It was July when 2-year-old Celeste Felder started crying and refusing to eat. At first, her parents thought she was jealous of her baby brother, who had been born June 5. When the crying didn’t let up, her parents called the family physician. He diagnosed intestinal grippe, prescribed penicillin, and told them not to worry.

But Celeste got worse. As the weeks went by, her crying turned to screams, and what little food her parents could get her to eat, she couldn’t hold down. The doctor insisted she would improve.

By Monday, August 20, her father, William, a 34-year-old subway clerk, was beside himself. He took her to see another doctor, who said that Celeste had a viral infection—nothing to worry about.

On Tuesday, Celeste “went out of her head” before lapsing into unconsciousness. William Felder rushed his daughter to Kings County Hospital, which wasn’t far from their home on Macon Street in Bedford-Stuyvesant. The doctor who saw her there said it was an upper respiratory infection. Felder pleaded that she was too sick for that, but the doctor gave him more medicine and told him to take Celeste home.

On Wednesday, Celeste began having convulsions—they shook her small body all day. In desperation, Felder called the police, who sent an ambulance that took Celeste to Bushwick Hospital. There, a doctor examined Celeste and said she had a bad case of tonsillitis. Take her home, let her rest, and give her medicine, she advised. “You don’t understand,” William Felder cried. “My baby’s dying.” But the doctor told him it “would be foolish and a waste of money” to admit Celeste for further observation. “Take her home,” the doctor repeated.

Back home on Macon Street, the convulsions and periods of unconsciousness continued. So Felder, unable to believe what he’d been told, took his daughter to yet another hospital, the third in as many days. At Brooklyn Eye and Ear, the doctor, who was the fifth to see Celeste since she had first gotten sick, agreed with Mr. Felder. Although the little girl did have inflamed tonsils, that didn’t explain how sick she was. This doctor had another idea: “It might be lead poisoning.”

Felder said that that was possible because his daughter had a habit of eating “anything she could get her hands on,” including dirt, plaster, putty, and paint. But Brooklyn Eye and Ear wasn’t equipped to treat lead poisoning, so Celeste was transferred to Cumberland Hospital, where doctors agreed with the diagnosis and began treatment to try to rid her body of lead.

But by then it was too late. Celeste Felder died at 4:15 AM on Thursday, August 23, 1951.

Toxic Truth: A Scientist, a Doctor and the Battle Over Lead
Lydia Denworth, 2009
Children’s Environmental Health

Lead basics

Mark E. Anderson MD FAAP
Director, Rocky Mountain Region PEHSU
Denver Health, Denver, Colorado
Associate Professor of Pediatrics and Epidemiology
University of Colorado Schools of Medicine and Public Health
October 2022
Acknowledgments

The Pediatric Environmental Health Specialty Units (PEHSUs) exist across all Federal regions in the United States and serve to protect the environmental health of children. The PEHSUs typically bring together pediatricians, occupational medicine providers, toxicologists, nurses, and other disciplines such as industrial hygienists to provide an evidence-based approach to children with environmental concerns. Poison Centers often partner with PEHSUs to provide call center services and toxicology expertise. The current PEHSU program is administered by the American Academy of Pediatrics (AAP). Funding for the program is based in the Agency for Toxic Substances and Disease Registry (ATSDR) within the Centers for Disease Control. Each PEHSU must be an academic center and have capacity to provide medical services as needed.

This presentation was supported by the American Academy of Pediatrics (AAP) and funded (in part) by a cooperative agreement with the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (CDC/ATSDR). The U.S. Environmental Protection Agency (EPA) supports the PEHSUs by providing partial funding to CDC/ATSDR through an Inter-Agency Agreement. The findings and conclusions in this presentation have not been formally disseminated by CDC/ATSDR or EPA and should not be construed to represent any agency determination or policy. Use of trade names that may be mentioned is for identification only and does not imply endorsement by the CDC/ATSDR or EPA.
Objectives

• State some of the effects of lead exposure on children, specifically the effects at lower levels of lead
• Link public health interventions of the last 50 years to average blood lead levels in children – lens of 3 champions
• State the lead screening recommendations
• Understand the basic epidemiology of lead exposure in our area and consider drinking water as a source of lead

• To begin: what does ‘micrograms per deciliter’ mean?
= 500 cc = 5 deciliters
= 2.8 grams = 2.8 µg x 1000

1/100\textsuperscript{th} of the sugar packet is 28 µg in 5 dL = 5.6 µg/dL

Younger child

Older child

Adult

6 to 10 months
Lead Effects – Why worry?

- Takes very little lead to poison
- Harm even at ‘low’ levels
- Effects on multiple systems
- Follows calcium – a ‘bank’ of lead for a lifetime of exposure
- Treatment is imperfect

<table>
<thead>
<tr>
<th>BLLs</th>
<th>Adults</th>
<th>Kids</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 µg/dL</td>
<td>?? (ACOG)</td>
<td>Impairment IQ</td>
</tr>
<tr>
<td>10 µg/dL</td>
<td>Hypertension may occur</td>
<td>Crosses placenta Impairment IQ, growth (dose dep. &gt; low BLLs) Partial inhibition of heme synthesis</td>
</tr>
<tr>
<td>20 µg/dL</td>
<td>Inhibition of heme synthesis</td>
<td>Beginning impairment of nerve conduction velocity</td>
</tr>
<tr>
<td></td>
<td>Increased erythrocyte protoporphyrin</td>
<td></td>
</tr>
<tr>
<td>30 µg/dL</td>
<td>Systolic hypertension</td>
<td>Impaired vitamin D metabolism</td>
</tr>
<tr>
<td></td>
<td>Impaired hearing(↓)</td>
<td></td>
</tr>
<tr>
<td>40 µg/dL</td>
<td>Infertility in males</td>
<td>Hemoglobin synthesis inhibition</td>
</tr>
<tr>
<td></td>
<td>Kidney &amp; Nerve effects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatigue, headache, abdominal pain</td>
<td></td>
</tr>
<tr>
<td>50 µg/dL</td>
<td>Anemia, GI sx, headache, tremor</td>
<td>Colicky abd pain, neuropathy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 µg/dL</td>
<td>Lethargy, seizures, encephalopathy</td>
<td>Encephalopathy, anemia, nephropathy, seizures...death</td>
</tr>
</tbody>
</table>
Champion # 1

Herb Needleman
1 in 5 > 63µg/dL
↓ 78% 1976 to 1991
FIGURE. Timeline of lead poisoning prevention policies and blood lead levels in children aged 1–5 years, by year — National Health and Nutrition Examination Survey, United States, 1971–2008
“Low” lead levels – Action Level was 10 µg/dL

- 4853 children aged 6 to 16 years between 1988 and 1994 in NHANES III
- Lead tests known on population
  - 2386 (36.5%) 2.5 µg/dL or greater
  - 810 (9.7%) 5 µg/dL or greater
  - 327 (3.8%) 7.5 µg/dL or greater
  - 172 (2.1%) 10 µg/dL or greater
- Multiple linear regression – controlled for gender, racial/ethnic background, iron status, serum cotinine level, region of U.S., marital status, educational level, poverty, others

- For every 1 µg/dL increase in blood lead:
  - 0.7-point decrement in mean arithmetic scores
  - 1-point decrement in mean reading scores
  - 0.1-point decrement in non-verbal reasoning
  - 0.5-point decrement in short-term memory scores

“Deficits in cognitive and academic skills associated with lead exposure occur at blood lead concentrations lower than 5 µg/dL”

Criticisms (teaser: Environmental Justice)

• Secondary data set (NHANES)
• Prospective
  – 172 children < 60 months
  – Each 10 µcg increase saw a 4.6 point IQ decrease (p=0.004)
  – For children increasing from 1 µcg to 10 µcg, average IQ decrease = 7.4 (p=0.003)

• Biologic threshold

https://www.youtube.com/watch?v=E6KoMAbz1Bw
Lead Testing Result – Denver Health

• 13,805 unique values (2016 to 2019)
• 340 or 2.5% at 5 µg/dL or greater
• 257 or 1.9% at 5 µg/dL up to 10 µg/dL “level of concern”
• 83 or 0.6% at or greater than 10 µg/dL “classic elevated”

• Argument to screen?
Changing Epidemiology

**THEN**

- Paint Deteriorated
- Repainting/Remodeling
- Soil
- Pica Soil
- Home remedy/cultural
- Occupational/Hobby
- Other
- Unknown

Number of cases

**NOW**

- Outside...
- Paint
- Unknown
- Other
- Occupa...
- Soil
- Pottery/...
- Keys
- Cultural...
- Herbal
- Toys

Percentages

ROCKY MOUNTAIN REGION

Pediatric Environmental Health Specialty Unit
Elevated Blood Lead Levels in Children Associated With the Flint Drinking Water Crisis: A Spatial Analysis of Risk and Public Health Response

Mona Hanna-Attisha, MD, MPH, Jenny LaChance, MS, Richard Casey Sadler, PhD, and Allison Champney Schnapp, MD
A Modern Champion

FIGURE 1—
Comparison of Elevated Blood Lead Level Percentage, Before (Pre) and After (Post) Water Source Change From Detroit-Supplied Lake Huron Water to the Flint River: Flint, MI, 2013 and 2015

Note. WLL = water lead level.

*P < .05.
<table>
<thead>
<tr>
<th>ZIP code</th>
<th>Est. # of Homes (&gt;1000/ZIP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80203</td>
<td>1,182</td>
</tr>
<tr>
<td>80204</td>
<td>4,114</td>
</tr>
<tr>
<td>80205</td>
<td>6,306</td>
</tr>
<tr>
<td>80206</td>
<td>3,832</td>
</tr>
<tr>
<td>80207</td>
<td>5,491</td>
</tr>
<tr>
<td>80209</td>
<td>5,263</td>
</tr>
<tr>
<td>80210</td>
<td>8,119</td>
</tr>
<tr>
<td>80211</td>
<td>7,636</td>
</tr>
<tr>
<td>80212</td>
<td>3,975</td>
</tr>
<tr>
<td>80216</td>
<td>2,039</td>
</tr>
<tr>
<td>80218</td>
<td>2,340</td>
</tr>
<tr>
<td>80219</td>
<td>7,207</td>
</tr>
<tr>
<td>80220</td>
<td>8,589</td>
</tr>
<tr>
<td>80221</td>
<td>1,733</td>
</tr>
<tr>
<td>80222</td>
<td>1,480</td>
</tr>
<tr>
<td>80223</td>
<td>2,928</td>
</tr>
</tbody>
</table>

Approx 72,000 homes; mostly in the Cty/Cty
Total Denver Water service lines is about 312,000
Considerations with water and schools

• Has the water been tested?
• What barriers exist to remediation?
  – Do schools become ‘responsible’ and at what cost?
  – What local resources exist?
• Most vulnerable population
• What do parents want for their children?