Prevention Paradox

Why a Little Lead is Too Much

Bruce Lanphear, MD, MPH
Child & Family Research Institute,
BC Children’s Hospital
Faculty of Health Sciences
Simon Fraser University
Blood Lead Concentrations Considered to Be Elevated by the Centers for Disease Control and Prevention.

To convert the values for blood lead concentrations to micromoles per liter, multiply by 0.0483. Data are from the Centers for Disease Control and Prevention, 1991.¹
Percent of Preschool Children Exceeding Selected Blood Lead Levels, NHANES II - III

Blood Lead Levels \( \geq 10 \, \mu g/dL \) among Children in Rochester, 1995
Low-level Lead Exposure and Cognitive Deficits

Adapted from Lanphear BP, et al. Public Health Reports 2000;115:521-529
Verb Generation Task by Lifetime Mean Blood Lead Concentration (n=42)

Low Lifetime Mean Blood Lead (7.6 μg/dL)

High Lifetime Mean Blood Lead (26 μg/dL)

Lead Toxicity at Blood Lead Levels <10 µg/dl

An Epidemic of Politics

Editorial

An Epidemic of Politics

Versions have come to accept the role of politics in the appointment of certain kinds of public officials. For an issue so pronounced, though, some may be disappointed when a federal judge—perhaps because the case did not turn on a single principle—denied preliminary injunctive relief. The administration has acted in a way that would require the reinstatement of the science advisory committee on Science Technology, which involves reviewing and analyzing the data from the study of workplace injuries.

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News Focus

Overhaul of CDC Panel Revives Lead Safety Debate

The National Institute of Occupational Safety and Health Advisory Committee on Occupational Health and Safety, which is also involved in the CDC’s Advisory Committee on Lead Poisoning and Prevention, is now in the process of reviewing the science advisory committee’s role. The advisory committee has been criticized for its role in the decision to remove the study of workplace injuries.

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Research Supporting Adverse Cognitive Effects at Blood Lead Levels < 10 µg/dL

Mean Adjusted Full-Scale IQ Scores by Quartiles for Tibial Bone Lead and Mean Lifetime Blood Lead Levels

Mean Adjusted Full-Scale IQ Scores by Quartiles for Tibial Bone Lead and Average Lifetime Blood Lead Levels – Combined Analysis

Body Burdens of Lead in Ancient Peoples, Typical American and Overt Lead Poisoning

Figure 1-1  Body burdens of lead in ancient people uncontaminated by industrial lead (left); typical Americans (middle); people with overt clinical lead poisoning (right). Each dot represents 40µg of lead. Source: Patterson et al., 1991; adapted from NRC, 1980.
Blood Lead Concentrations Considered Harmful by the CDC

In 2012, the CDC eliminated the term, "blood lead level of concern" and declared there is no safe level of lead in children's blood.
The Prevention Paradox

The majority of disease and disability occurs in people who are at low to moderate risk.
The Prevention Paradox

Estimated Loss of IQ in US Children at Different Intervals of Blood Lead

- Current Reference Value = 5 µg/dl
  - .5 Million
    - 5.7 Million
    - 6.1
    - 3.1 Million
  - 2.10 µg/dl
    - 6.4 Million
    - 1.6
    - 9.3 Million
  - 1.43 µg/dl
    - 12.7 Million
    - 0.9
    - 5.7 Million
    - 0.3
    - 4.7 Million

No. of Children in Distribution \times IQ Loss Average = Estimated IQ Points Lost

Adapted from Bellinger D. EHP 2011;120:501-507.
High-Risk or Low-Risk Strategy?
Low-level Toxicity

**Figure 1.** Log-linear regression line for reading scores by serum cotinine levels. Dashed lines indicate 95% confidence interval.

**Figure 2.** Log-linear model for cotinine (solid line) versus linear models for cotinine among children with cotinine above and below 1 ng/mL (dashed lines; ~80th percentile).

Mean adjusted birth weight by third-trimester urinary cotinine concentration (n = 2,481)
Daily Mortality in London for Winters (1958-1972) by Particulate Air Pollution (British Smoke)

Risks of Ischemic Heart Disease, CVD and Cardiopulmonary Disease Mortality by Cigarette Smoke

Exposure Response Relationship for Benzene and Leukemia: A Meta-analysis

No Acceptable Levels?
Low-Level Lead Toxicity and Psychopathology
Gray Matter Loss by Childhood Lead Exposure

Adjusted for child’s age, birth weight, sex, gestational age, IQ, prenatal tobacco, prenatal alcohol, prenatal marijuana, total intracranial volume, SES and HOME Inventory did not alter results (Cecil K, PLoS Medicine, et al. 2008).
Key Imaging Findings in ADHD

• Brain areas with reduced size in ADHD
  – Frontal cortex
    • Prefrontal
      – Cingulate cortex
  – Basal ganglia - striatum
    • Caudate, putamen
  – Cerebellum

Giedd et al., 2001; Seidman et al., 2005
Reduction in Gray Matter by Childhood Blood Lead Levels and Subject’s Sex

Men (n=83)

Women (n=74)

Adjusted for child’s age, birth weight, Sex, gestational age, IQ, prenatal tobacco, prenatal alcohol, prenatal marijuana, total intracranial volume, SES and HOME Inventory did not alter results (Cecil K, Brubaker C, Dietrich KN, et al. PLoS Medicine 2008).
Tooth Lead Levels and Criminality

No. of Arrests by Childhood Lead Exposure

The Cincinnati Lead Study

Risk of Conduct Disorder by Blood Lead Concentration in US Children, 8 to 15 years, NHANES 2001-2004

Lead Exposure and Murder Rate (/100,000) in the United States

Nevin R. Environmental Research 2000:83;1-22
Cost-Benefit of Reducing Childhood Lead Exposure
$1 = $17 to 220

Lead: IQ Alert

Lead-free environments enable successful learning.

21.9% of African-American children in older housing are poisoned by lead compared with 2.2% of all American children.

Lead in children's blood
Mean blood lead level in urban children by WHO sub-region
2002 or latest available data
micrograms per deciliter (μg/dL)

- over 15.0
- 10.1 - 15.0
- 5.1 - 10.0
- 5.0 and under
- no data

Blood and lead
Percentage of children with blood lead levels above 10 micrograms per deciliter (μg/dL) 2002 or latest available data by WHO sub-region

- The Americas
- Europe
- Eastern Mediterranean
- Africa
- South-East Asia
- Western Pacific

Blood lead levels above 10 μg/dL are a serious cause for concern.

$977 Billion

Implications for Prevention

• Eliminate all non-essential uses of lead worldwide and develop regulations to control lead emissions

• Establish empirically-derived health-based standards for lead in air, house dust, soil and water

• Screen housing units for lead hazards before purchase or occupancy, after renovation and abatement

• Lower “level of concern” to < 1 µg/dL and set new goals to achieve population levels with adequate margin of safety

• Lower “action” level to 5 µg/dL and begin environmental interventions at lower blood lead level
"All scientific work is incomplete – whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time."

Austin Bradford Hill