Educational Interventions for Children Affected by Lead

A Summary of Recommendations from CDC’s 2015 Expert Panel

Pat McLaine, DrPH, MPH, RN

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Childhood Lead Exposure: a critical public health issue

• Tens of millions of US children adversely affected by lead in last 20 years – lifelong effects
• Lead exposures continue: from deteriorated paint, dust, soil, water, air and other sources
• Once child’s cognition harmed, effects can be permanent and continue to adulthood
• Effects are costly: more than $50 billion/year in reduced cognitive potential and lost productivity
Other considerations

• Clear evidence of the impact of BLL in early childhood on later academic performance
• Excellent evidence for providing optimal educational environment for young children
• Poor understanding of how community lead exposure affect community educational outcomes
• No clarity on extent to which Federal requirements for education could be used to ensure access to educational services for lead exposed children
Many Unanswered Questions

• Does education make a difference?
  – Some evidence for neurological impairments similar to lead
  – No studies of intervention with children previously exposed to lead
  – Early intervention – clear cost benefit
Charge of the Workgroup

• Compile existing evidence of neurodevelopmental and cognitive impact of lead
• Summarize Individuals with Disabilities Education Act (IDEA) – Parts B and C
• Identify how provisions of IDEA relate to children affected by lead
• Describe specific action steps to ensure that children affected by lead receive timely and appropriate educational interventions
Expert Panel

- Sher Lynn Gardner, MD, FAAP
- Mary Jean Brown, ScD, RN
- Cassandra Archie
- Helen J. Binns, MD, MPH
- Vivian Cross, PhD (deceased)
- Kim N. Dietrich, PhD, MA
- Sue Gunderson
- Valarie Johnson
- Linda Kite
- Jane Malone
- Pat McLaine, DrPH, MPH, RN
- Reghan O. Walsh
- Dana Williams
- Pongsuda Rattanamasmongkol, EdS, RN
Wide range of expertise

- Worked with Childhood Lead Poisoning Prevention Programs (CLPPPs)
- Parent and child advocates
- Academics and researchers
- Health care providers
- Educators
- Lead poisoning prevention and policy advocates
- Special education consultants
- Lead in housing experts
- Geographic representation
Lead and Cognitive Effects

• Lead associated cognitive effects in children
  – Decreased IQ
  – Decreases in visual-spatial skills, cognitive flexibility, working memory
  – 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.
Association Between IQ Scores & Blood Lead Levels in Children

- Fulton et al. (1987)
- WHO/CEC (Winneke et al., 1990)
- Lansdown et al. (1986), manual occupation
- Lansdown et al. (1986), non-manual occupation
- Yule et al. (1981)
- Schroeder et al. (1985)
- Hawk et al. (1986)
Low Level Exposure and Cognitive Function

WISC-R Full Scale I.Q. Scores

Adjusted Score

Blood lead (µg/dL) at 24 months

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

*p<0.0001*  

Blood lead and IQ in children – International pooled analysis

- Estimated IQ decrements estimated with increases in blood lead from:
  - 2.4 to 10 μg/dL: 3.9
  - 10 to 20 μg/dL: 1.9
  - 20 to 30 μg/dL: 1.1

→ Steepest declines were at blood lead levels <10 μg/dL
Focus on Reading

• 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
Studies of Lead and Educational Outcomes
Based on ability to link individual measures of blood lead exposure in early childhood with individual measures of reading, math, reading readiness at a later time.
Data Sources

- School Enrollment
- Health Dept. Blood Lead
- Education Measure

Linked Dataset
Lead and Reading Scores

~8,600 children

Miranda et al. EHP 2007;115(8):1242-1247
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</td>
</tr>
<tr>
<td>1</td>
<td>-3.3</td>
</tr>
<tr>
<td>2</td>
<td>-2.7</td>
</tr>
<tr>
<td>3</td>
<td>-5</td>
</tr>
<tr>
<td>4</td>
<td>-8.1</td>
</tr>
<tr>
<td>5</td>
<td>-8.2</td>
</tr>
<tr>
<td>6</td>
<td>-9.3</td>
</tr>
<tr>
<td>7</td>
<td>-7</td>
</tr>
<tr>
<td>8</td>
<td>-13</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10+</td>
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</tbody>
</table>
### Achieving Benchmark Standards
**Reading Readiness – Kindergarten**

<table>
<thead>
<tr>
<th>GM BLLGroup</th>
<th>Prevalence Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children with BLL 0-4μg/dL</td>
<td>1.00 Reference</td>
</tr>
<tr>
<td>Children with BLL 5-9μg/dL</td>
<td>1.21 (1.19, 1.23)</td>
</tr>
<tr>
<td>Children with BLL 10+μg/dL</td>
<td>1.56 (1.51, 1.60)</td>
</tr>
</tbody>
</table>

\( p \) trend = \(<0.001\)

Model adjusted for: lead, age at start of kindergarten, year, sex, race, child language, free/reduced lunch status
<table>
<thead>
<tr>
<th>Blood Lead Levels</th>
<th>Educational Impact</th>
<th>Size of Study</th>
<th>Location of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 3 μg/dL</td>
<td>Decreased end of grade test scores</td>
<td>More than 57,000 children</td>
<td>North Carolina (Miranda et al. 2009)1</td>
</tr>
<tr>
<td>4 μg/dL at 3 yrs old</td>
<td>Increased likelihood learning disabled classification in elementary school Poorer performance on tests</td>
<td>More than 57,000 children</td>
<td>North Carolina (Miranda et al. 2009)1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35,000 children</td>
<td>Connecticut (Miranda et al. 2011)</td>
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## Lead and Educational Outcomes – 5-9μg/dL

<table>
<thead>
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<th>Educational Impact</th>
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<th>Location of Study</th>
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</thead>
</table>
| 5 μg/dL          | 30% more likely to fail third grade reading and math tests  
                   More likely to be non-proficient in math, science, and reading | More than 48,000 children | Chicago (Evens et al. unpublished data) |
| 5-9 μg/dL        | Scored 4.5 points lower on reading readiness tests | 3,406 children | Rhode Island (McLaine et al. 2013) |
## Lead and Educational Outcomes – 10-19μg/dL

<table>
<thead>
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<th>Educational Impact</th>
<th>Size of Study</th>
<th>Location of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥10 μg/dL</td>
<td>Scored 10.1 points lower on reading readiness tests</td>
<td>3,406 children</td>
<td>Rhode Island (McLaine et al. 2013)</td>
</tr>
<tr>
<td>10 and 19 μg/dL</td>
<td>Significantly lower academic performance test scores in 4th grade</td>
<td>More than 3,000 children</td>
<td>Milwaukee (Amato et al. 2012)</td>
</tr>
</tbody>
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# Lead and Educational Outcomes – 25+μg/dL

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<th>Educational Impact</th>
<th>Size of Study</th>
<th>Location of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 25 μg/dL</td>
<td>$0.5 million in excess annual special education and juvenile justice costs</td>
<td>279 children</td>
<td>Mahoning County, Ohio (Stefanak et al. 2005)</td>
</tr>
</tbody>
</table>

Identifying Developmental Delays

• Young child may not have “delay” – but effects may present later
• Long term surveillance of behavior and neurodevelopment is needed
  – Annual by PCP
• Changes may be identified during critical transition points
  – 1st, 4th, 6th grades
Child Educational Development - 1

- Preschool – listening, attention, social and emotional skills
- Early Elementary (K-3) – learning to read, learning basic math skills
- Upper Elementary (4-5) – reading to learn, increased social networks and physical challenges (balance)
Child Educational Development - 2

• Middle School (grades 6-8) – more formal academic structure, requiring higher order cognitive and organizational skills, executive functioning and impulse control, more academic problems, dropping out

• High School (grades 9-12) – more rigorous and disciplined environment, requiring good study and organizational skills; poor grades, poor reading skills, increasing failure to graduate
## Enriched/Nurturing Environment

### Animal Studies
- Stimulation and exercise improve behavior and learning
  - Toys
  - Exercise wheels
  - Other rats

- Improvements associated with changes in:
  - Brain size, weight, structures
  - Changes in neuro-circuitry
  - Increases in synaptic plasticity

- Continuous exposure to enriched environment necessary to maintain gains

### Human Studies
- Stimulation, higher SES and increased environmental control improve academic performance.
  - Books and materials
  - Parent involvement
  - Nurturing relationships

- Stress associated with decreased brain size, structures

- School intervention for poor readers associated with changes in brain neuro-circuitry

- Reading interventions must continue during vacation to maintain progress
Knowledge Gaps

• Contribution of early education
  – Clearly makes a difference for at-risk children ($3-7 savings for every dollar spent)
  – Significant improvements documented for children with autism and developmental disorders

• If/how specific educational programs make a difference
  – No studies
  – For reading disability, individual approach appears to work best

• If supporting parents and improving their parenting skills would improve outcomes
  – No studies - might help
Urban School Districts: Challenges Underestimated

• The extent of lead exposure risks for urban children is not well understood.
• Urban children from higher income families may attend private/parochial/charter schools
• Population of children remaining in public schools often at higher risk for poor educational outcomes:
  – Lower income
    • Poor housing
  – Higher proportion of children with lead exposure history
Prevalence of BLLs $\geq 10\mu g/dL$ among Providence kindergarten students

- Much higher than national estimates

- 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 $\geq 10\mu g/dL$.

How many children affected by lead now attend Rochester Public Schools?

• Once in school, the burden of early lead exposures may be invisible
• Lead exposure may account for significant proportion of children with poor academic progress
• If you don’t know about a child’s lead exposure, you may not be able to provide appropriate educational services.
Individuals with Disabilities Education Act

IDEA

- Provides federal funds and oversight for
  - early intervention
  - special education and
  - related services

- Part B - Child Find – identifies children 0-21
  - Programs must coordinate with MCH, EPSDT, Head Start, Early Head Start, and SSI Programs
  - Resources include parent centers and community parent resource centers

- Part C Early Intervention Program – children 0-3
IDEA – Part C – Early Intervention for Infants and Toddlers with Disabilities

• Child is less than 3 years of age
• Child needs early intervention services:
  – Is experiencing developmental delays in one or more areas (cognitive, physical, communication, social/emotional, or adaptive development) or
  – Has diagnosed condition of established risk that has high probability of resulting in developmental delay
• States have discretion to provide services to children who are at-risk for substantial delays if they do not receive early intervention services
• States can extend services until elementary school
• Child less than 3 with lead exposure may not yet have delay
Part C Eligibility (2012) for children with lead exposure

- Eight states mention lead exposure as eligible condition for services or tracking (exposure or exposure plus poor educational performance)
- 12 more states specify BLL thresholds as criteria (>10µg/dL to >45µg/dL)
- 13 more states including New York mention non-specific “toxic” exposures
- No specific definition for lead poisoning in Federal statute or regulation
Eligibility for IDEA Part B

• Child has identified disability and needs special education and related services
• Child age 3-9 years experiencing developmental delays and needs special education and related services

• Developmental Delays:
  – Physical development
  – Cognitive development
  – Communication development
  – Social or emotional development
  – Adaptive development
Definitions of Disability – IDEA Part B

- Autism
- Deaf-blindness
- Deafness
- Emotional disturbance
- Hearing impairment
- Mental retardation
- Multiple disabilities
- Orthopedic impairment
- Other health impairment

“Other health impairment” is due to chronic or acute health problems including lead poisoning and adversely affects a child’s educational performance.
Part B – Special Education for children 3-21 years of age

• Child identified
• Child evaluated
• Eligibility for special education is decided
• If child is determined to be eligible for services
  – Individualized education program (IEP) team including parents meet, prepare IEP
  – Services provided
  – Progress measured and reported through report card or as requested by parents
• IEP reviewed annually
• Child reevaluated at least every 3 years
Are children affected by lead eligible?

- YES, if child
  - Has one or more of 13 listed IDEA disabilities including “other health impairment”
  - Needs special education
  - At age 3-9 is experiencing developmental delay as defined by state

- NOTE: the condition must adversely affect the child’s educational performance
IDEA: Part B

• Section 619 Preschool - children 3-5 with same conditions as Part B
• Coordinated Early Intervening Service (CEIS) - Non-special education services for K-12 children
• Two intervention models:
  – Response to Intervention for children who are struggling academically
  – Positive Behavioral Support for children with problem behaviors
  – Could be used to develop monitoring plan to address needs of lead affected students with reading, math, behavioral problems but not ID with disability
Rehabilitation Act of 1973, Section 504: Federal Civil Rights Protections

• Services for children with disabilities who are not eligible for IDEA
• Requires schools meet specialized needs of children with disabilities and provide access to same resources provided to children without disabilities
• Targets individuals with physical or mental impairment that substantially limits a major life activity: walking, seeing, hearing, thinking, reading, learning, concentrating
• Child does not need to qualify for special education
Decision Chart
Guidance from Connecticut: pre-school

• Incorporates Child Find, immediate interventions with PCP, housing, school nurse, school team

• Actions dependent on existence of risk factors (yes or no) and noted or suspected developmental delays

• Child with BLL 5µg/dL or above and no risk factors receives monitoring plan with annual review and referral to enrichment program
Guidance from Connecticut: K-12

- Uses Child Find, multiple referral sources
- Immediate interventions include PCP, housing assistance, school nurse, school team
- Intervention based on length of exposure, risk factors, existence of developmental delay or disability
- Minimal intervention includes monitoring plan, follow in Scientific Research-Based Intervention Framework (especially for attention, executive function, language, behavior), annual review, after-school enrichment program
Educational Follow-up

• Local education agencies can ensure that children affected by lead are identified, assessed and receive educational support.

• If lead exposure is not identified or tracked, problems at school may not receive appropriate response

• Some children are more affected at a given BLL and will require different interventions

• Keys to intervention:
  – Connecting children to early intervention services and early enrichment
  – Identifying delays at critical transition points
  – Intervene as early as possible
CDC Recommendations for Local Education Agencies

• Develop policies and procedures identifying services for children who may be affected by lead
• Request parents or PCPs provide results of all BLL tests and developmental assessments, keep confidential
• Ensure teachers know about children’s lead exposure and monitor progress regularly
• Use Child Find for ID and early referrals
• Develop monitoring plan within Scientific Research-Based Intervention (SRBI) framework for students 3-21 affected by lead
• Educate school personnel about adverse affects of lead exposure on academic performance & behavior
CDC Recommendations for Local Education Agencies – cont.

• Refer students to Section 504 team for determination

• Collaborate with parent centers, parents, community partners

• Obtain census tract BLL data to identify populations at high risk for HBLLs – prioritize for referrals and resources

• Communicate with MCOs and PCPs about needs of children affected by lead
Overall Conclusions

• Lead exposure contributes to many disparities observed in educational settings.
• Eliminating exposures to lead hazards remains key.
• There is no “safe” level of lead.
• Data linkage approaches would benefit public schools and public health.
• Advocacy for resources and approaches that work is critical.
• Ensuring that all children with elevated BLLS receive the educational services they need will set the stage for a better future for individual children and the communities where they live.
Questions?