean?

- BLL = Recent or ongoing exposure---Not the total body lead burden

- 10mcg/dl is the BLL clinically considered to require intervention.

There is no safe level of lead for a child
Understanding the Biology of Exposure: Sources

Diagram showing various sources of lead exposure:
- Lead in air
- Lead in water
- Lead in food
- Lead in paint
- Lead in soil
- Lead dust on toys
- Lead dust on pets

Sources include:
- Industrial emissions
- Auto emissions
- Lead solder in cans
- Lead in pipes

Institutional logos:
- Jack, Joseph, and Morton Mandel School of Applied Social Sciences, Case Western Reserve University
- Frances Payne Bolton School of Nursing, Case Western Reserve University
Understanding the Biology of Exposure: Routes of Intake

- **Eating (Ingestion)**
  - Lead particles on hands transferred to food, drinks and children sucking on their fingers
  - 20% absorbed in adults
  - 70% absorbed in children and pregnant women

- **Breathing (Inhalation)**
  - Lead Particles in the Air
  - up to 100% absorbed
Understanding the Biology of Exposure: Factors Affecting Absorption

• Lead Absorption depends on:
  – Particulate size: smaller particles absorb more completely
  – Route of exposure: (respiratory, digestive)
  – Individual nutritional status, overall health & age

• In Children:
  – 50% of lead ingested after a meal is absorbed
  – 100% of lead is absorbed on an empty stomach
  – Close to 100% of inhaled lead is absorbed
Lead Distribution in Children’s Bodies

Blood not excreted is stored in three areas

1-5% • Blood

5-20% (Liver, Kidneys Brain, Heart) • Soft Tissue

70-90% (Bones, Teeth) • Mineralized Tissue
Lead Effects in Children’s Bodies

Dosage Matters

Amount of lead $\times$ Length of exposure

- Brain: Behavior problems, lower IQ, hearing loss, learning disabilities
- Body: Decreased bone and muscle growth
- Blood: Anemia
- Kidneys: Abnormal function and damage
- Nervous System: Damage
Mobilization of Lead from Bone to Blood

Conditions that promote the mobilization of lead from bone to blood include:
* Pregnancy
* Lactation
* Broken bones
* Stress
* Calcium deficiency
Factors Increasing the Lead Risk for Children

During pregnancy lead can cross the placental barrier
During breastfeeding lead can be transmitted to the baby

Eat more food, drink more water and breathe more air per unit of body weight

More likely to have nutritional deficiencies that lead to increased absorption of lead
Factors Increasing the Lead Risk for Children

Have an innate curiosity to explore their worlds and engage in developmentally appropriate hand-to-mouth behavior.

Spend more time in a single environment.

Rapid development creates more vulnerability to lead damage.
Treatment Recommendations

• Primary prevention
• At levels 5mcg/dl-9mcg/dl
  — Education and nutritional support
  — Identify and reduce sources of exposure
  — Retest
• At levels 10mcg/dl and above
  — Educational and nutritional support
  — Health Department home assessment/follow up
  — Chelation therapy at 45mcg/dl and above
  — Retest
Using Different Lead Metrics

• Key variables
  – Lead level used (e.g., 5 or 10 mcg/dl)
  – Time period covered
  – Population (denominator)

• Examples
  – Point-in-time
  – Longitudinal
  – Geographic
Annual Point-in-Time Metrics

Children under the age of 6 with EBLL≥5µg/dL: Cuyahoga County and the City of Cleveland, 2004-2016
Longitudinal Metric

Cumulative Percent of Children with an EBLL $\geq 5 \mu g/dL$ by Age 5 by Birth Cohort

% OF TESTED CHILDREN WITH EBLL$\geq 5MG/DL$ BY AGE 5

31.4% 27.7% 26.3% 23.6% 22.3% 20.2% 19.3% 17.7% 16.7% 16.7% 15.7% 14.1% 13.2% 12.2% 11.9% 10.7%
In 2016, Cuyahoga County accounted for 14% of Ohio's lead tested children, but 41% of all children with EBLLs ≥5 µg/dL.

The number of children in just the suburbs with EBLLs (n=303) exceeds the total number of children with EBLLs in all other counties in Ohio except Lucas and Hamilton.
CMSD kindergarteners

Neighborhoods with the highest proportions of kindergarteners who have a history of EBLL are Glenville (40.4%) St. Clair-Superior (36.2%), Buckeye-Woodhill (34.7%), Broadway-Slavic Village (34.6%) on the City’s east side and Stockyards (34.0%) on the west side.

Schools with the highest proportions of kindergarteners with an EBLL history are geographically concentrated. Of the 10 schools with the highest EBLL rates, 5 are in Glenville, 2 are in Broadway-Slavic Village, and one each in Goodrich-Kirtland Park, Hough, and St. Clair-Superior.

In 15 CMSD schools, one-third or more of the kindergarteners have a documented EBLL prior to entering school.

68% of CMSD’s kindergarteners are African-American – 28% have an EBLL history compared to 20% of White CMSD kindergarteners.
CMSD kindergarteners
Comparing results from two methods

- Lifetime metric always higher than point-in-time
- On average, in these schools lifetime EBLL is 6 times higher than the EBLL for 3-5 year olds
- Lower EBLL at age 3-5 reflects less ongoing exposure, but doesn’t reflect damage from earlier exposure

<table>
<thead>
<tr>
<th>CMSD School</th>
<th>3-5 year olds with EBLL, 2018-19</th>
<th>Kindergarteners with lifetime EBLL, 2014-2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>AJ Rickoff</td>
<td>6.0%</td>
<td>36.2%</td>
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<tr>
<td>Bolton</td>
<td>4.0%</td>
<td>33.8%</td>
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<tr>
<td>Buhrer</td>
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<td>11.7%</td>
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<td>Case</td>
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<td>Charles A. Mooney</td>
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<td>Daniel E. Morgan</td>
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<td>Franklin D. Roosevelt</td>
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<td>45.7%</td>
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<td>Fullerton</td>
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<td>45.2%</td>
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<tr>
<td>Harvey Rice</td>
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<td>Louis Agassiz</td>
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<td>22.4%</td>
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<tr>
<td>Marion Seltzer</td>
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<td>23.4%</td>
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<tr>
<td>Mound</td>
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<td>Paul Dunbar</td>
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<td>Scranton</td>
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<td>Michael R. White</td>
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<td>38.8%</td>
</tr>
<tr>
<td>Willow</td>
<td>7.0%</td>
<td>31.2%</td>
</tr>
</tbody>
</table>
Using Metrics

• Developing Intervention
  – Child-level
  – Cohort-level

• Fielding Prevention
  – Targeting housing remediation

• Understanding systems impacts
  – Children with EBLL history entering educational and other services
Work going forward

**Poverty Center** - three studies underway

1) **Landlord study** – examine ownership of rental properties in Cleveland and the lead risk of these properties to children

2) **Downstream outcomes** – to what extent do children with EBLLs have different outcomes in juvenile justice, high school graduation, and early earnings

3) **Cost-effectiveness study** – what strategies have been tried nationally to address lead and what do we know about their cost and outcomes

**School of Nursing**
Expanding testing of 3-5 year olds to X CMSD schools in 2019-20