

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



David Núñez, MD, MPH
Family Health Medical Director
Orange County Health Care Agency
Public Health Services

Adapted from a presentation by Jean Woo, MD MPH MBA, Medical
Consultant, Childhood Lead Poisoning Prevention Branch
California Department of Public Health

Overview

- Lead poisoning is the most common and preventable environmental disease among California children¹
- 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^{1,2}
 - Half-life in blood is about 1 month
 - Half-life in bone is 10-30 years

Lead lines →

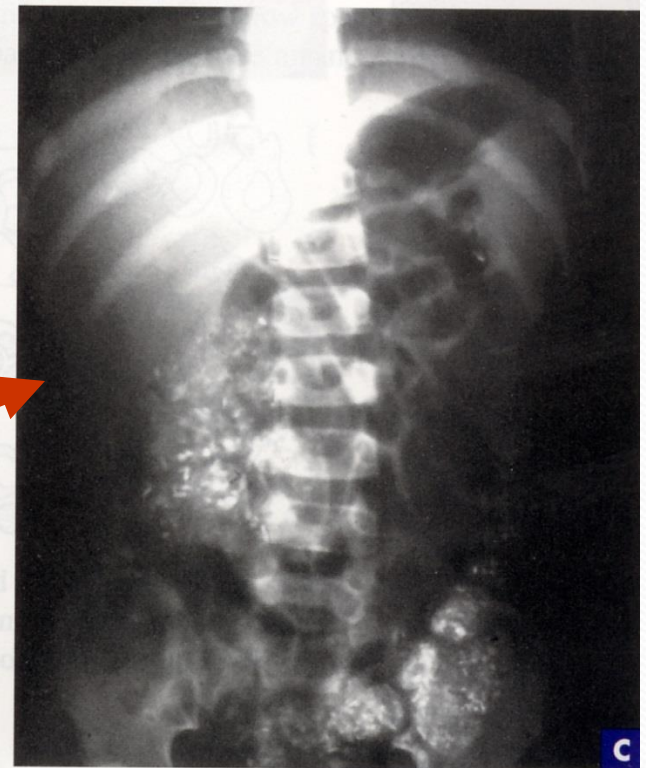


¹Barry, PS, Br J Ind Med. 1975 May; 32(2): 119-139.

²Leggett, RW, Environ Health Perspectives 1993; 101: 598-616

Most Children Don't Present with Clinical Symptoms

- Earliest clinical symptoms may include:
 - Anemia
 - Anorexia
 - Abdominal pain¹
 - Constipation²
 - Consider Abdominal x-ray if BLL over 20mcg/dL and particulate lead exposure is suspected



Case reports:

¹ Clinical Pediatrics Jan 2008: *Toxic remedy*

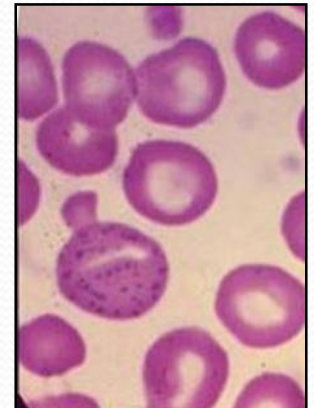
² Clinical Pediatrics Jan 2007: *Constipation*

Known Effects of Lead Poisoning

- Hematopoietic 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

Effects of Lead on the Hematopoietic System

- Iron insufficiency associated with increased lead absorption
- Iron deficiency anemia often associated with elevated blood lead level¹
- 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

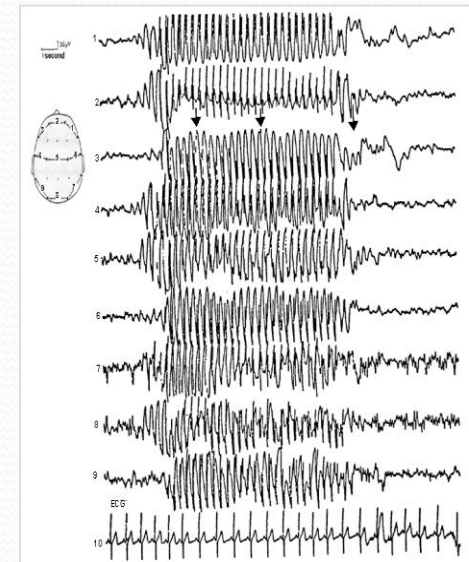
Lead Effects on CNS

- Substitutes for calcium in the brain and in neurotransmitter and receptor development
- Neurologic toxin – affects early development of blood-brain barrier¹
- 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

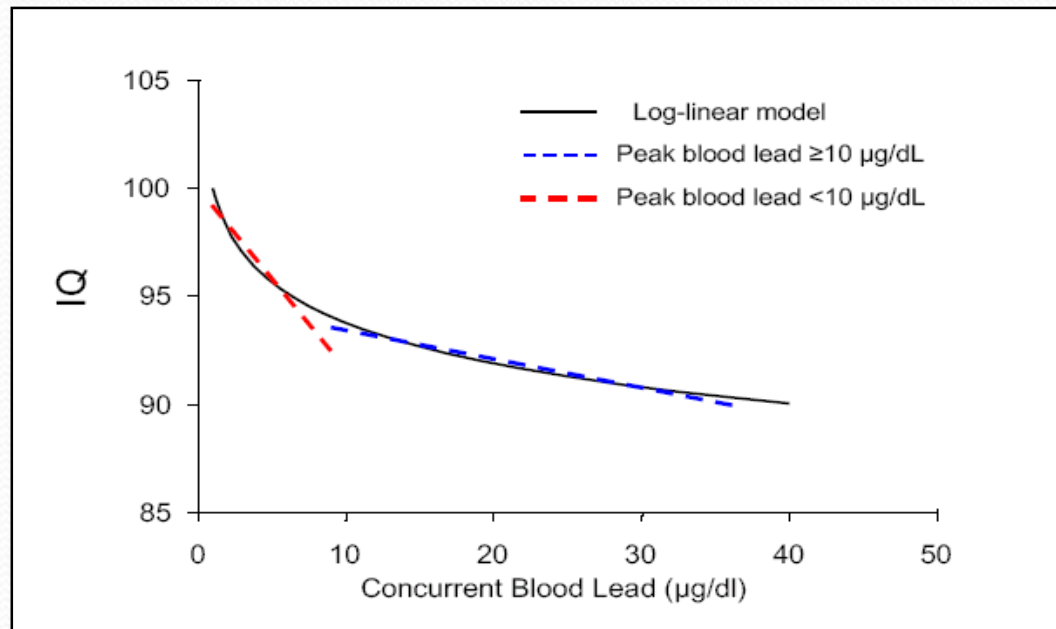
Toxicity - Rare Clinical Symptoms

- 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 scores¹
- There is an increased rate of loss of IQ at levels less than 10 mcg/dL²
- There are no known safe levels³



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, IUGR¹
 - Reproductive Disorders
 - Delayed Sexual Maturation
- Learning Issues
 - Associated with ADHD²
- Cardiovascular Disorders
 - Link to childhood³ and adult hypertension⁴
- Behavioral Disorders
 - Violence and Aggressive Behavior^{5,6}
 - Juvenile delinquency^{7,8}
 - Elevated school drop-out rate⁹
 - Direct effect on behavior¹⁰
 - Potential link to criminal behavior¹¹

Sources of Lead Exposure



The Most Common Sources of Lead are Environmental

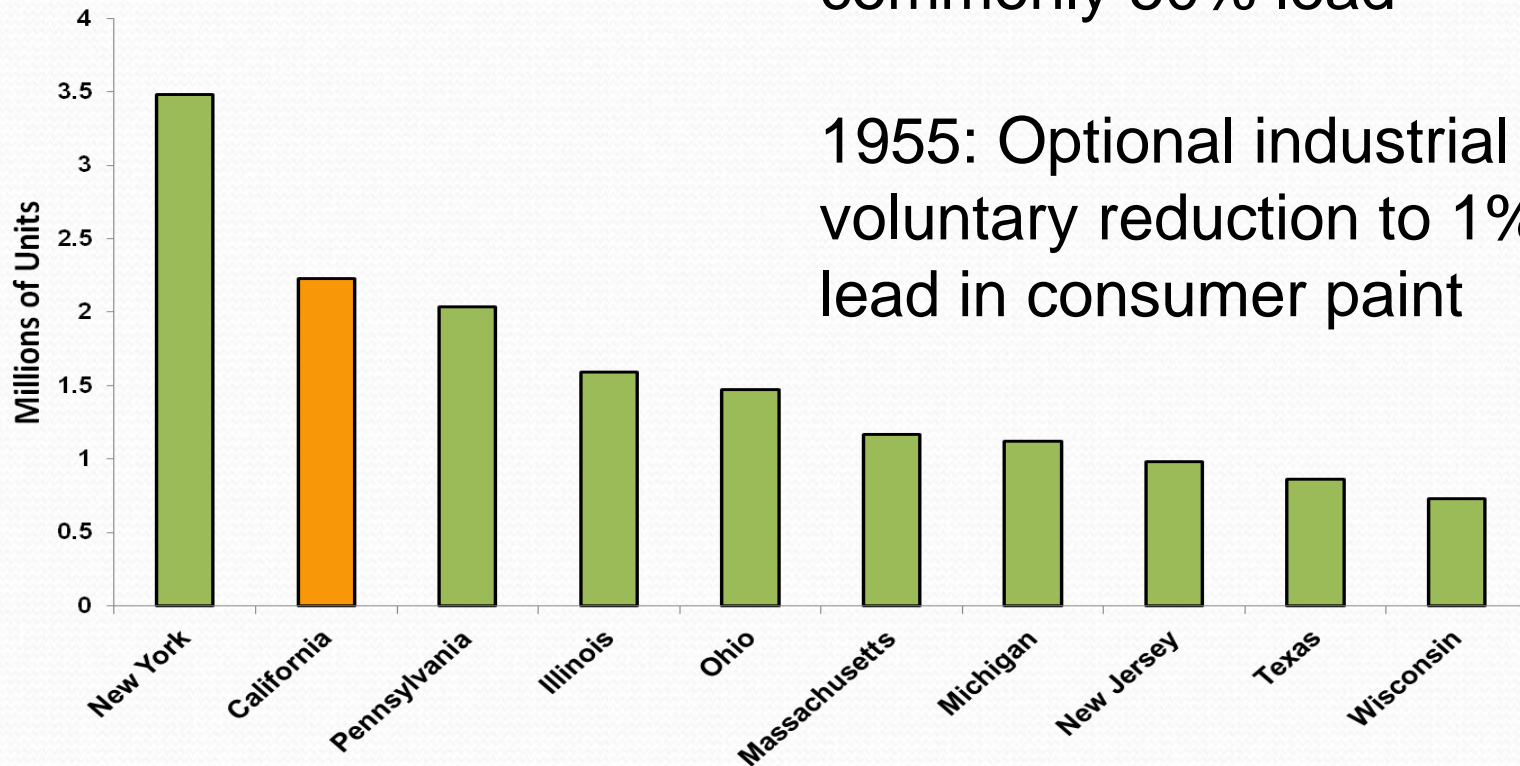
- Deteriorated **lead-based paint**
 - Cracking, flaking, peeling
- **Leaded gasoline**
- Lead-contaminated dust
- Lead-contaminated soil



Top Ten States with Pre-1950 Housing¹

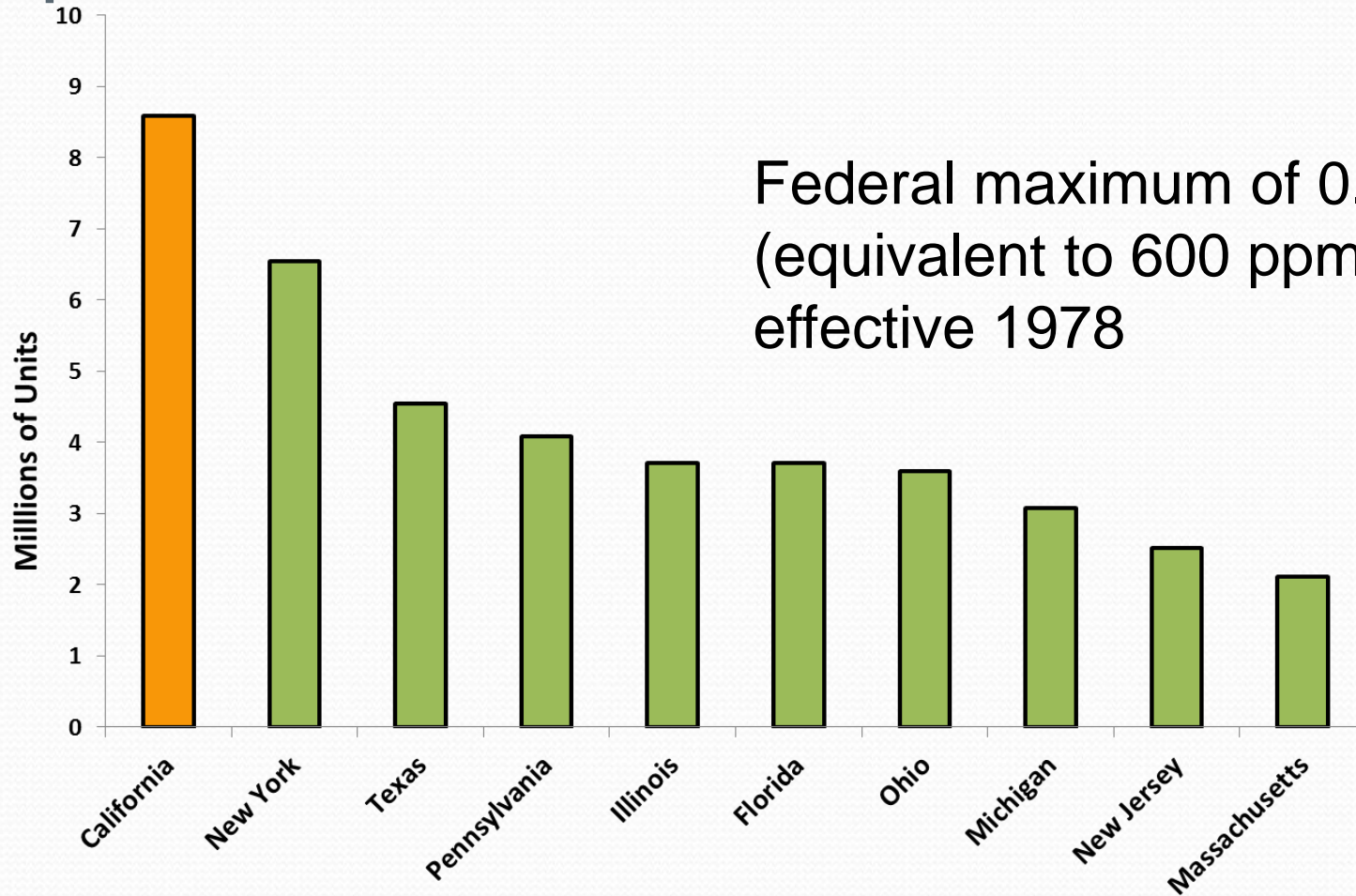
Pre-1955: White paint was commonly 50% lead

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



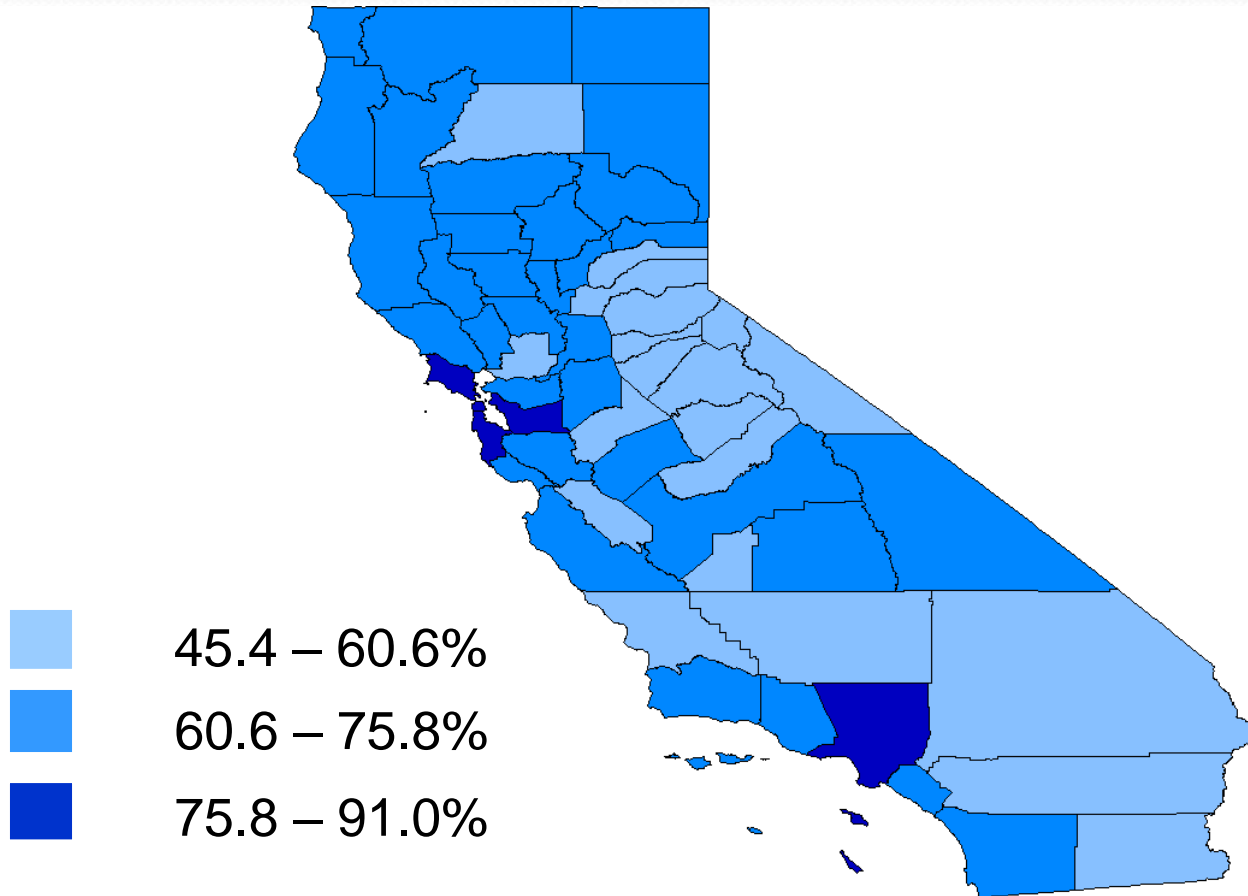
¹ Based on 2010 Census Data

Top Ten States with Pre-1980 Housing¹



¹ Based on 2010 Census Data

Percent of homes built before 1980 in California by County (2000 Census data)

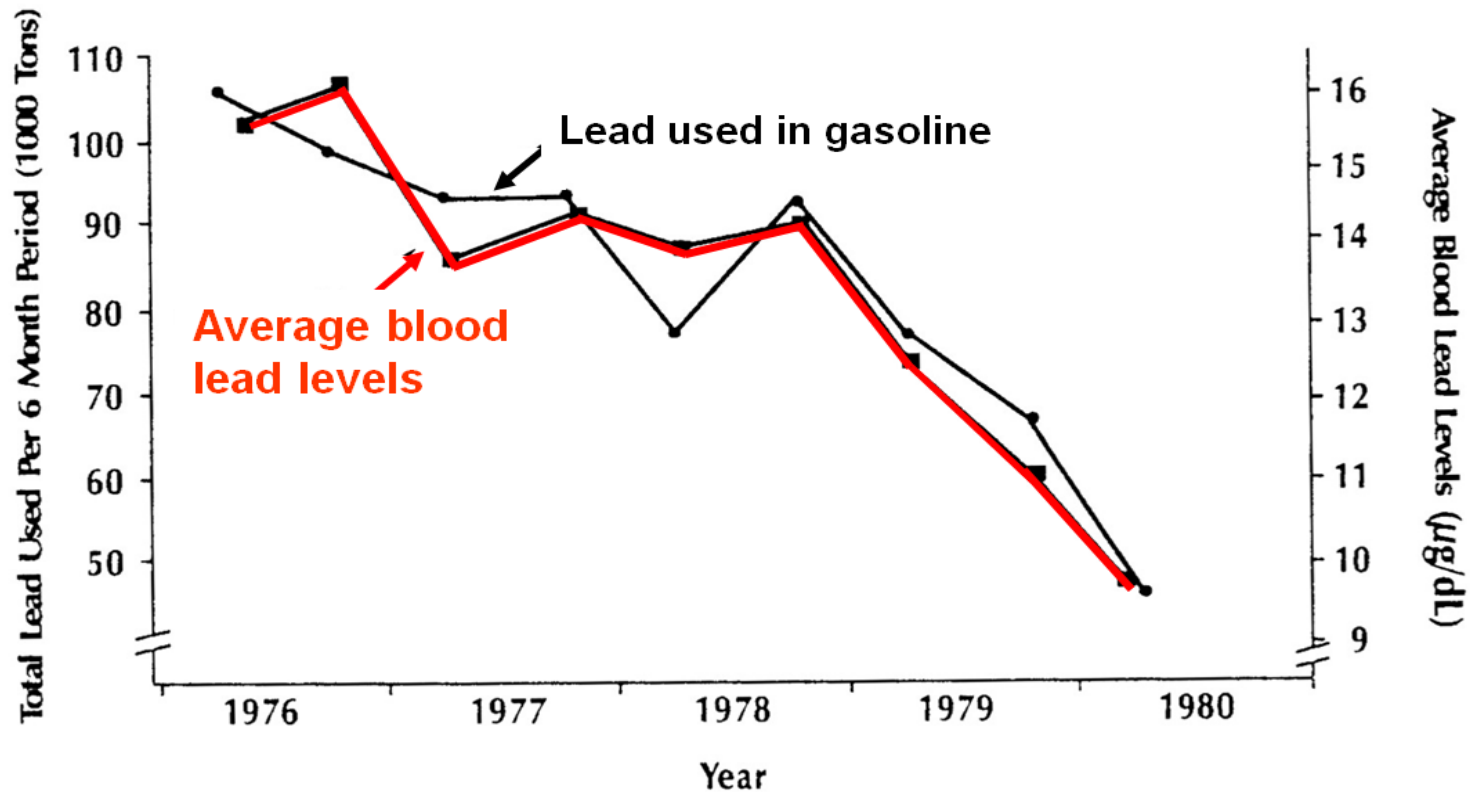




- Pica
- Chipping paint
- Dust



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

- 1991 – Safe Drinking Water Act prohibited lead pipe for residential use (EPA 1991)
- 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>

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

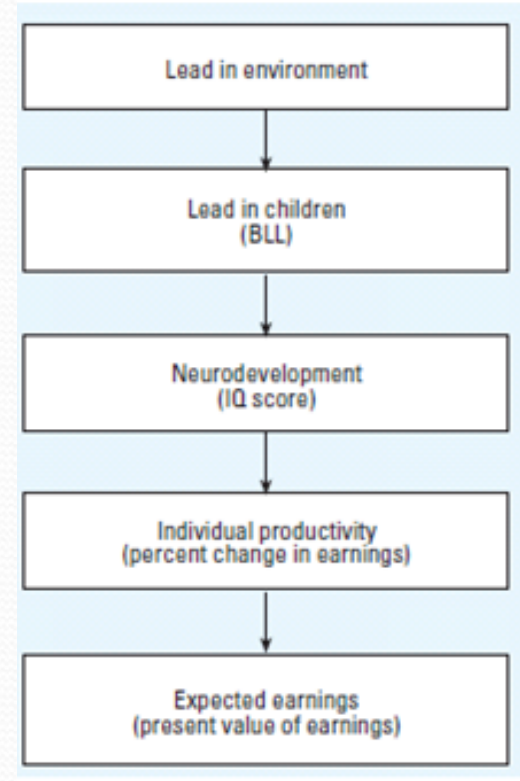
Occupational Sources Brought Home

- 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 billion¹



¹Grosse 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 1950 > 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)

- Fingertick 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/dL¹
- 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 years²
- Most children have BLL below 2 mcg/dL³

¹ MMWR May 27, 2005 / 54(20);513-516

² http://www.cdc.gov/nceh/lead/ACCLPP/CDC_Response_Lead_Exposure_Recs.pdf

³ Bellinger, Current Opinions in Pediatrics, 2008, 20:172-177

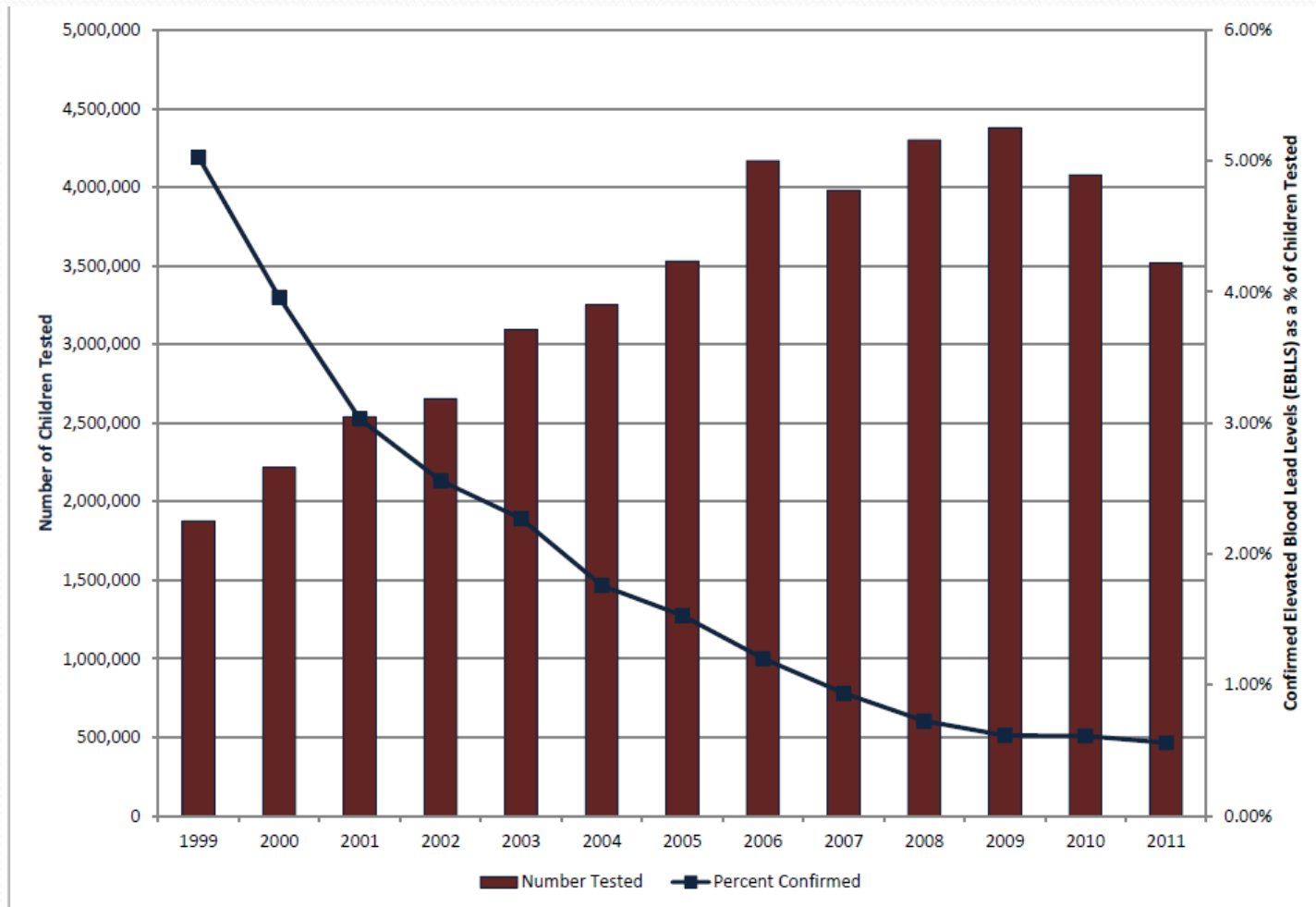
California Lead Poisoning Prevention Program 2010 Statistics

- Total children tested for BLL * 727,042
(Ages less than 21 years)
- Total BLL > 4.5 mcg/dL¹ (5mcg/dL) &
< 9.5 mcg/dL 21,457
- Total BLL > 9.5 mcg/dL¹ (10 mcg/dL) 2,297

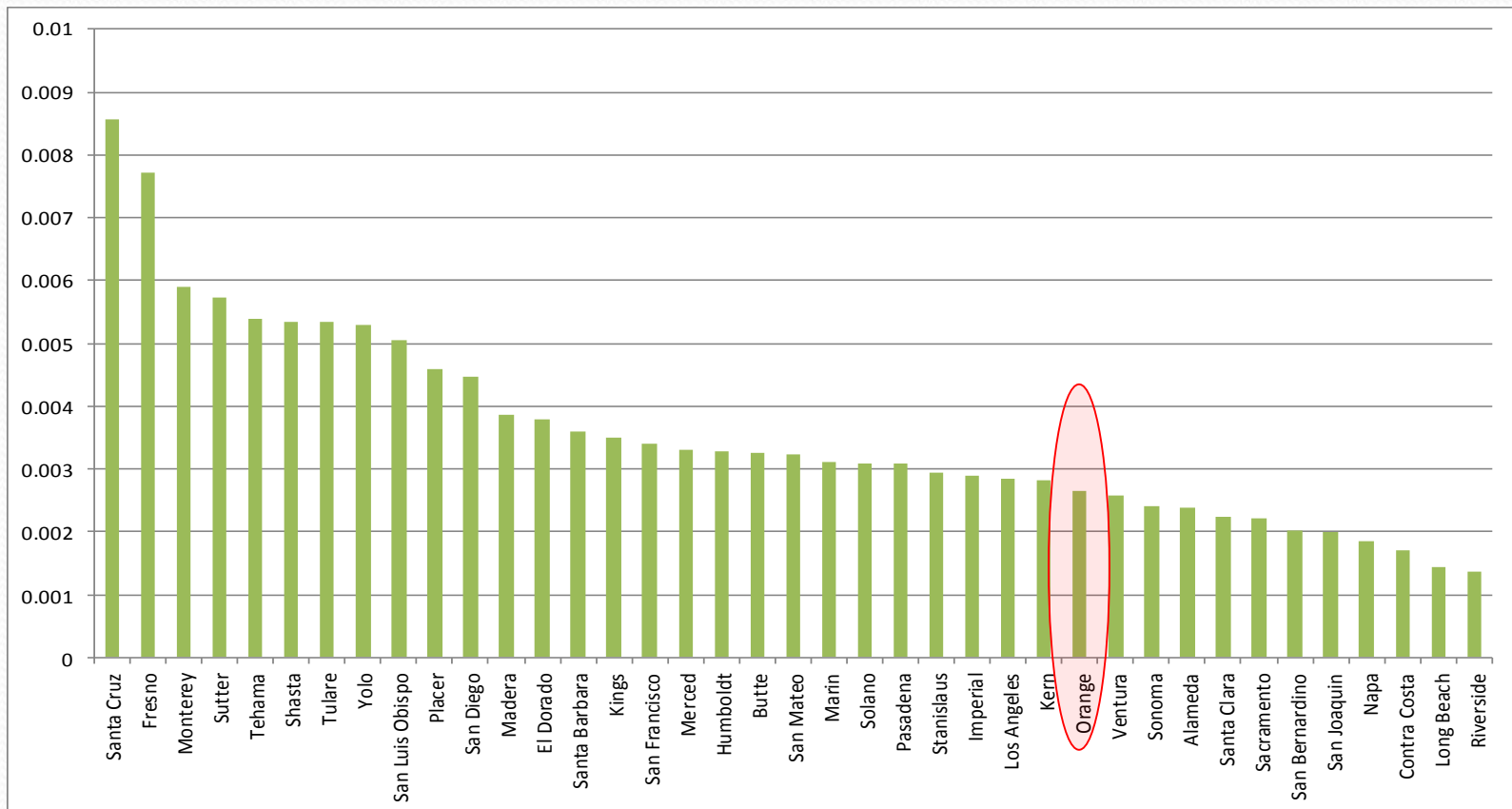
*Blood Lead Level = BLL

¹In 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

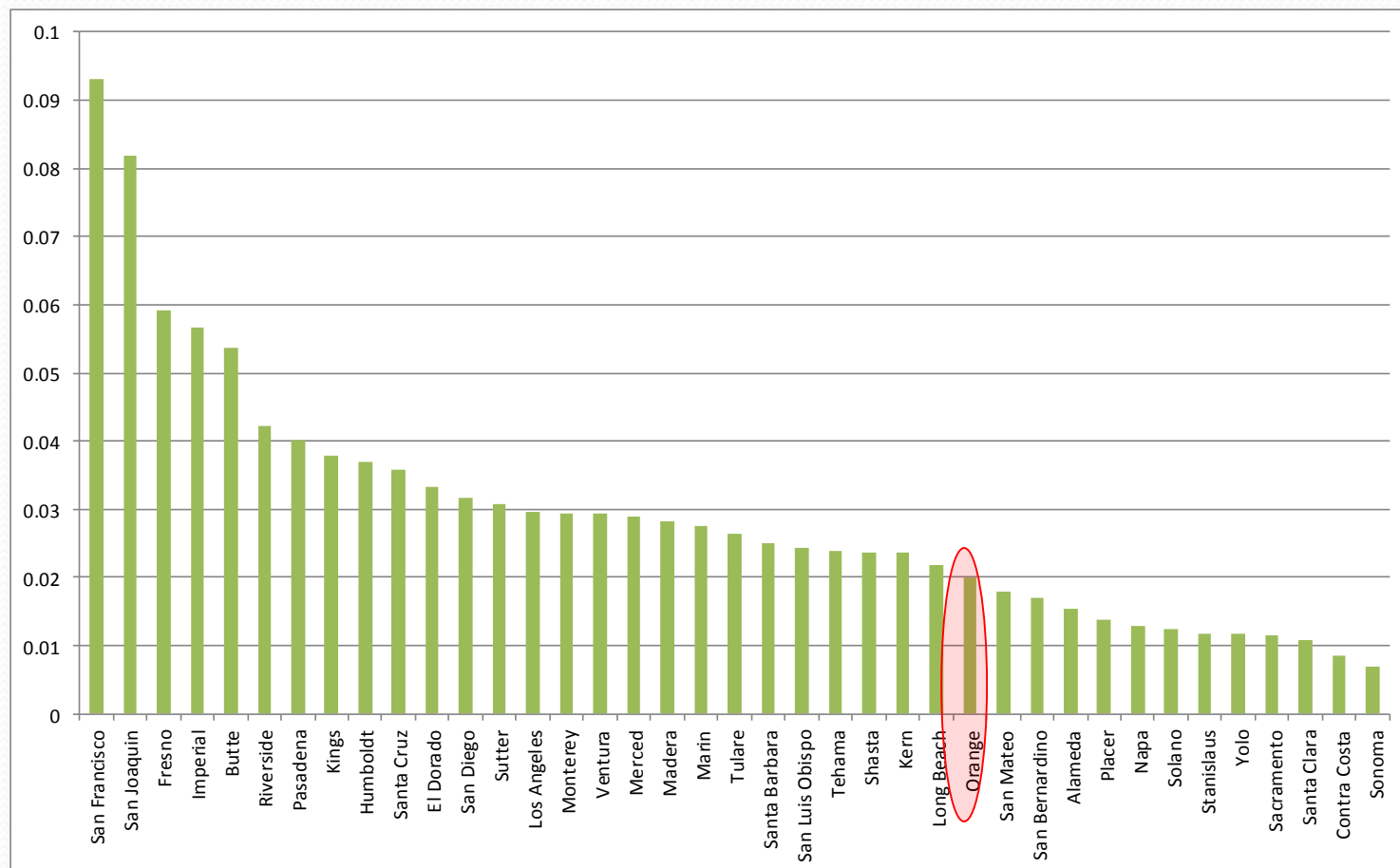
U.S. Totals Blood Lead Surveillance Report 2007-2011



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



Childhood Lead Poisoning Disparities and Environmental Justice¹

- 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.

1. http://www.cdc.gov/healthyhomes/ej/ej_1page_english.pdf



**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 ≥ 20 mcg/dL (19.5 mcg/dL)
- Any child with two blood lead levels ≥ 15 mcg/dL (14.5 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 21years
 - 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>

² AAP Current Management:

<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/medical/Pages/default.aspx>
- California Children's Services – CCS
<http://www.dhcs.ca.gov/services/ccs/pages/default.aspx>
- Head Start - www.caheadstart.org
- Healthy Families -
<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>
- WIC - <http://www.cdph.ca.gov/programs/wicworks>

Federal Resources

- CDC - www.cdc.gov/nceh/lead/
- Recalls - www.cdc.gov/nceh/lead/recalls/
- EPA - www.epa.gov/lead/
- US Consumer Product Safety Commission - <http://www.cpsc.gov/about/cpsia/sect101.html>
- Guidelines on Lead Exposure in Pregnancy and Lactating Women - <http://www.cdc.gov/nceh/lead/publications/LeadandPregnancy2010.pdf>

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

- ¹Hernandez-Avila, M, et al, Arch. Env. Health 2002; 57, 482-48
- ²Braun, et al. Environ Health Perspective 2006; 114:1904-9
- ³Gerr, F, et al, Am J. Ind. Med. 2002; 42:98-106
- ⁴Poreba, R, et al, Toxicology and App Pharmacology 2010; 249: 41-46
- ⁵Gould E Environ Health Perspective 2009; 117(7): 1162-7
- ⁶ Mielke, HW, Zahran, S, Environment International 2012; 43:48-55
- ⁷Dietrich KN, et al. Neurotoxicol Teratol 2001; 23(6):511-8
- ⁸Needleman,HL, et al. Neurotoxicol Teratol 2002; 24(6):711-717
- ⁹ Needleman, et al. NEJM 1990; 322(2):83-8
- ¹⁰ Chen, et al. Pediatrics 2007; 119:e650-8
- ¹¹Wright et al. PLoS Medicine 2008; 5:e101



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.



Soft Lead



Copyright © 2004 Theodore W. Gray

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



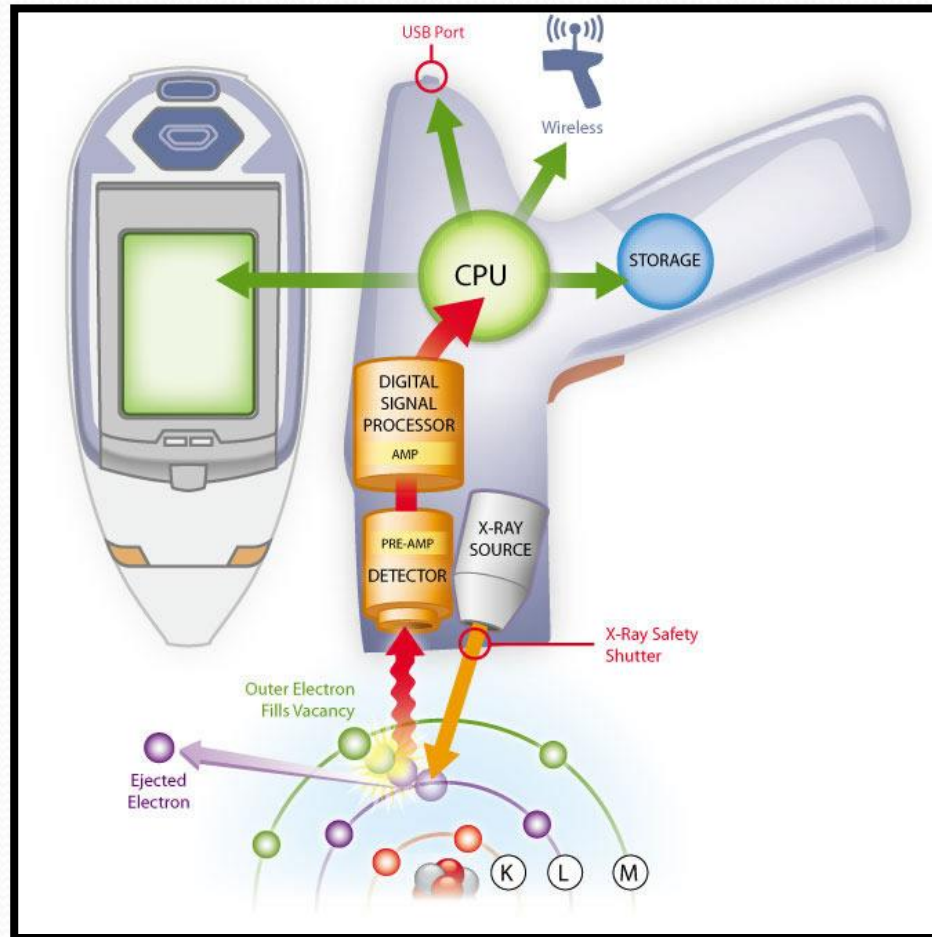
Lead Hazards

- Deteriorated Lead-Based Paint
- Lead-contaminated dust
- Lead-contaminated soil
- *Lead in drinking water, > 15 ppb*

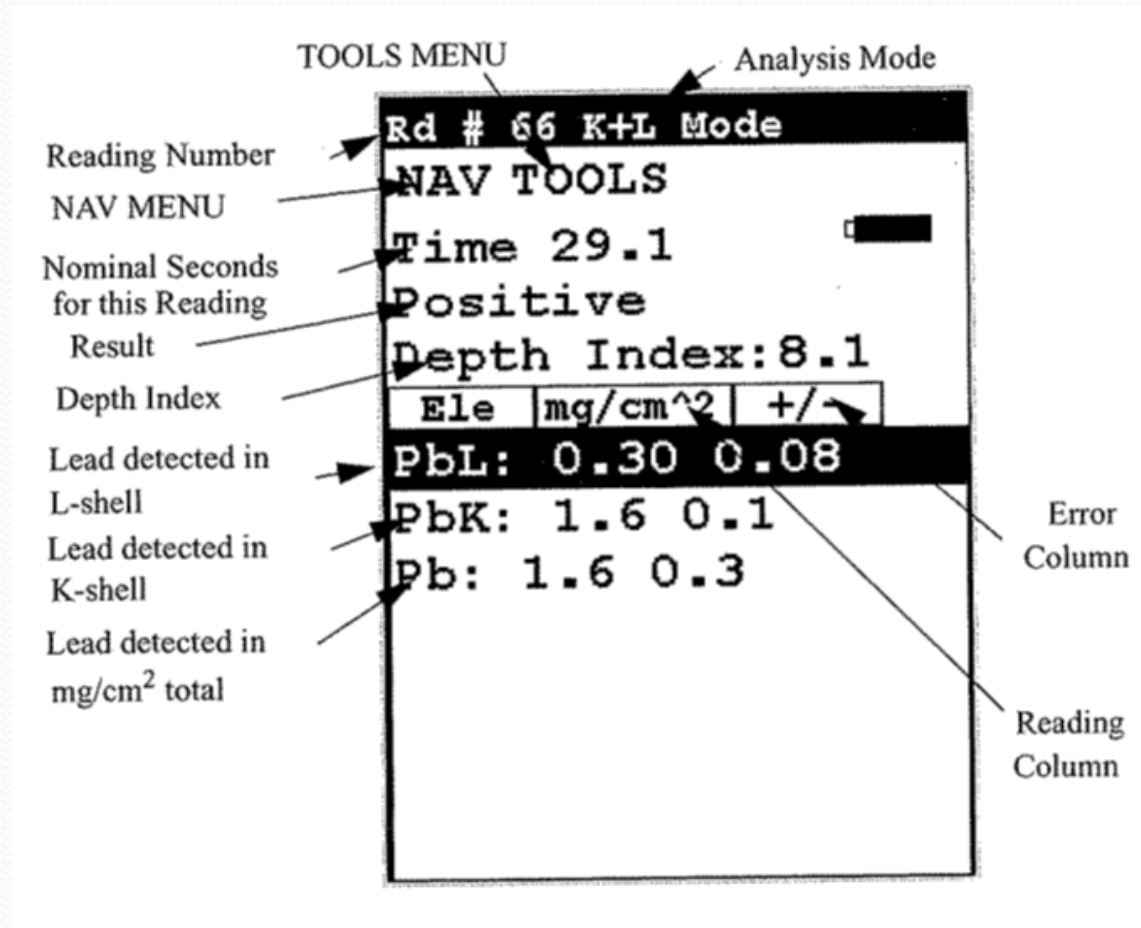
XRF Lead Analyzer



XRF Diagram



Positive Results



Negative Results

TOOLS MENU Analysis Mode

Reading Number → Rd # 64 Standard Mode

NAV MENU → NAV TOOLS

Nominal Seconds for this Reading → Time 0.4

Result → Negative

Depth Index → Depth Index: 1.0

Lead detected in mg/cm^2 → Pb: 0.00

Ele	mg/cm^2	+/-
Pb	0.00	



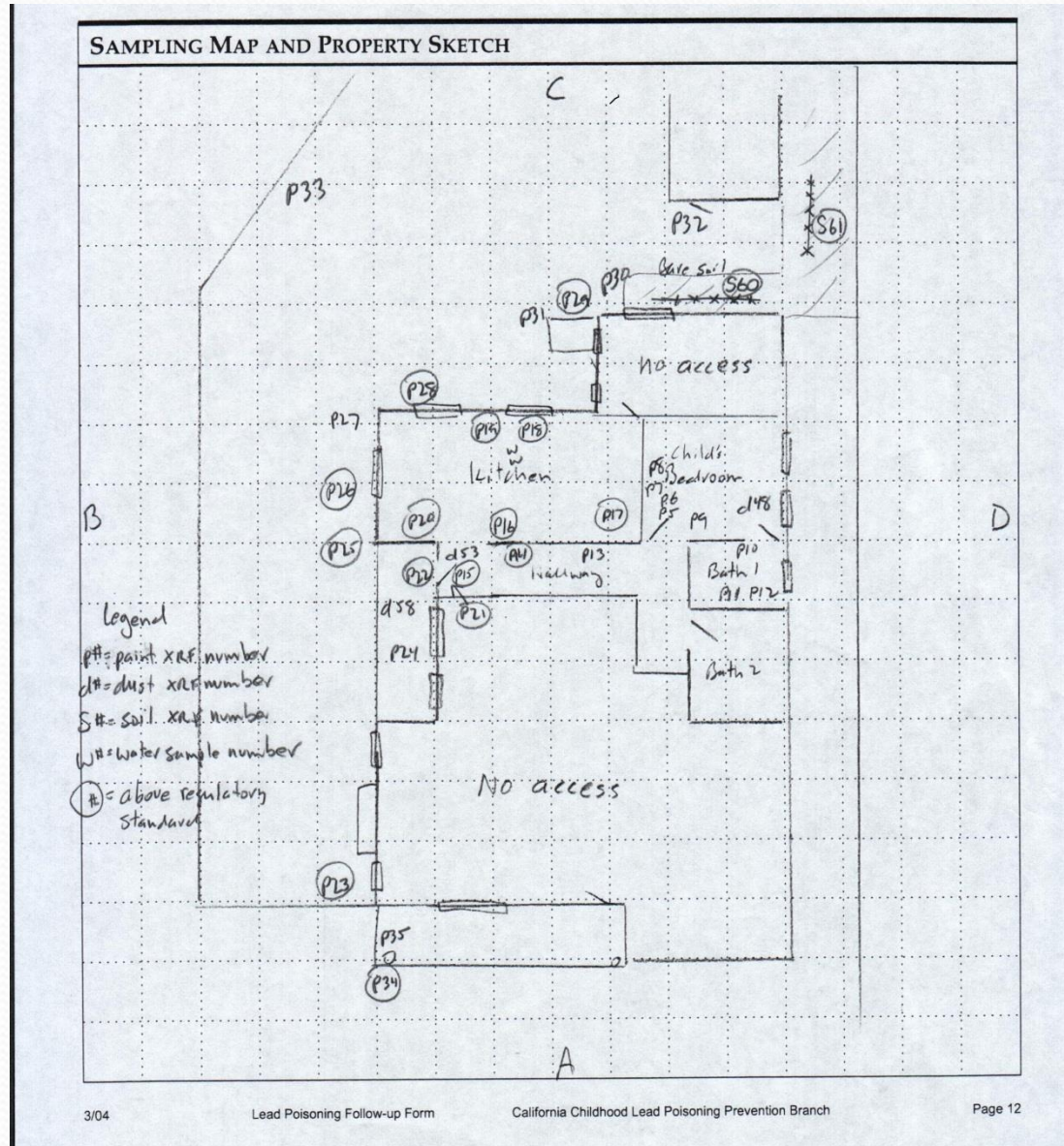
Visual Assessment



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) **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

- 1991 – Safe Drinking Water Act prohibited lead pipe for residential use (EPA 1991)
- 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



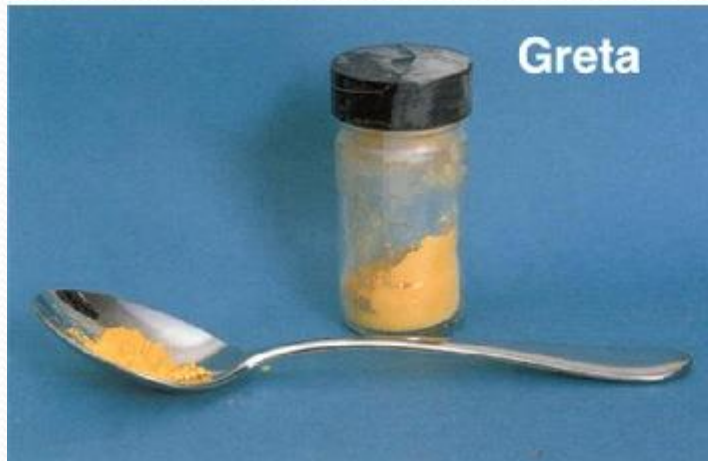
Oaxacan Pottery



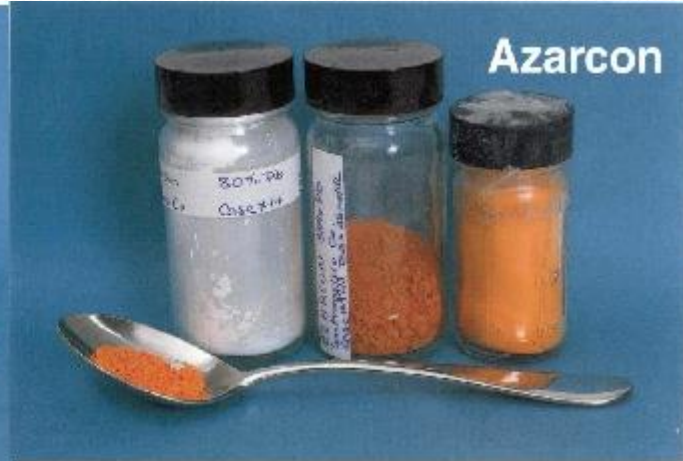
Ceramic Water Crock



Home Remedies & Cultural sources



Greta



Azarcon



Surma, Kohl, Khali

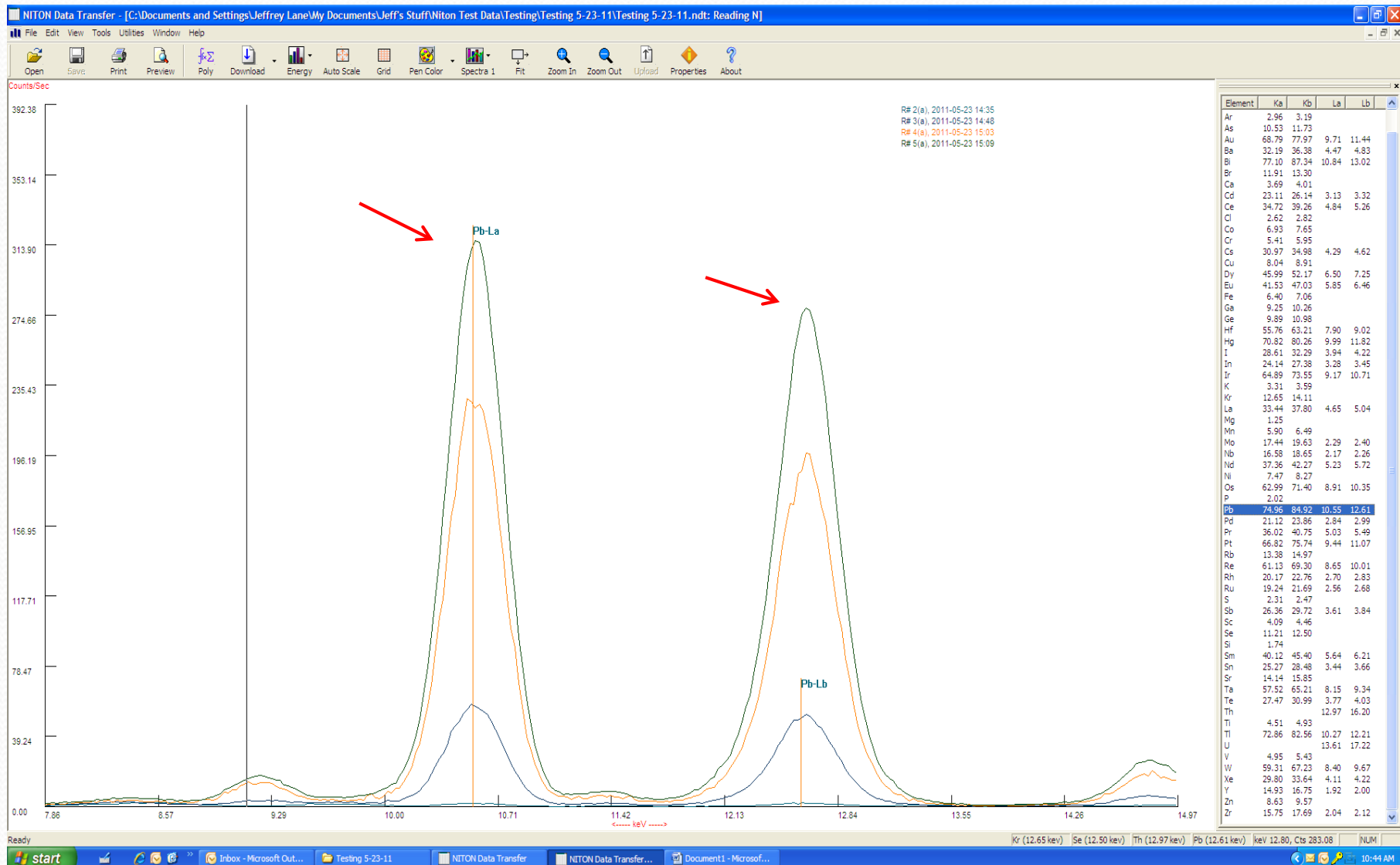


Sindoor

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



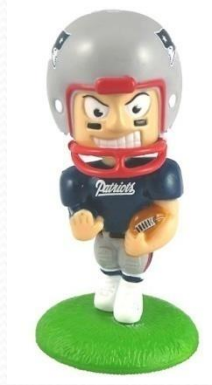
Chapulines



Children's Jewelry



All Contain Lead !



Questions?

Medical: CLPPP (714) 567-6220

Environmental Lead: Environmental Health (714) 433-6000

