Educational Attainment

• Lead associated with cognitive effects in children
  – Decreased IQ
  – Poor school performance
    • Lower scores on end of grade exams (reading, math)
    • Failure to graduate from high school
  – Reading disability
  – Increased attentional dysfunction
  – Increased aggression
  – Increased delinquency
• Early deficits may persist.
• No threshold.
Reading Readiness

• About 25% of US children enter kindergarten not ready to learn to read

• Reading readiness predicts
  – success in school
  – later employment opportunities

• **Early** educational intervention is more effective
  – 80% if before 3rd grade
  – 10-15% if after 5th grade
## Effects of Blood Lead <5 µg/dL on Standardized Tests

**NHANES III, n=4,853, ages 6-16 years**

<table>
<thead>
<tr>
<th>Current Blood lead</th>
<th>Math Test Adjusted mean</th>
<th>Reading Test Adjusted mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1 µg/dL</td>
<td>95.8</td>
<td>94.5</td>
</tr>
<tr>
<td>1.1-1.9 µg/dL</td>
<td>94.0</td>
<td>93.3</td>
</tr>
<tr>
<td>2.0-3.0 µg/dL</td>
<td>94.7</td>
<td>93.0</td>
</tr>
<tr>
<td>&gt;3.0 µg/dL</td>
<td>91.4</td>
<td>88.2</td>
</tr>
</tbody>
</table>

\[ p<0.0001 \quad p<0.0001 \]

Lead and Reading Scores
~8,600 children

[Graph showing the relationship between blood lead levels and reading scores, with model 1 and model 3 indicated.]
Differences in Mean Fall PALS-K Scores between Refined GM BLL Category & Reference Category

<table>
<thead>
<tr>
<th>GM BLL Category</th>
<th>Difference in Adjusted Mean Fall PALS-K Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref.</td>
<td>-2.7  -3.3  -2.7  -5   -8.1  -8.2  -9.3  -7   -13</td>
</tr>
</tbody>
</table>
Overview – Part 2

• Who is affected
• What are the recommendations
• When are they effective
• How can we improve primary prevention
• Barriers and opportunities
• Next steps
Thank you!

- Patrick Parsons, New York State Dept. of Health
- Paula Montgomery, MDE
- Ezatollah Keyvan, MDE
- John Krupinsky, MDE
- Peter Simon, RI Department of Health
- Kate Scott, Baltimore City Health Department
- Jane Malone, National Center for Healthy Hsg.
- Members of Maryland Lead Commission
- Mary Jean Brown, CDC
MARYLAND DEPARTMENT OF THE ENVIRONMENT
Lead Poisoning Prevention Program

Number of Children 0-72 Months Tested for Lead and Percent Reported to Have Blood Lead Level ≥10 µg/dL: 1995-2010
Who is affected

- Public health, environmental health, housing and education agencies at all levels
  - Federal (including CDC, HUD, EPA, Education)
  - State
  - Local
- Primary care providers
- Families
- Advocacy organizations
What are the recommendations

1. Eliminates “level of concern”

2. Establishes a childhood BLL reference value based on 97.5\textsuperscript{th} percentile of the population BLL in US children ages 1-5 [now 5µg/dL] to:
   a. Identify children
   b. Identify environments with lead hazards

3. To develop and implement a national primary prevention strategy to ensure no US children live in or spend significant time in homes, buildings, other environments exposed to lead hazards
Recommendations, continued

4. **Clinicians** serve as a reliable source of information on lead hazards, taking primary role in educating families about prevention
   a. Environmental assessments prior to BLL screening

5. **Clinicians** notify family and monitor health status of children with confirmed BLL $\geq 5\mu g/dL$
   a. until environmental investigation/remediation complete

6. Where no mandatory reporting, **clinicians** to
   a. ensure reporting of all BLLs at or above reference value to local/state health and housing agencies
   b. collaborate with agencies to provide appropriate services and resources to children/families
Recommendations, continued

7. **Education** on **primary prevention** in homes and child-occupied facilities to eliminate hazards before children are exposed.
   
a. Targets families, providers, advocates, public officials

8. Develop **primary prevention infrastructure**:
   
a. Encourage data sharing between health and housing
b. Develop and enforce preventive lead-safe housing standards for rental and owner occupied properties
c. ID funding for lead hazard remediation
d. Provide families with information so they can protect their children from home environment hazards
Recommendations, continued

9. Work with elected officials, health, housing and code enforcement agencies to ensure adoption of a suite of primary prevention policies to protect children from lead exposure in their homes.

10. Adopt primary prevention strategies to reduce environmental exposures in soil, dust, paint and water before children are exposed

   a. Emphasize environmental assessment to ID and remediate lead hazards before children’s BLLs are at/above reference value
11. **Multi-family housing**: if lead hazards trigger actions in any unit, apply the same actions to all similar but untested units in the complex unless risk assessment shows no hazards are present.

12. Encourage **health outcomes research** focused on interventions that can maintain child BLLs below reference value.

13. **Research priorities**:
   - a. improve use of screening data,
   - b. develop point-of-care analyzers,
   - c. improve knowledge of epigenetic mechanisms of lead action
Recommendations - Summary

• Major shift to primary prevention
  – Federal
  – State
  – Local
  – Private providers
  – Families

• No level that can be thought to be “safe”

• Unacceptable to wait until children reach a specific BLL to “qualify” for lead-safe housing
When are they effective

• Advisory Committee for Childhood Lead Poisoning Prevention issued on January 4, 2012
• CDC reviewed, issued response on May 13, 2012
  – CDC concurs or concurs in principle on all points
  – CDC budget cuts eliminated funding for state/local CLPPPs, beginning FY2013 [$29 million to $2 million]
  – Despite national efforts to restore funding, many state/local CLPPPs face layoffs as of Sept. 30, 2012
  – States will implement based on state data, resources
Environmental Sources of Childhood Lead Exposure
The many faces of lead in housing
More recent sources of childhood lead exposure
Other sources of lead

• Lead in consumer products
  – Cosmetics – kohl, surma
  – Medicinals
  – Metal charms, jewelry
  – Toys
  – Candy

• Lead in cigarettes

• Occupational exposures of parents
  – Construction
  – Do-it-yourself home repairs
How can we improve primary prevention?
Health Care Providers

– Conduct environmental assessment in the office to ID children at risk
  • Begin before children begin to crawl
  • Use photos, drawings to identify risky environments
  • Document and share results with family
– Connect office assessment with solutions
  • Know state and local laws for housing standards:
    – who can follow through
    – how to best transmit information about risk

  Notice of Defect → Local LPPP

• Be aware of risks in privately owned housing
  – Renovation, remodeling, painting
  – Poor maintenance
  – Who can follow through, how to contact them
Health Care Providers - 3

• Connect office assessment with solutions
  • Know about potentially risky consumer products
    – Options for testing
    – Safe alternatives
  • Provide encouragement to address smoking
    – Motivational interviewing, referral for smoking cessation
    – Monitor outcomes
– Use blood lead tests
  • Initial at 1 and 2 years, following state and federal guidelines
  • Accurate laboratory, use of proper tubes to draw samples critical
  • Follow-up testing of confirmed levels of 5µg/dL and higher
Blood Lead Laboratories

- Official state laboratory capacity may be restricted to oversight
- Surveillance requires reporting laws and active program to ensure quality and follow-up
- Accuracy affected by:
  - Type of equipment used in analysis
  - Type of supplies used in blood draw
Analytical Methods for Blood Lead Testing

- Colorimetric & Flame AA
- ASV 3010
- Delves Cup Flame AAS (DC-AAS)
- Graphite Furnace Atomic Absorption Spectrometry (GFAAS)
- Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

Venous Blood (7 mL)
- 60 µg/dL
- 40 µg/dL

Capillary Blood (200 µL)
- 30 µg/dL
- 25 µg/dL
- 10 µg/dL
- 5 µg/dL

CDC blood lead level of concern (µg/dL)

- 70 µg/dL
- 60 µg/dL
- 50 µg/dL
- 40 µg/dL
- 30 µg/dL
- 25 µg/dL
- 10 µg/dL
- 0 µg/dL

Years:
- 1965
- 1970
- 1975
- 1980
- 1985
- 1990
- 1995
- 2000
- 2012
### Current Analytical Methods for Blood Lead Measurements

<table>
<thead>
<tr>
<th>Method</th>
<th>Detection Limit</th>
<th>Cost ($)</th>
<th>Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphite furnace (Electrothermal) Atomic Absorption Spectrometry (GFAAS/ETAAS)</td>
<td>≈ 1 µg/dL</td>
<td>30K - 50K</td>
<td>Automated</td>
</tr>
<tr>
<td>Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)</td>
<td>≈ 0.05 µg/dL</td>
<td>180K – 250K</td>
<td>automated</td>
</tr>
<tr>
<td>Anodic Stripping Voltammetry (ASV)</td>
<td>≈ 2-3 µg/dL</td>
<td>10K – 15K</td>
<td>Non-automated</td>
</tr>
<tr>
<td>Lead Care I (ASV-hand held)</td>
<td>≈ 2 µg/dL</td>
<td>2K – 3K</td>
<td>Non-automated</td>
</tr>
<tr>
<td>Lead Care II (ASV-hand held)</td>
<td>≈ 3 µg/dL</td>
<td>2K – 3K</td>
<td>Non-automated</td>
</tr>
</tbody>
</table>
### Maryland: Method of Blood Lead Measurement used by Reporting Laboratory, Calendar Year 2011*

<table>
<thead>
<tr>
<th>Method</th>
<th>Number of Labs</th>
<th>Number of Reports</th>
<th>Percent of Reports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphite furnace Atomic Absorption Spectrometry (GFAAS)</td>
<td>12</td>
<td>101,069</td>
<td>80.3</td>
</tr>
<tr>
<td>Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)</td>
<td>3</td>
<td>15,915</td>
<td>12.7</td>
</tr>
<tr>
<td>Anodic Stripping Voltammetry (ASV)</td>
<td>2</td>
<td>2,590</td>
<td>2.1</td>
</tr>
<tr>
<td>Lead Care I (ASV-hand held)</td>
<td>6</td>
<td>2,566</td>
<td>2.0</td>
</tr>
<tr>
<td>Lead Care II (ASV-hand held)</td>
<td>11</td>
<td>2,754</td>
<td>2.2</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
<td>983</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36</strong></td>
<td><strong>125,877</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

* Courtesy MDE. Preliminary numbers.
Relative problem of contamination and error in analysis of high and low blood lead concentration

<table>
<thead>
<tr>
<th>Error in Blood Lead Reporting</th>
<th>Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>0.5 µg/dL</td>
</tr>
<tr>
<td>Sampling/Collection</td>
<td>0.5 µg/dL</td>
</tr>
<tr>
<td>Storage/Transportation</td>
<td>0.5 µg/dL</td>
</tr>
<tr>
<td>Analysis</td>
<td>0.5 µg/dL</td>
</tr>
</tbody>
</table>

Blood lead level reported 26.5 µg/dL. ≈ (94%) blood lead, (6%) error

Blood lead level reported 4.5 µg/dL. ≈ (67%) blood lead, (33%) error.

Adapted from Flegal and Smith, 1992
Problem with specimen collection

Instruction on specimen collection

Lead, Blood (Pediatric), Synonyms: Pb, Blood

Test Number: 717009 CPT Code: 83655

Related Information:
- Lead and Protoporphyrin (FEP/ZPP), Blood (Pediatric)
- Lead, Blood (Adult)

Specimen: Whole blood

Volume: 0.5 mL (capillary) or 3 mL (venous)

Container: Royal blue-top (EDTA) tube or tan-top lead-free tube; submit original tube.

Collection: Mix blood thoroughly to avoid clotting.

Storage Instructions: Maintain specimen at room temperature.

Patient Preparation: Caution: Microtainer™ results may be artificially elevated due to skin surface contamination. Venipuncture is preferred. For capillary puncture, wash skin surface thoroughly to minimize contamination.

Causes for Rejection: Clotted specimen
Health care reform

• **Use existing programs** to assess for lead safety
  – Increased funding for **evidence-based home visiting programs** to parents and young children (A.C.A)
    • Outcomes of interest also impacted by exposure to lead – where housing old, must also address lead
    • Advantage – already in the home, able to ID at-risk conditions and connect with solutions
  – Medical homes and federally qualified health centers in high risk areas could:
    • Use home visitors to assess for lead safety in the home environment
    • Use care manager to coordinate assessment & follow-up
State and Local Health Departments

- Identify additional resources for public health
  - State and local budget cuts
  - CDC – FY 2011 = $29 million, FY 2012 = $2 million

- Monitor individual & population lead levels
  - Reporting system, surveillance, follow-up
  - Public Health Tracking - GIS
  - Distributions of BLLs within populations vary
    - Maryland 2010: BLL > 10µg/dL = 531 0.5%
    - BLL > 5µg/dL = 4037 3.6%
Prevalence of BLLs $\geq 5\mu g/dL$
Kindergarten Students
Providence, RI 2004-2006

- 20% - one in five - had at least one BLL $\geq 10\mu g/dL$.
- NHANES 1999-2004: 1.4% of 1-5 year olds had BLL $\geq 10\mu g/dL$.
- 67% had at least one BLL $\geq 5\mu g/dL$
State & Local Health Departments - 2

– Address problems at population level
  • Establish housing standard of care
  • Target at-risk housing for home visits or housing code enforcement (target source of problem – don’t wait for poisoned child)
  • Where majority of children are exposed, consider universal access to pre-school education
  • Focus on smoking cessation – increase resources if necessary
  • Target other sources identified in case-management of children with elevated BLLs
– Expand data linkage opportunities
  • Link BLL data with educational outcome data
  • Use electronic medical record to track screenings, health outcomes

– Assess analytic capacity for BLL laboratories
Other Federal Partners

• Dust and soil standards that confer protection
  – EPA and HUD

• Continued emphasis on prevention in renovation, repair, and painting activities

• Funding for lead hazard control

• Early education a part of the solution
  – Department of Education
Barriers and Opportunities

• Funding for public health activities
  – Program layoffs would severely impact capacity
• Current capacity of public health system

• Evidence and policy supports prevention priority
• Program has more than 20 years experience
• Health care reform includes new approaches
  – may increase assessment options in home
Next steps

- Funding
- Additional guidance from CDC
- State & local health department plans
- Focus on population approach
  - housing
  - other identified exposure sources
- Collaboration with provider community
  - Focus on primary prevention –
    - Individual families need information, solutions
    - Providers can empower families to act
  - Coordination will be key
Questions? Comments?

Thank you!