Prevention of Childhood Lead Poisoning: Why Physicians Should Counsel on Lead and Screen for Lead Exposure

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Overview

- Lead poisoning is the most common and preventable environmental disease among California children\(^1\)
- No known safe levels \(^2,3\)
- Prevention is the best approach, so children are not exposed
- Screening provides opportunity for early diagnosis, identification of exposure(s), and follow-up

\(^1\) MMWR May 27, 2005 / 54(20);513-516
\(^2\) Koller et al. EHP, Jun 2004
\(^3\) Bellinger, Current Opinions in Pediatrics, 2008, 20:172-177
Metabolism of Lead

- Main absorption in children is gastrointestinal
- Absorption is similar to iron and calcium
- 65 - 70% total body lead is stored in bone in children\textsuperscript{1,2}
  - Half-life in blood is about 1 month
  - Half-life in bone is 10-30 years

\textsuperscript{1}Barry, PS, Br J Ind Med. 1975 May; 32(2): 119–139.
\textsuperscript{2}Leggett, RW, Environ Health Perspectives 1993; 101: 598-616
Most Children Don’t Present with Clinical Symptoms

- Earliest clinical symptoms may include:
  - Anemia
  - Anorexia
  - Abdominal pain
  - Constipation
- Consider Abdominal x-ray if BLL over 20mcg/dL and particulate lead exposure is suspected

Case reports:
1 Clinical Pediatrics Jan 2008: *Toxic remedy*
2 Clinical Pediatrics Jan 2007: *Constipation*
Known Effects of Lead Poisoning

- Hematopoetic System: Anemia
  - Interferes with Heme Synthesis
- Neurologic System: Neurotoxin
  - Learning Disorders, IQ
  - Attention Deficit Hyperactivity Disorder (ADHD)
- Cardiovascular and Renal Systems
  - Hypertension
  - Atherosclerosis
  - Renal disease or impaired renal function
- Endocrine System
  - Delayed Puberty

Bellinger, Current Opinions in Pediatrics, 2008, 20:172-177
Effects of Lead on the Hematopoietic System

- Iron insufficiency associated with increased lead absorption
- Iron deficiency anemia often associated with elevated blood lead level\(^1\)
- Lead interferes with hemoglobin synthesis by interfering with several enzymatic steps in the heme pathway
- Also decreases RBC survival
- Lab findings
  - ↑ free erythrocyte protoporphyrin
  - ↑ basophilic stippling on smear

\(^1\) Wright, et al, J Pediatr, 2003; 142: 9-14
Lead Effects on CNS

- Substitutes for calcium in the brain and in neurotransmitter and receptor development
- Neurologic toxin – affects early development of blood-brain barrier
- Reduced development of neurons in first 2 years of life with reduced pruning associated with brain maturation
- No evidence that chelation will reverse cognitive impairment

¹Sanders, T, et al, Rev Env Health; 2009;24(1):15-45
Toxicity - Rare Clinical Symptoms

- Blood lead over 70 mcg/dL
  - Changes in mentation (encephalopathy)
  - Confusion
  - Ataxia
  - Seizures
  - Coma
  - Death
Why is BLL Under 10 mcg/dL of Concern?

- Even levels below 10 mcg/dL are inversely associated with lower IQ scores\(^1\)
- There is an increased rate of loss of IQ at levels less than 10 mcg/dL\(^2\)
- There are no known safe levels\(^3\)

\(^{1}\) Canfield et al. NEJM 2003; 348(16):1517-26
\(^{2}\) Meta-analysis by Lanphear et al. Environ Health Perspect 2005
\(^{3}\) Confirmed by meta-analysis by Koller et al. EHP, Jun 2004
Examples of Other Disorders Associated with Lead Exposure

- Developmental Disorders
  - Fetal Growth, IUGR\textsuperscript{1}
  - Reproductive Disorders
  - Delayed Sexual Maturation
- Learning Issues
  - Associated with ADHD\textsuperscript{2}
- Cardiovascular Disorders
  - Link to childhood\textsuperscript{3} and adult hypertension\textsuperscript{4}
- Behavioral Disorders
  - Violence and Aggressive Behavior\textsuperscript{5,6}
  - Juvenile delinquency\textsuperscript{7,8}
  - Elevated school drop-out rate\textsuperscript{9}
  - Direct effect on behavior\textsuperscript{10}
  - Potential link to criminal behavior\textsuperscript{11}
Sources of Lead Exposure
The Most Common Sources of Lead are Environmental

- Deteriorated *lead-based paint*
  - Cracking, flaking, peeling
- Leaded gasoline
- Lead-contaminated dust
- Lead-contaminated soil
Top Ten States with Pre-1950 Housing¹

Pre-1955: White paint was commonly 50% lead

1955: Optional industrial voluntary reduction to 1% lead in consumer paint

¹ Based on 2010 Census Data
Top Ten States with Pre-1980 Housing\(^1\)

Federal maximum of 0.06% (equivalent to 600 ppm) effective 1978

\(^1\) Based on 2010 Census Data
Percent of homes built before 1980 in California by County (2000 Census data)
- Pica
- Chipping paint
- Dust
Change in Blood Lead Levels in Relation to Decline in Use of Leaded Gasoline 1976-1980

1Annest JL, 1983
Lead in Soil Remains
Lead in Tap Water

- EPA regulatory level is 15 ppb
- Pre-1986 housing more likely to have lead in pipes, fittings, solder, fixtures and faucets
- In 2010, California further lowered allowable lead content in plumbing fixtures
- Families should consult with an environmental professional about testing if they have concerns
  [http://water.epa.gov/drink/info/lead/index.cfm](http://water.epa.gov/drink/info/lead/index.cfm)
Sources of Lead Poisoning

Deteriorated Lead Based Paint
Imported Candies
Imported Toys
Contaminated Dust
Traditional Remedies & Cosmetics
Take Home Exposure
Bare Soil
Imported Jewelry
Imported Pottery
Occupational Sources Brought Home

- Construction/abatement/remodeling
- Smelting/soldering/painting
- Storage battery production
- Firing ranges
- Recycling Centers
Economic Impacts

- Reducing blood lead has been and continues to be a huge benefit to society
- Estimated savings to society for the decrease of lead from 17.1 mcg/dL to 2 mcg/dL based on productivity
- For the year 2000, US birth cohort of 3.8 million individuals
- Approximates $100-300 billion\textsuperscript{1}

\textsuperscript{1}Grosse et al, Environmental Health Perspectives, June 2002, 110:563-569
Who is at Risk for Lead Exposure?
Children at Risk

- Children living in older housing (pre 1050 > pre 1978)
- Toddlers 1-2 years old
  - Hand-mouth behavior, pica
- Children in publicly funded programs/Low income children
  - Medicaid/Medi-Cal (and Healthy Families)
  - CHDP
  - WIC
  - Head Start
- Children from countries with higher environmental lead exposures
Lead Poisoning is Measured By Blood Lead Level (BLL)

- Fingerstick capillary BLL is utilized in most clinics
  - Properly collected capillary samples have a 10% false-positive rate.
  - Once an elevated lead level (≥ 10 mcg/dL) is detected, a venous lead level is assessed for confirmation.
- BLL is a single measurement that reflects both short and long-term sources
  - Exposure from past and current exogenous sources
  - Release of endogenous lead from bone
  - Pregnant and lactating women have high bone turnover during pregnancy and breastfeeding.
Blood Lead Level

- CDC’s previous “level of concern” was equal to or greater than 10 mcg/dL\(^1\)
- In 2012, CDC eliminated the term “level of concern”, since even low levels associated with permanent deficits
- CDC recommends that providers monitor and provide follow-up for children with levels > 2 S.D. above the mean for the population as defined in the most recent National Health and Nutrition Examination Survey (NHANES), which is now 5 mcg/dL
- Guidance to be reevaluated every 4 years\(^2\)
- Most children have BLL below 2 mcg/dL\(^3\)

\(^1\) MMWR May 27, 2005 / 54(20);513-516
\(^3\) Bellinger, Current Opinions in Pediatrics, 2008, 20:172-177
California Lead Poisoning Prevention Program 2010 Statistics

- Total children tested for BLL * 727,042
  (Ages less than 21 years)
- Total BLL > 4.5 mcg/dL\(^1\) (5mcg/dL) & < 9.5 mcg/dL 21,457
- Total BLL > 9.5 mcg/dL\(^1\) (10 mcg/dL) 2,297

*Blood Lead Level = BLL

\(^1\)In California blood lead levels are rounded to the nearest whole number, with numbers with decimals equal to and above 0.5 rounded up and numbers with decimals below 0.5 rounded down

Graph showing the number of children tested and the percentage confirmed with elevated blood lead levels (EBLLS) from 1999 to 2011.
Average Proportion of Children Screened for Lead (Age < 6 yrs) with Elevated Blood Levels > 9.5 mcg/dL Among Selected Jurisdictions, 2010
Proportion of Children Screened for Lead (Age less than 6) with blood lead levels $> 4.5$ and $< 9.5$ mcg/dL, Among Selected Jurisdictions, 2010
Environmental justice states that no group of people should bear an uneven burden of harmful environmental exposures/consequences.

Progress has been made in reducing children’s BLL’s in the U.S. However, average blood-lead levels remain unequally high in the U.S. among non-Hispanic Black children (NHANES).

CA state Lead Program does not collect information on race/ethnicity.

Many low-income and minority groups live in poorly built or substandard homes.

Removing disparities in access to healthy, safe, and affordable homes is essential to improving the quality of life for minority and low-income populations.

What Providers Need to Do: California’s Regulatory Requirements for Children
Anticipatory Guidance

- At each periodic health assessment from six months to 72 months
- Inform parents of risk of lead exposure to young children
- Reduce soil exposure and dust levels
  - Especially deteriorating/disturbed lead-based paint and lead contaminated dust
  - After child begins crawling
  - Young children and hand-mouth behavior
- May be living in older housing with leaded pipes or fixtures
PREVENTION is the Goal

- Anticipatory Guidance (6 mos – 6 yrs)
  - Inquire about lead hazards
  - Provide simple written prevention information
- General prevention
  - Frequent hand washing
  - Wash toys and pacifiers, reduce soil exposure and dust levels
  - Good nutrition especially iron, calcium and vitamin C
- Infant stimulation
- Prevent neurodevelopmental compromise, especially if lead exposure is noted
  - Enroll in Head Start/Early Childhood Education
  - Early developmental evaluation and follow-up
Statewide Targeted Assessment Policy

- At 12 months and at 24 months of age
- Blood test (screen) all children who receive services from publicly funded programs
  - Medi-Cal (and Healthy Families)
  - CHDP
  - WIC
  - Head Start
- “Catch up” testing between 2 & 6 years of age
Current Statewide Targeted BLL Assessment Policy

- Children not in publicly funded programs whose family answers “yes” or “don’t know” to the following question:
  
  “Does your child live or spend a lot of time in a place built before 1978 that has chipped or peeling paint or has been recently remodeled?”

- Change in circumstances has put child at risk of lead exposure
Other Indications for Obtaining BLL

- If parent requests
- If refugee or recent immigrant
- If known lead exposure in family members or close contacts

http://www.cdph.ca.gov/programs/CLPPB/Documents/CLPPB-care%20guideline_sources%20of%20lead.pdf
Federal Refugee Guidelines

- Blood Lead Testing of all refugee children 6 months to 16 years old at entry to the US
- Repeat Blood Lead Testing of all refugee children ages 6 months to 6 years—from 3 to 6 months after children are placed in permanent residences and older children, if warranted, regardless of initial test results.
- Evaluation of the child’s iron status including a hemoglobin/hematocrit and red blood cell indices

www.cdc.gov/immigrantrefugeehealth/guidelines/lead-guidelines.html
Services Provided by County Childhood Lead Poisoning Prevention Programs
Definition of Lead Poisoning

“State Case”

- Any child with a blood lead level $\geq 20 \text{ mcg/dL} (19.5 \text{ mcg/dL})$
- Any child with two blood lead levels $\geq 15 \text{ mcg/dL} (14.5 \text{ mcg/dL})$ drawn at least 30 days apart
  - If the initial test was a capillary test, the second test must be venous
- Children with these levels are designated as “State Cases” and receive case management services
County Childhood Lead Poisoning Prevention Program (CLPPP)

- Automatic referral and services when child is a State Case –
  - PHN Case management services and home visits
  - Home environmental investigation to identify lead sources

- Children with lower BLLs (4.5-19.4) may be eligible for services from the local CLPPP as Local Cases

- Services are not related to funding source
  - Only to the blood lead level & age less than 21 years
  - As resources allow, some services for BLL <14.5 mcg/dL
Case Management Services Provided Through the Local Health Jurisdiction

- Most local health departments contract with the State
  - Public health nursing services
  - Risk/exposure queries and tailored education
  - Further environmental interventions to identify and correct lead sources
  - Identify other affected children/family members
- Orange County’s CLPPP is a jointly staffed program of OCHCA Family Health and Environmental Health Divisions
Case Management Services (Continued)

- Surveillance and follow-up
  - Includes follow-up of child over time to ensure that lead levels decrease
  - Nurses may remind provider to check follow-up blood lead levels (venous) and make appropriate referrals
  - Continued education as needs are identified
- PHN Referral to WIC, Head Start, CCS, Special Education
  - If no local Childhood Lead Poisoning Prevention PHN, MD must make the CCS referral if situation warrants
Management of Elevated BLL

- Refer to the California Management Guidelines on Childhood Lead Poisoning (Guidelines) for retesting, timelines and referrals: http://www.cdph.ca.gov/programs/CLPPB/Documents/HAGS_201107.pdf

- Very high BLL (> 44 mcg/dL) requires rapid retesting and referral

- For retests, test with a venous sample (not utilizing an office-based test device)
Current Standards of Care for Children 1,2

- Refer to Head Start/Early Childhood Education
- Consider periodic developmental testing if BLL is ≥5 mcg/dL (4.5 mcg/dL)
- Request assistance of CLPPP when BLL is ≥10 mcg/dL (9.5 mcg/dL) or have questions at any level
- Refer family members for blood lead test when appropriate
- Inquire if family members who are pregnant have been tested for lead

1 California Recommendations: [http://www.cdph.ca.gov/programs/CLPPB/Pages/provideroutreach-clppb.aspx](http://www.cdph.ca.gov/programs/CLPPB/Pages/provideroutreach-clppb.aspx)
2 AAP Current Management: [http://pediatrics.aappublications.org/content/116/4/1036.full.html](http://pediatrics.aappublications.org/content/116/4/1036.full.html)
When is Chelation Necessary?

- Very rare
  - Not usually indicated for BLL < 45 mcg/dL
- Initial high blood lead level should always be confirmed with a venous sample
  - Urgent attention
  - Contact local CLPPP to evaluate the child’s environment
- Always consult with provider experienced in managing chelation
State and County Resources

- Orange County CLPPP
  - http://ochealthinfo.com/phs/about/family/lppp
  - http://ochealthinfo.com/eh/more/lead
- California Lead Poisoning Prevention Branch
  - http://www.cdph.ca.gov/programs/CLPPB/Pages/default.aspx
- County Childhood Lead Poisoning Prevention Program
  - http://www.cdph.ca.gov/programs/CLPPB/Pages/CLPPPIndex.aspx
- Lead Related Construction Program
  - http://www.cdeph.ca.gov/programs/CLPPB/Pages/LRCNav.aspx
- Occupational Lead Poisoning Prevention Program
  - www.cdph.ca.gov/programs/olppp
Other State Resources

- Medi-Cal - [http://www.dhcs.ca.gov/services/medi-cal/Pages/default.aspx](http://www.dhcs.ca.gov/services/medi-cal/Pages/default.aspx)
- Head Start - [www.caheadstart.org](http://www.caheadstart.org)
- Healthy Families - [http://www.healthyfamilies.ca.gov/Home/default.aspx](http://www.healthyfamilies.ca.gov/Home/default.aspx)
- CHDP – Child Health and Disability Prevention Program [http://www.dhcs.ca.gov/services/chdp/Pages/default.aspx](http://www.dhcs.ca.gov/services/chdp/Pages/default.aspx)
- WIC - [http://www.cdpd.ca.gov/programs/wicworks](http://www.cdpd.ca.gov/programs/wicworks)
Federal Resources

- CDC - [www.cdc.gov/nceh/lead/](http://www.cdc.gov/nceh/lead/)
- Recalls - [www.cdc.gov/nceh/lead/recalls/](http://www.cdc.gov/nceh/lead/recalls/)
- EPA - [www.epa.gov/lead/](http://www.epa.gov/lead/)
Food and Drug Resources

- California Food and Drug Branch – Lead in Candy
  http://www.cdph.ca.gov/programs/Pages/FDB%20Lead%20In%20Candy%20Program.aspx

- US Food and Drug Administration -
  http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/ChemicalContaminantsMetalsNaturalToxinsPesticides/ucm077904.htm
References for Articles: Other Disorders Associated with Lead Exposure

5. Gould E. Environ Health Perspective 2009; 117(7): 1162-7
Childhood Lead Poisoning Prevention: The Environmental Investigation

Jeffrey Lane, REHS
Environmental Health Specialist
Childhood Lead Poisoning Prevention
Environmental Health
County of Orange
Runs better unleaded

For more information on preventing lead poisoning call 1-800-424-LEAD or visit www.epa.gov/lead.
Lead

- Bluish-white metal, Galena
- Soft, malleable, resistant to corrosion
- Use dates back 8500 years.
Lead Uses

- Glazes, glasses, ornaments, water pipes
- Cosmetics, food preservative, sweetener
- Paints, gasoline, batteries, solder, bullets
- Electronics, fishing weights
- Stained glass, traditional medicines
- Shielding for x-rays
Environmental Investigation
Environmental Investigation

- Find the source of the lead exposure
- Prevent the child from further exposure
Environmental Investigation

- Registered Environmental Health Specialist or a Certified Industrial Hygienist
- Paint, Dust, Soil, Water
- Other possible sources
- X-ray fluorescence lead analyzer
- Lab analysis
- Lead hazards, advise family
- Owner notification, enforcement
Lead Hazards

- Deteriorated Lead-Based Paint
- Lead-contaminated dust
- Lead-contaminated soil
- Lead in drinking water, > 15 ppb
XRF Diagram
Positive Results

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Reading Number
NAV MENU
Nominal Seconds for this Reading Result
Depth Index
Lead detected in L-shell
Lead detected in K-shell
Lead detected in mg/cm² total

Rd # 66 K+L Mode

NAV TOOLS

Time 29.1
Positive

Depth Index: 8.1

Ele mg/cm² ±/

PbL: 0.30 0.08

PbK: 1.6 0.1

Pb: 1.6 0.3
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Negative Results
Visual Assessment
Information

- Interview the family
- Child’s access
- Sleep area
- Play habits
- Pica? Does child eat paint or soil? Chew paint?
- Parents occupation
- Time spent at other locations
Site Map
Testing Paint

- Accessible deteriorated surfaces
- Impact and friction surfaces
- Focus on window sills, door casing, doors
- Non-destructive sampling
Testing surface coating using XRF
Pre-1978 Housing
History of Lead Levels in Residential Paint

- Pre-1955: White paint was commonly 50% lead
- 1955: Optional industrial voluntary reduction to 1%
- 1971: Federal mandatory maximum allowable level in new paint set at 1%
- 1977: Federal maximum of 0.06% (equivalent to 600 ppm) \textbf{Effective 1978}
- 2009: Federal maximum is 0.009% (90 ppm) effective August 2009
Deteriorated Lead-Based Paint on 1920’s Apartment Building Window
Lead-Based Paint Abatement

- Minimize and control dust and debris when repairing deteriorated paint
- Do not dry sand/scrape paint
- Do not burn paint
- Use plastic tarps
- Clean up paint debris everyday
- Minimize access to the work areas
Window Sill Dust Wipe
Floor Dust Wipe Sampling
Dust Wipe Sampling Tools
Mobile Laboratory
Leaded Dust Abatement

- Regularly remove dust by cleaning
- Adjust doors and windows to reduce friction
- Don’t bring home lead dust on work clothes
- Clean shoes before coming into home
- Minimize and control lead dust during house renovations
Leaded Soil
Leaded Soil

- High concentrations at perimeter of older homes and along highways
- Deteriorating paint
- Leaded gasoline exhaust
- Sometimes in backyard of older homes
- Parts washing with leaded gas
Soil Sampling Tools
Soil Sampling
Soil Testing
Leaded Soil Abatement

- Cover with concrete, landscaping, gravel.
- Install fencing to block access
- Remove and replace with lead free soil
Water Sampling
Lead in Tap Water

- EPA regulatory level is 15 ppb
- Pre-1986 housing more likely to have lead in pipes, fittings, solder, fixtures and faucets
- In 2010, California further lowered allowable lead content in plumbing fixtures
- Families should consult with an environmental professional about testing if they have concerns
Pottery
Pottery

- Lead oxides added to glaze
- Smoother finish when fired at lower temperatures
- Home/Backyard kilns
- Traditional Use
Lead Check Swabs
Lead Check Swabs
Ceramic Candy Jars
Ceramic Drinking Cups
Oaxacan Pottery
Ceramic Water Crocks
Home Remedies & Cultural sources

Greta

Azarcon

Surma, Kohl, Khali

Sindoor
Traditional Medicines - Azarcon
Energy Spectra
Eye makeup - Surma
Lead in Candy

- Lead has been found in candy, wrappers, sticks, and jars
- Legal limit < 0.10 ppm lead
Chapulines
Children’s Jewelry
All Contain Lead!
Questions?

Medical: CLPPP (714) 567-6220

Environmental Lead: Environmental Health (714) 433-6000