Health Hazards of Low-Level Lead Exposure to Adults and the California Initiative for an Updated Workplace Lead Standard

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Lead in whole blood: The most common clinical measurement for human biomonitoring

OSHA Construction Medical Removal Level for Adults (since 1977)	50 µg/dL
OSHA “return to work” level	40
U.S. population geom mean (mid -late 1970’s)	12.8
US Population Geometric Mean (2010)	1.1

International standards for blood lead concentration requiring temporary removal from workplace lead exposure

Country	Blood lead concentration (µg/dL)
USA	60 (general industry); 50 (construction)
UK	60
Japan	60
Russia	50
Czech	40
Germany	40; 30 (women under 45 years of age)
France	40; 30 (all women)
Sweden	40; 25 (women under 50 years of age) [3 consecutive measurements]

Health effects of lead at low dose warrant a reappraisal of the levels of lead exposure that may be safely tolerated in the workplace.

- ***Chronic* effects of *cumulative* dose**

  Hypertension / Cardiovascular disease
  Decrements in renal function
  Cognitive dysfunction

- ***Acute effects of recent dose***

  adverse reproductive outcome

Assessing the Relationship between Pb and Blood Pressure

- Animal exposure experiments
- In vitro and in vivo studies to assess mechanisms and biological plausibility
- Human epidemiological studies

Blood Pressure Elevation in Young Dogs during Low-Level Lead Poisoning

[Fine et al, Tox Appl Pharm 93:388-93; 1988]

- Six 3 month old female dogs and matched litter-mates
- Animals fed Pb acetate or placebo 1 mg/kg/d x 5 mo.
- BP measured regularly by Doppler in foreleg without anesthesia or trauma by blinded investigator
- Blood lead at 15 weeks: 35.8 vs. 9.2 µg/dl
  BP at 20 weeks 120 ± 2.1 mm Hg vs 108 ± 1.5

BLOOD PRESSURE AND LEAD POISONING

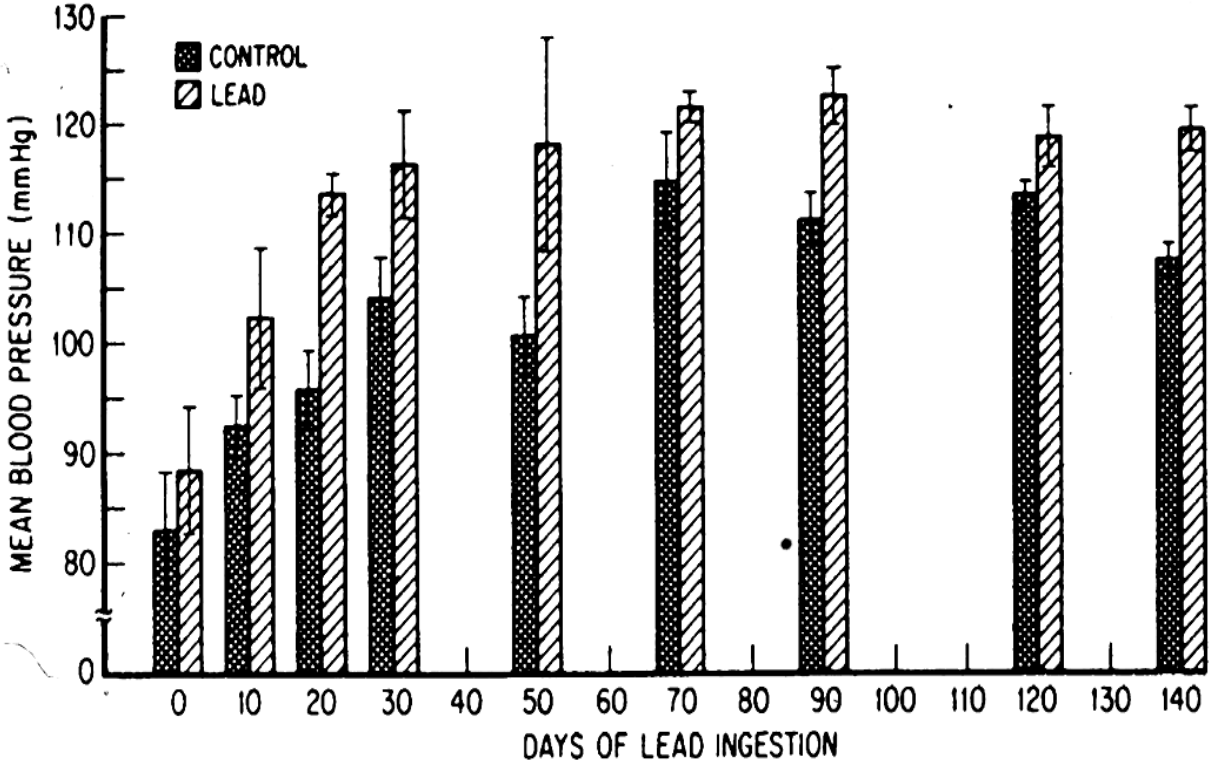


FIG. 1. Mean blood pressure levels during lead ingestion. The profile of the lead-exposed group was significantly higher than of the paired controls (repeated-measures ANOVA, $p = 0.0048$). The rise in the control group is normal for age. Measurements on Day 50 were obtained under pentobarbital anesthesia

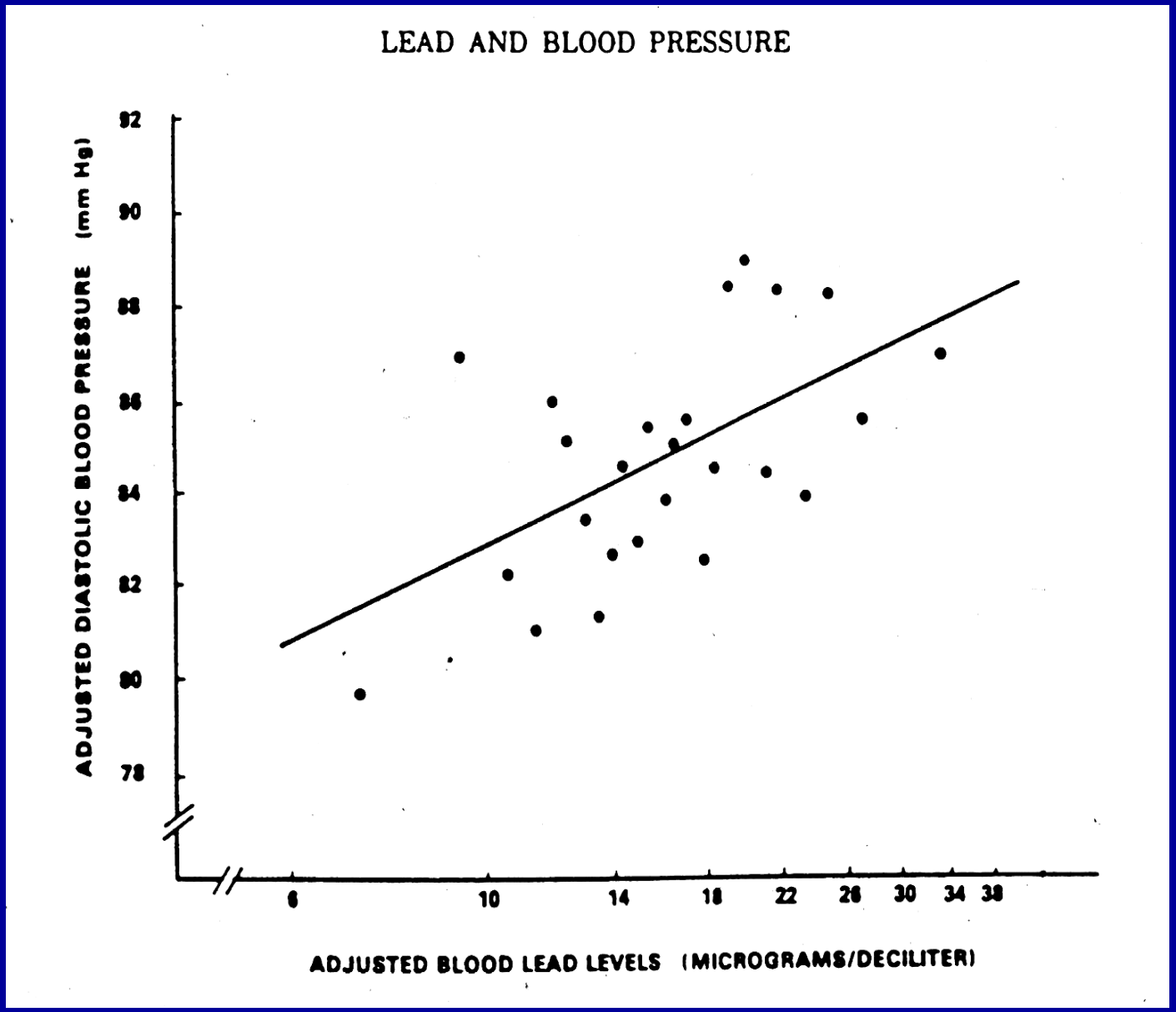
The Relationship Between Blood Lead and Blood Pressure in the NHANES II Survey

[Schwartz J Environ Health Persp 78:15-22; 1988]

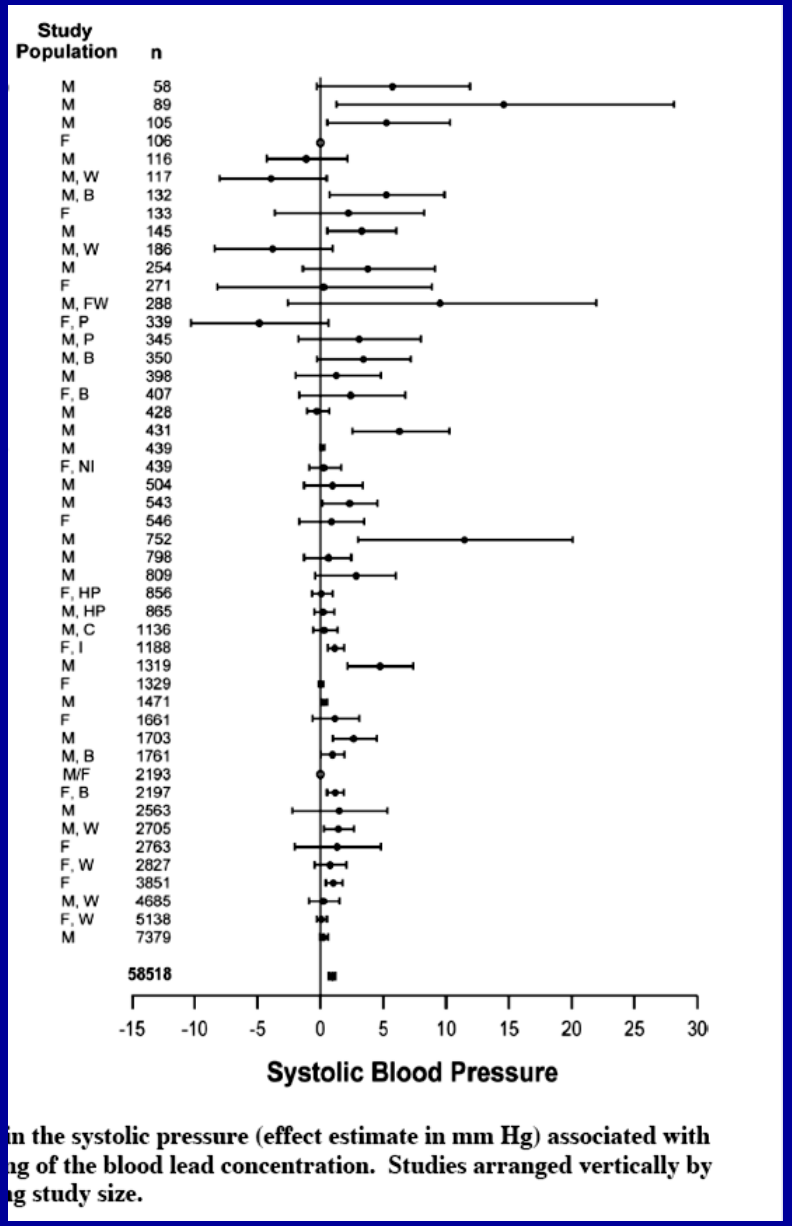
Representative cross-sectional survey of US Population 20,322 persons examined; PbB obtained on 9932

Mean blood lead in adults 13.1 µg/dl (12.7 -13.7)

Blood lead significantly associated with systolic and diastolic blood pressure, after controlling for age, BMI, demographic, multiple nutritional factors



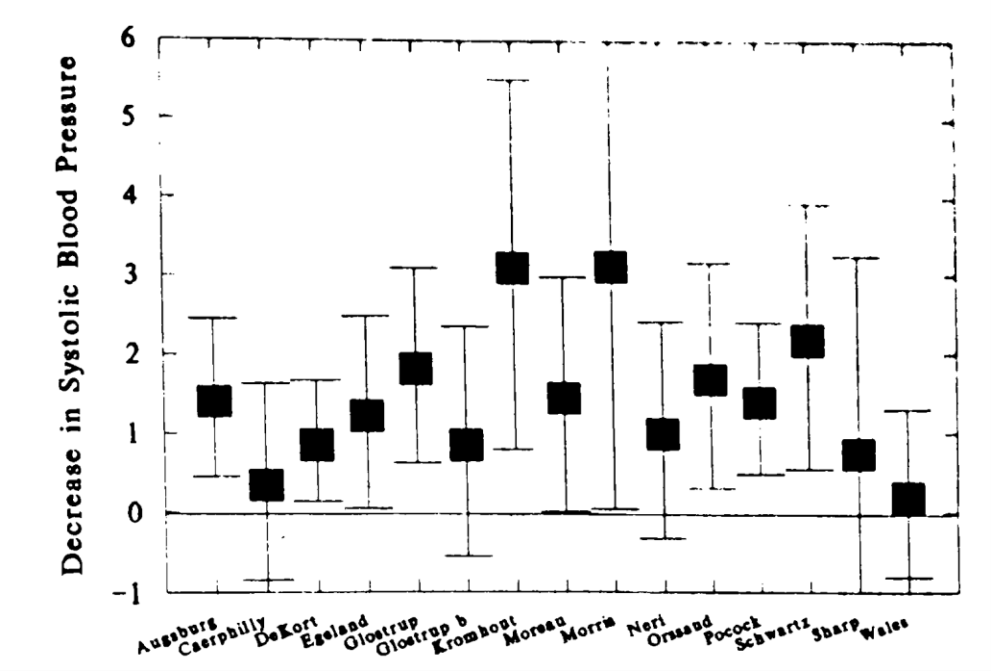
[Pirkle et al, 1985]



in the systolic pressure (effect estimate in mm Hg) associated with ng of the blood lead concentration. Studies arranged vertically by g study size.

Nawrot et al, 2002

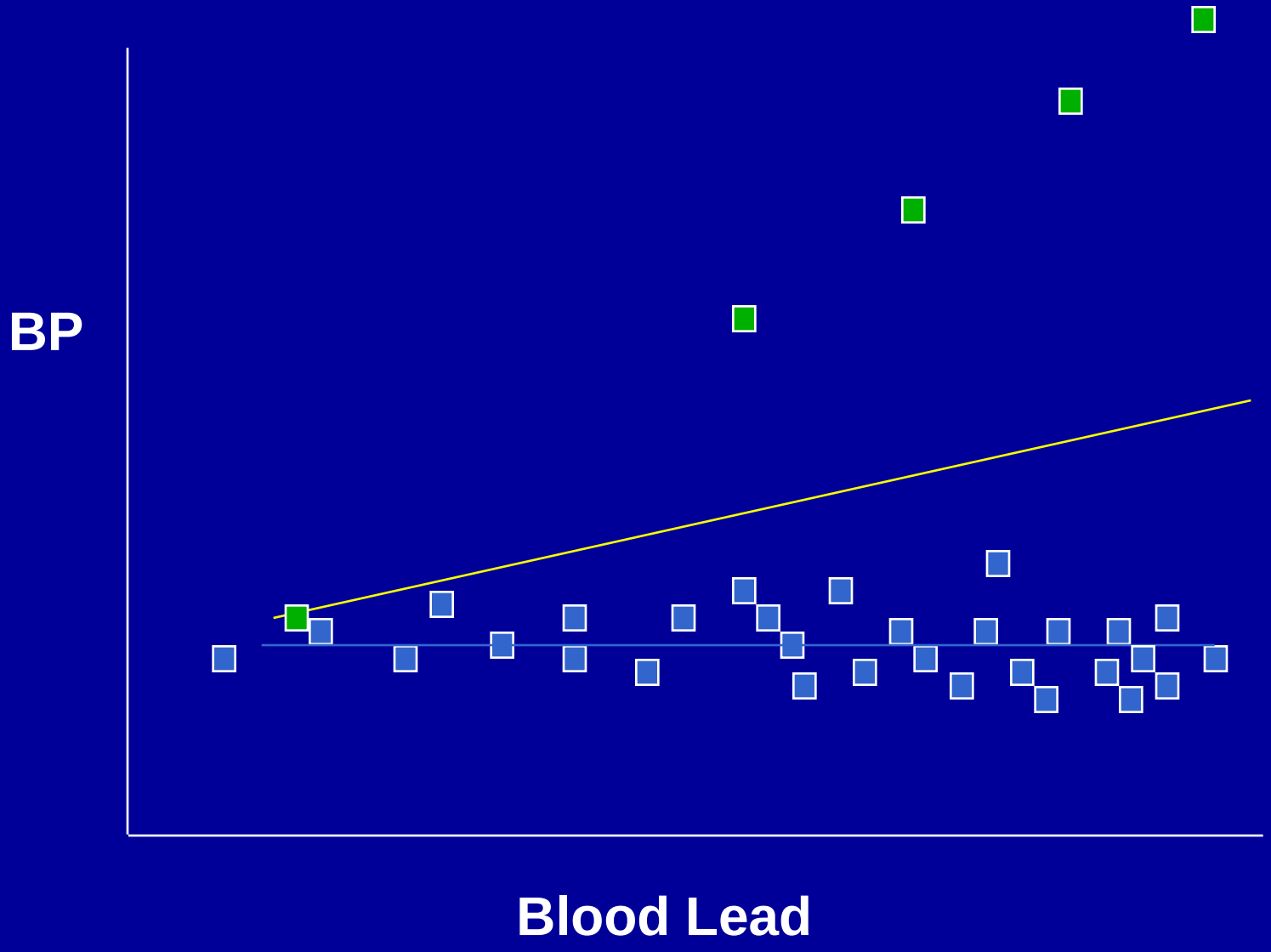
Schwartz, 1995



Meta-analyses:

ΔPbB 5 → 10 µg/dL

= Δ 1.0 or 1.25 mmHg in systolic blood pressure


BP
Blood Lead

Why measure lead in bone?

Greater than 90% of the body lead burden is found in the skeleton, where it remains with a half-life of years to decades.

Bone lead concentration is highly correlated ($r \approx 0.8$) with longterm, cumulative lead exposure (e.g. μg/dL • years)

[photo source: Mt Sinai School of Medicine]

The Relationship of Bone and Blood Lead to Hypertension. The Normative Aging Study

[Hu H et al, JAMA 1996; 275:1171-1176]

Case control study: 146 hypertensive men; 444 controls selected from large, ongoing prospective study of aging. Mean age = 66.6 ±7.2 y

Exposure reflects that of general population. (Mean PbB = 6.3 ug/dL)

Final logistic model (backward elimination) yielded 3 significant risk factors for hypertension:

Body mass index

Family history of hypertension

Tibia bone lead concentration

From the lowest quintile of bone lead to the highest quintile (Δ29 µg/g) , the odds of being hypertensive increased by 50 %
(O.R. = 1.5 (95% C.I. 1.1 - 1.8)

Lead and Hypertension in a Sample of Middle-Aged Women

Korrick AS et al, AJPH 1999; 89:330-335

Patella lead was associated with increased risk of hypertension in women with low level lead exposure

Case control study: 89 hypertensives and 195 controls

Boston subset of Nurses Health Study

Hypertensive = MD's diagnosis, or SBP ≥140 or DBP ≥ 90

Mean PbB = 3 ± 2 µg/dl

Logistic regression model: Δ 10th ⇒ 90th percentile bone Pb

6 µg/g ⇒ 31 µg/g

yielded *odds ratio for Hypertension of 1.86* (1.09, 3.19)

after adjustment for age, BMI, dietary Na, and family Hx of htn.

Compare the Δ tibia bone lead of 29 µg/g associated with the O.R. = 1.5 for hypertension (Hu et al 1996) with cumulative lead exposure:

The linear slope between tibia bone lead (µg/g) and cumulative blood lead index (µg/dL • years) is roughly 0.05

$$29 \div 0.05 = 580 \text{ µg/dL} \bullet \text{years}$$

Considered in context of a 40 year working lifetime, a decrease in BLL from 25 µg/dL to 10 µg/dL would reduce the cumulative blood lead index by 600 µg/dL • years

This might avert the 50 % increase in odds of developing hypertension observed by Hu et al (1996)

Blood Lead Levels and Cardiovascular Mortality: Results from NHANES III

(Schober et al, Environ Health Persp 114:1538-1541; 2006)

12 year longitudinal study of participants in the National Health and Nutrition Examination Survey.

Subjects ≥ 40 years of age (n = 9757)

Blood Lead	RR of Cardiovascular Mortality	
< 5 µg/dL	**1.0**	
5 - 9 µg/dL	**1.20**	**(0.93 - 1.55)**
≥ 10 µg/dL*	**1.55**	**(1.16 - 2.07)****

* Median = 11.8 µg/dL ** Test for trend ($P < 0.01$)

Bone lead as a risk factor for cardiovascular mortality in the Normative Aging Study [Weisskopf et al, Circulation, 2009; updated by Weisskopf et al, Environ Health Persp 123:1113 – 1122; 2015]

Longterm prospective study of Boston area men healthy at baseline in 1963

KXRF patella bone lead (in 1990s) in men < 45 yo at entry (n = 637)

135 all cause deaths through 2007 (mean follow-up time ≈ 9 years)

	Adjusted Hazard Ratio by Tercile of Patella Lead*			
	< 20 µg/g (reference)	22 - 31 µg/g	> 31 µg/g	*P* trend
Cardiovascular deaths (n = 75)	1.0	1.53 (0.78, 2.99)	2.47 (1.23, 4.96)	0.009
Ischemic Heart Disease death (n = 35)	1.0	3.09 (1.01, 9.46)	5.20 (1.61, 16.8)	0.005

*Adjusted for age, smoking, education; maternal and paternal age & occupation, and inverse probability weighting for attrition from enrolled cohort

Factors independent of hypertension may contribute to the impact of lead on cardiovascular morbidity and mortality

Implicated modes of action of lead include oxidative stress, production of pro-inflammatory cytokines such as TNF-α, alteration in endothelial cell function, and others.

In epidemiological studies, including the NAS, lead biomarkers have been associated with alterations in cardiac conduction (e.g. QT and QRS) [Peters JL et al, 2012; Chen CC et al, 2013]

Blood Lead Below 0.48 µmol/L (10 µg/dL) and Mortality Among US Adults

[Menke et al, Circulation 114:1388-1394; 2006]

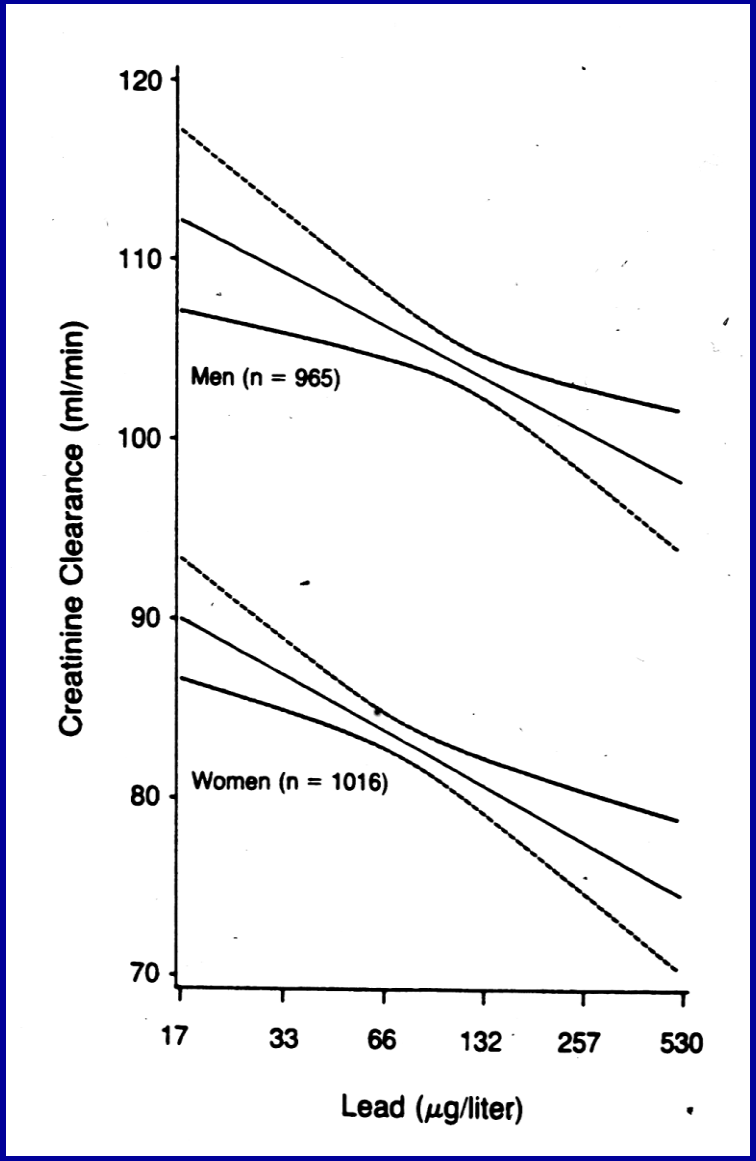
12 year longitudinal analysis of mortality among NHANES III participants (1988 - 1994) ≥ 17 yo (n = 13,946).

Hazard Ratios for Mortality, multivariate adjusted*

	Tercile I BLL ≤ 1.93 µg/dL		Tercile III BLL ≥ 3.63 µg/dL	
Cause	n	hazard ratio	n	hazard ratio
Myocardial infarction	50	1.0	234	1.89 (1.04 - 3.43)
Stroke	22	1.0	63	2.51 (1.20 - 5.26)
Cancer	67	1.0	238	1.10 (0.82 - 1.47)

*Age, race-ethnicity, sex, diabetes, BMI, current/former smoking, alcohol, physical activity, income, CRP, cholesterol, education, urban, menopause, hypertension, renal function

Impairment of renal function with increasing blood lead concentration in the general population



Staessen JA et al. NEJM 327:151-6; 1992

- Random population sample of 965 men and 1016 women (age 20 to 88)
- Blood lead range 1.7 - 72.5 ug/dL; geometric mean ≈ 10 ug/dL
- Significant correlation between age-adjusted creatinine clearance and blood lead
- Relationship persisted after excluding subjects with occupational Pb exposure, or those with highest tercile of PbB (geom. mean 18.4 ug/dL)
- "Reverse Causation" remains unresolved question

Association of Cumulative Lead and Neurocognitive Function in an Occupational Cohort

[Khalil et al, Neuropsych 209:10-19; 2009]

Lead workers and controls previously assessed in 1982 underwent re-testing of neuropsych status, plus bone lead measurement, in 2004.

Mean BLL of workers in 1982 = 40 µg/dL; in 2004 = 12 µg/dL (n=83)
Control BLL (1982) = 7.2; (2004) = 3 (n=51)

Mean age of workers in 2004 = 54 ± 9 years; last worked with lead a mean of 6 years prior (interquartile range 0.02 - 16 y).

Tibia bone lead of exposed subjects	57 µg/g (20, 86)
of unexposed subjects	12 µg/g (-8, 32)

Regression Coefficients for Δ Cognition by Bone Pb

Peak tibia Pb (µg/g)	Total Cognitive Score	Spatial	Executive Function
Exposed	- 0.352*	- 0.338*	- 0.342*
Nonexposed	- 0.049	0.079	0.166

*$P < 0.01$; Adjusted for age, education, income, BP, yrs employed, yrs since last worked, smoking, etoh, and baseline score

In models, blood lead was not associated with cognitive function

The lead exposed workers experienced 17% greater loss in total cognitive score as compared with nonexposed controls.

[Khalil et al, 2009]

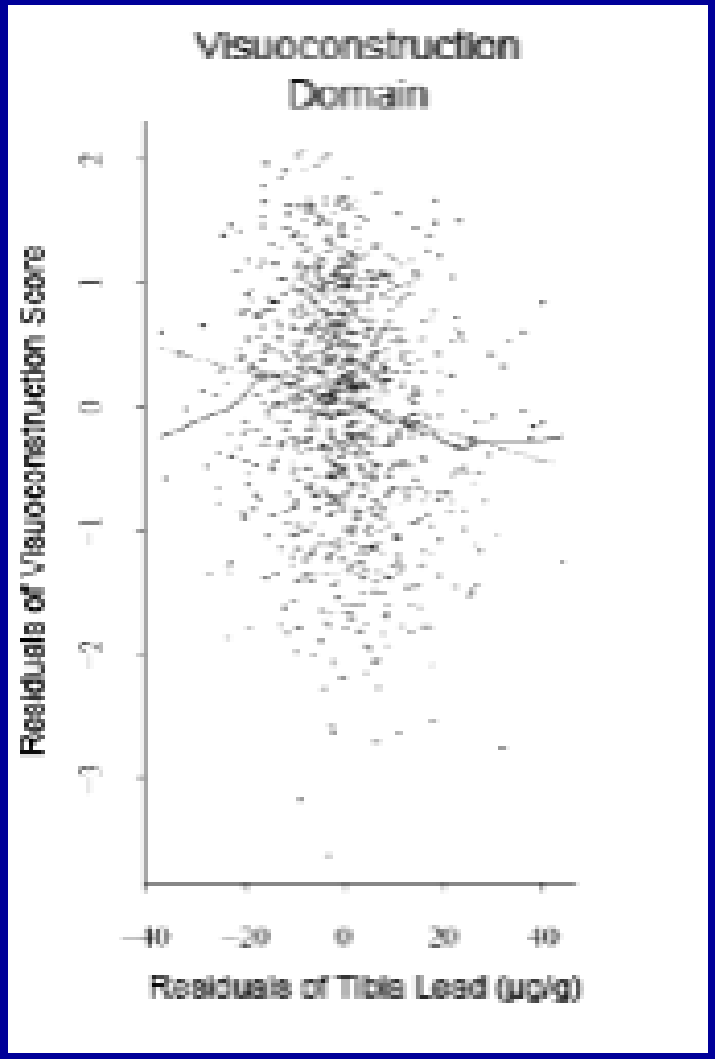
Environmental lead exposure and cognitive function in community-dwelling older adults. [Shih et al. Neurology 14:1556-1562; 2006]

N = 991 randomly selected, sociodemographically diverse community dwelling adults, aged 50 to 70 yrs

Mean PbB = 3.5 ± 2.2 µg/dL

Tibia lead: ↓visuoconstruction on neuropsych testing

Δ 13 ppm equivalent impact of 4.8 years of age



Bone lead concentration predicts decrements in cognitive function in older adults

Normative Aging Study (Weisskopf et al, Epidemiology. 18:59; 2007)

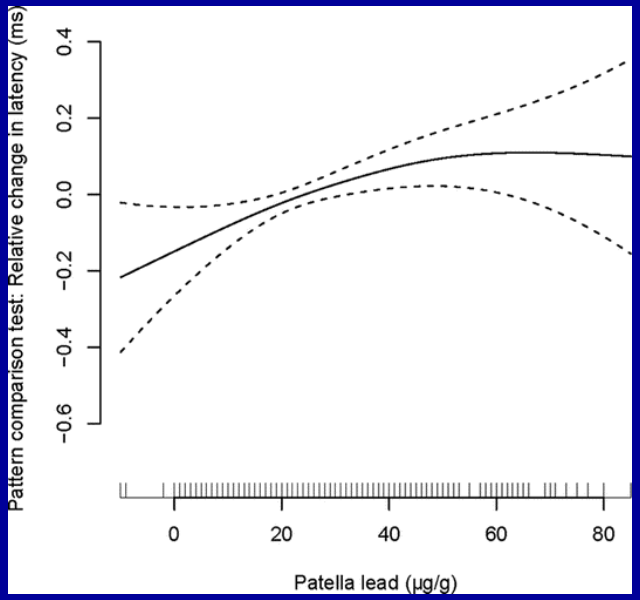
N = 1089 older, mainly white men, mean age 68.7 ± 7.4 yrs.

Repeat neuropsych testing over ≈ 3.5 yr interval

Median PbB = 5 µg/dL (IQR 3 - 6)

Bone lead: longitudinal ↓visuospatial performance (N = 761)

Response latency on pattern recognition test

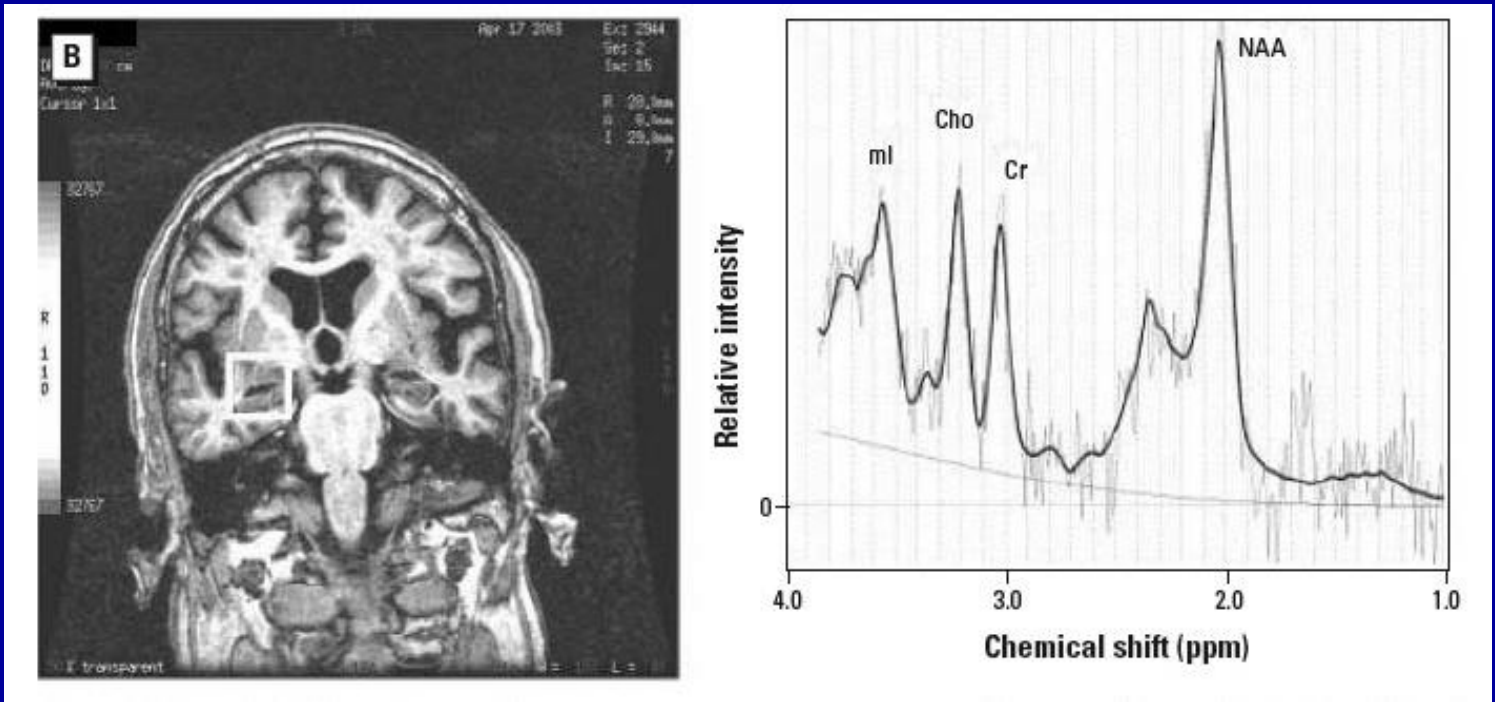


Patella Pb

Proton Magnetic Resonance Spectroscopic Evidence of Glial Effects of Cumulative Lead Exposure in the Adult Hippocampus

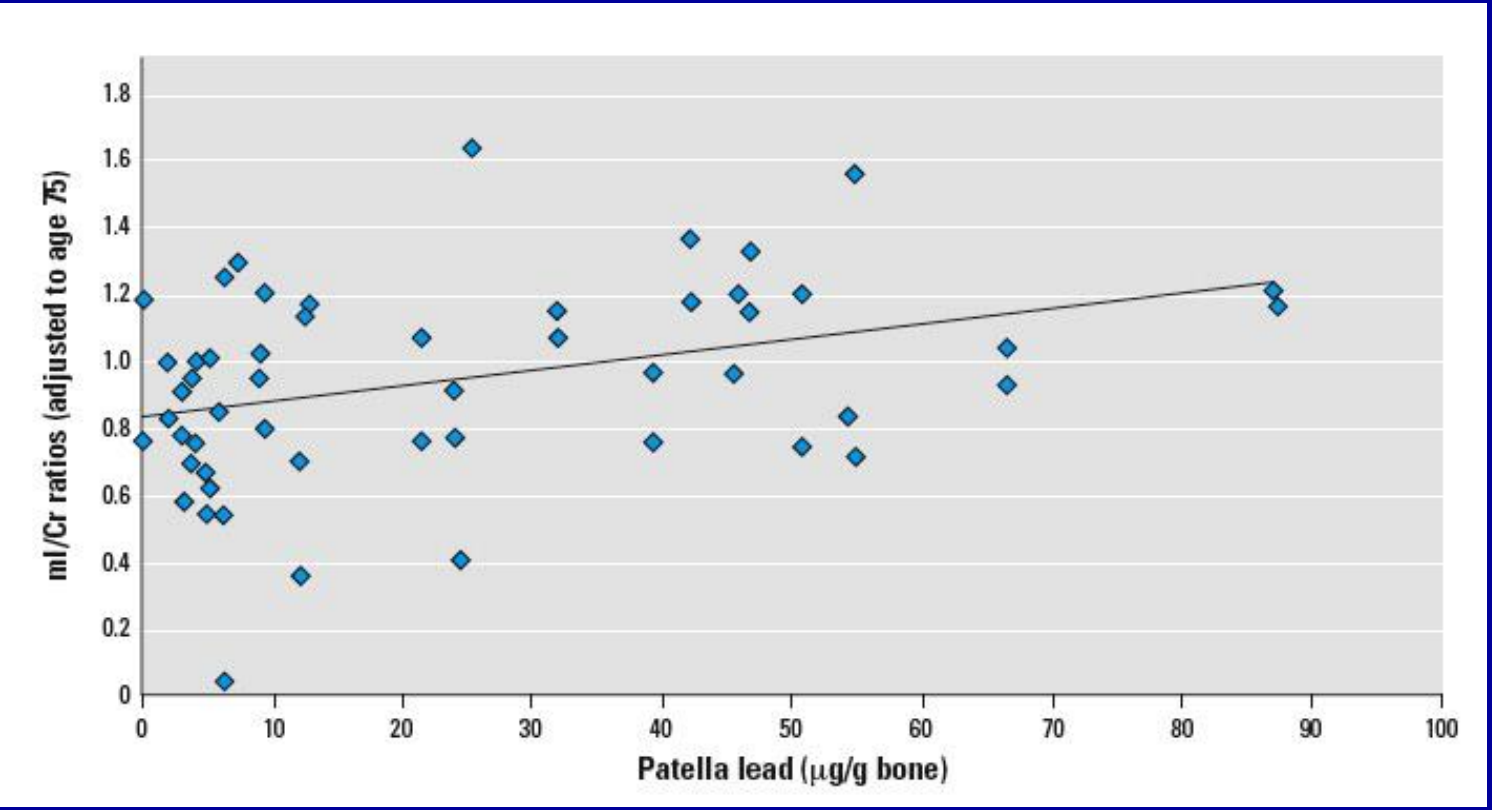
[Weisskopf M et al, EHP. 115:519-523; 2007]

A subset of the Normative Aging Study, (n =31 older men, mean age 77), underwent XRF bone lead measurements, and noninvasive PMR scanning to measure specific brain tissue metabolites in the hippocampus.



Cumulative Lead Exposure was associated with Age-adjusted Myoinositol to Creatinine Ratio

Myoinositol, a component of glial cells (astrocytes), may be a biomarker of glial proliferation and plaque formation present in preclinical Alzheimer's Disease.



[Weisskopf et al, 2007]

Blood Lead Levels Measured Prospectively and Risk of Spontaneous Abortion [Borja-Aburto et al, 1999]

- 562 of 668 women followed through week 20; (16% loss to follow-up)
- Average blood lead at enrollment: 11 ug/dL
- Cases (n=35) PbB = 12 ug/dL Controls (n=60) PbB = 10 ug/dL

PbB level (ug/dL)	Odds Ratio
< 5 [referent]	1.0
5-9	2.3
10-14	5.4
≥ 15	12.2

test for trend $p = 0.021$

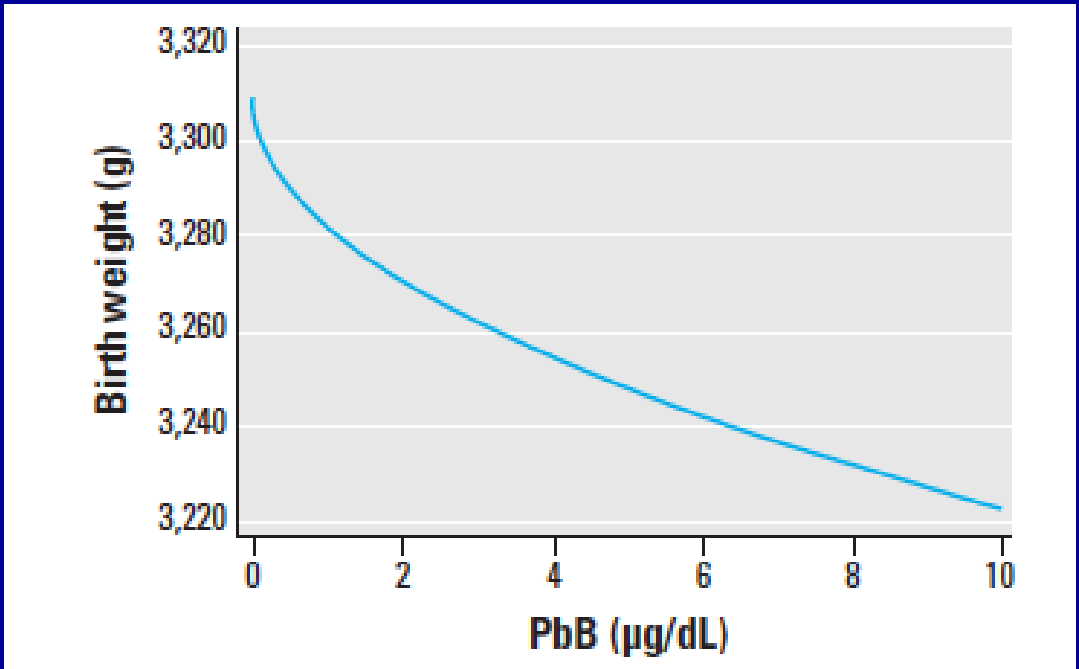
for Δ PbB of 5 µg/dL, O.R. = 1.8 (C.I. 1.1, 3.1)

Maternal Low-Level Lead Exposure and Fetal Growth

[Zhu M et al, Environ Health Perspect; 118:1471-1475]

Linkage of NY State Heavy Metals Registry maternal prenatal or birth BLL records with birth outcome (wt, preterm delivery, small for gestational age); adjusted for confounders

43,288 mother-infant pairs, restricted to BLL < 10 µg/dL.
Mean BLL = 2.1 µg/dL; median = 2 µg/dL

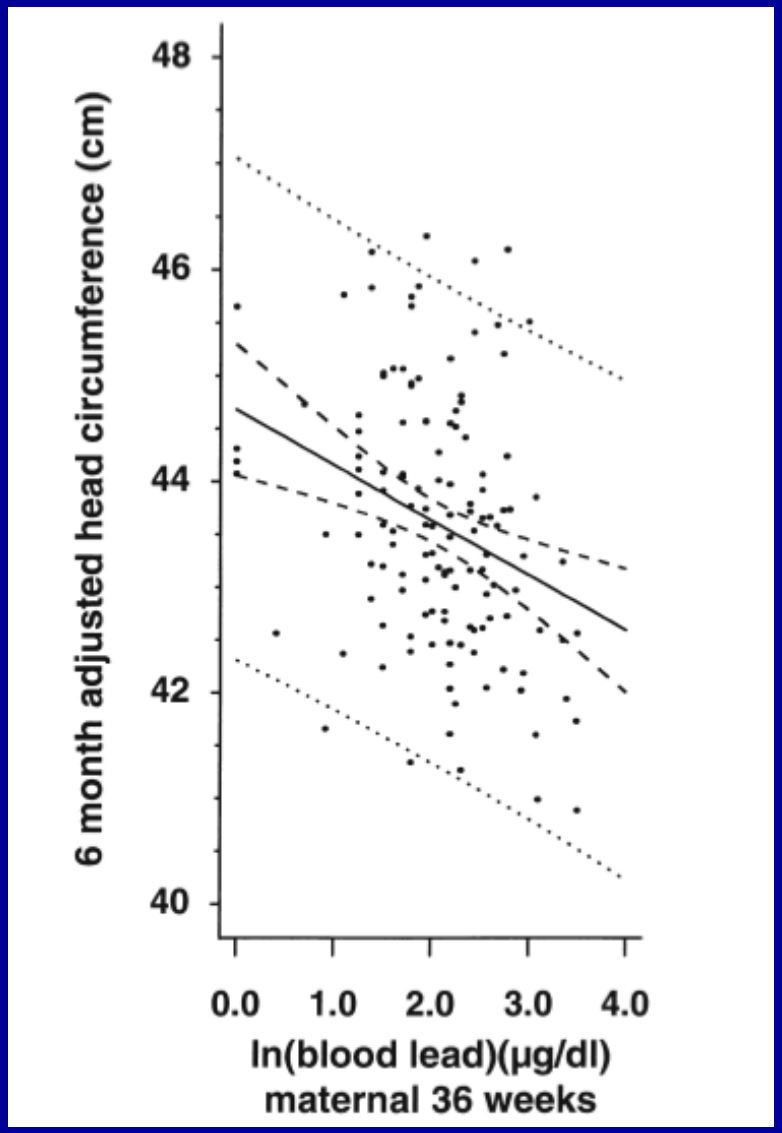


Model adjusted for time of test, gest. Age, maternal age, race, Hispanic, education, smoking, alcohol, drug abuse, income assistance, parity, gender

Prenatal (maternal) BLL at 36 weeks gestation predicts child head circumference at 6 months of age

Subjects were part of a prospective longitudinal study of effect of lead on development, beginning with pregnancy (Mexico City Prospective Lead Study)

Median Maternal BLL @36 weeks = 8 µg/dL (IQR 5.5 - 12)



Rothenberg et al, Neurotox Teratol 21:1; 1999

Prenatal Lead Exposure is Associated with Postnatal Changes in IQ

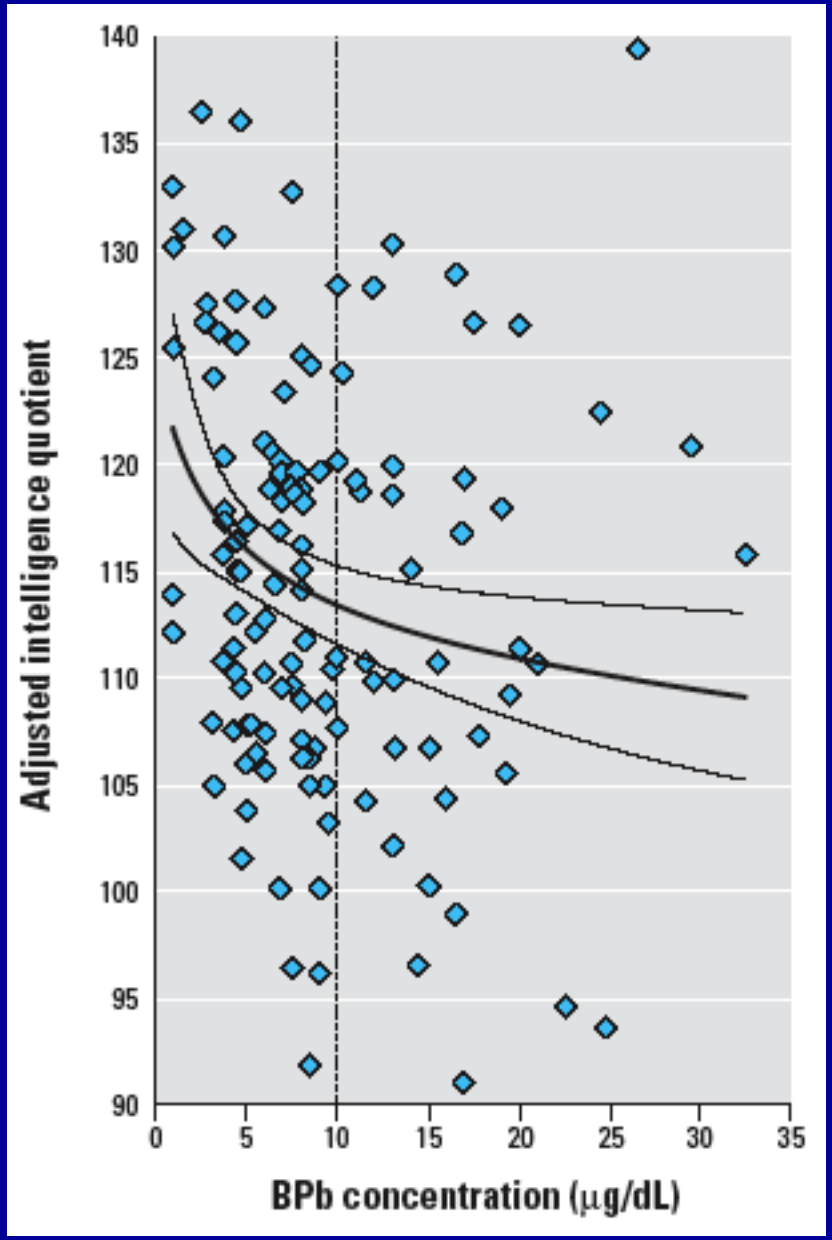
Mexico City Prospective Lead Study

(Schnaas et al 2006)

3rd Trimester PbB = 7.8 µg/dL

Every doubling of PbB associated with IQ ↓2.7 pts at 6 - 10 yrs of age

N = 150



ehp ENVIRONMENTAL HEALTH PERSPECTIVES

Research | Mini-Monograph

Recommendations for Medical Management of Adult Lead Exposure

Michael J. Kosnett,[1] Richard P. Wedeen,[2] Stephen J. Rothenberg,[3,4] Karen L. Hipkins,[5] Barbara L. Materna,[6] Brian S. Schwartz,[7,8] Howard Hu,[9] and Alan Woolf[10]

Vol 115, No. 3, pp 463-471, March 2007

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BLL (µg/dL)	Management
< 5	None indicated
5 - 9	Discuss health risks Reduce Pb exposure for women who are or may become pregnant
10 - 19	Decrease lead exposure. Increase biological monitoring. Consider removal from exposure to avoid long term risks if exposure control over an extended period does not decrease BLL < 10, or if medical condition present that increases risk with continued exposure
20 -29	Remove from exposure if repeat BLL measured in 4 weeks remains ≥ 20

BLL (µg/dL)	Management
30 - 39	Remove from lead exposure
40 - 79	Remove from lead exposure Refer for prompt medical evaluation Consider chelation for BLL >50 with significant symptoms or signs
≥ 80	Remove from lead exposure Refer for immediate/urgent medical evaluation Probable chelation therapy

Summary of Key Points

Occupational health standards that tolerate blood lead concentrations > 20 µg/dL are insufficiently protective and are outdated.

Low to moderate levels of lead exposure in adults – blood lead levels in the range of 10 to 20 - are associated with a risk of hypertension and cardiovascular disease, cognitive dysfunction later in life, adverse reproductive outcomes, and a possible decrement in renal function,

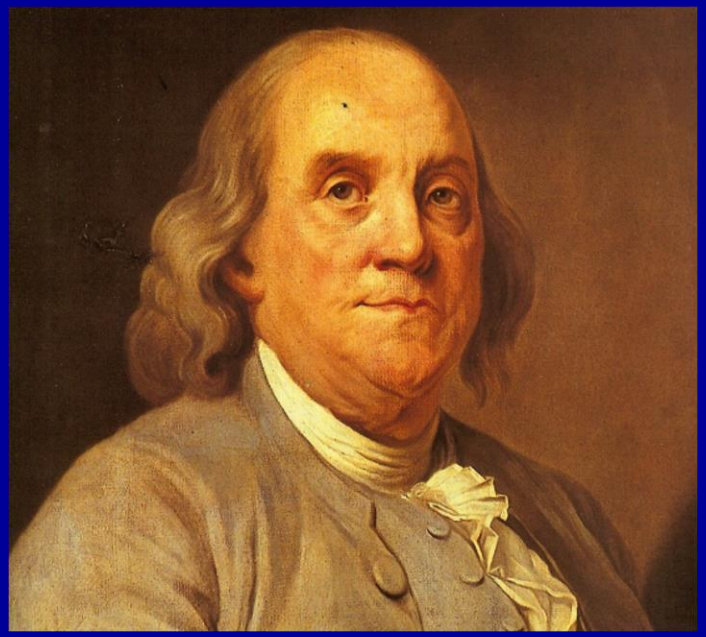
The goal is to keep long-term BLL < 10 µg/dL (< 5 µg/dL in women of reproductive age); a single level over 30, or two consecutive BLL over 20 µg/dL merit medical removal protection (MRP)

David Michaels, PhD, MPH
Director, U.S. Occupational Health and Safety Administration

"When it comes to health hazards, we have a standards process that is broken. [Our] health and safety standards process was written 44 years ago, and then as a result of subsequent court decisions, we have a regulatory process that requires tremendous amounts of study, and that's particularly true for OSHA standards.

… It takes many years to pass a new standard. The result is that many workers in U.S. workplaces are not adequately protected."

Interview with NBC News, July 14, 2014.



“….You will see by it, that the Opinion of this mischievous Effect from Lead, is at least above Sixty Years old; and you will observe with Concern how long a useful Truth may be known, and exist, before it is generally received and practiced on.”

Benjamin Franklin

July 31, 1786

The California Initiative for an Updated Workplace Lead Standard

Briefing for Washington DOSH – January 26, 2016

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In the Spring of 2011, acting on a recommendation from the Occupational Health Branch of the CDPH and support from WOEMA, Cal/OSHA established an advisory committee for revision of the lead standards

STATE OF CALIFORNIA
Governor

EDMUND G. BROWN, JR

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MEETING AGENDA

Advisory Committee for Revising the
Occupational Exposure to Lead Requirements
in California Code of Regulations Title 8 Sections 1532.1 and 5198

Wednesday, February 23, 2011
Industrial Relations Training Room 1304, 13th Floor
Elihu Harris State Building
1515 Clay Street
Oakland, California

Four major goals for a health protective revision of the current Cal/OSHA lead standards

- Maintain blood lead levels (BLL) less than 10 µg/dl and provide more protective “medical removal protection”
- Revise the Permissible Exposure Limit to reduce lead exposure
- Do not rely on air monitoring alone to determine who needs medical surveillance – introduce concept of threshold amount of lead work (for General Industry) as well as Trigger Tasks (Construction)
- Apply basic hygiene measures to all occupational lead exposure, not just exposure > PEL

Under current OSHA rules, Medical Removal Protection (MRP) provides a worker removed from lead exposure because of an elevated BLL or a medical determination to receive *full pay, benefits and seniority*.

MRP may last up to 18 months.

Under current Cal/OSHA rules (since 1978), MRP has to be provided when a single BLL ≥ 60 µg/dL, or the average of the last 3 BLL ≥ 50, provided last is ≥ 40 [50 µg/dl in construction]

Physicians have had discretion to order MRP at any BLL based on their judgement that a worker risks material health impairment from further lead exposure

OSHA, 1977

[http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10033]

“… if the examining physician recommends special protective measures for an employee (e.g., use of a powered air purifying respirator) or recommends limitations on an employee's exposure to lead, then the employer must implement these recommendations. Recommendations may be more stringent than the specific provisions of the standard. The examining physician, therefore, is given broad flexibility to tailor special protective procedures to the needs of individual employees….The return of the employee to his or her former job status, or the removal of special protections or limitations, depends upon the examining physician determining that the employee is no longer at increased risk of material impairment or that special measures are no longer needed.”

New criteria for MRP in Cal/OSHA discussion drafts

- One BLL ≥ 30 µg/dl, *or*
- Last two BLLs ≥ 20 µg/dl, *or*
- Average BLL in last 6 months ≥ 20 µg/dl, *or*
- Final medical determination of physician(s)

During MRP:

- Monthly BLL monitoring
- No work ≥ Action Level (2 µg/m^3)
- No altering or disturbing lead materials (≥ 0.5% Pb by wt)

Return to work permissible when 2 consecutive BLLs taken at least 30 days apart are ≤ 15 µg/dl, *or*

when employee no longer has health-related condition, including ability to procreate a healthy child, that places him or her at increased risk of material impairment from exposure to lead

When first promulgated in 1978, OSHA lead standards set a Permissible Exposure Limit (PEL) for lead in air of 50 µg/m^3 as an 8 hour time-weighted average.

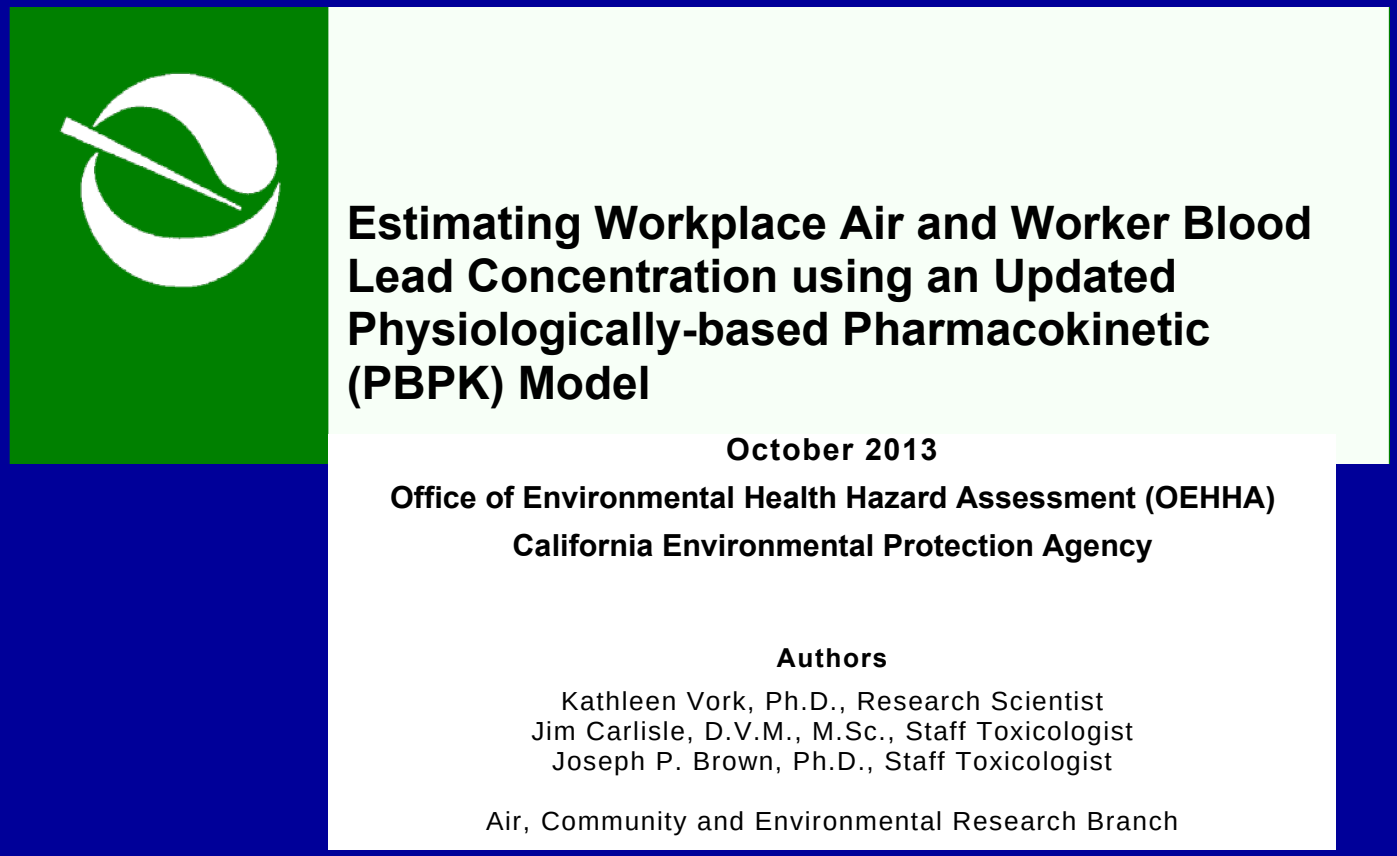
Based on a pharmacokinetic model, OSHA estimated that this PEL would maintain mean worker blood lead levels (BLL) in the mid 30s (µg/dL), with ≈ 70% of workers ≤ 40 µg/dL, and ≈ 95% ≤ 50 µg/dL. (Froines et al, 1995)

Background adult BLL in 1977 assumed to be 19 µg/dL

In 2016, what PEL would maintain most workers' BLL less than 10 µg/dL for a working lifetime?

The California Office of Environmental Health Hazard Assessment (OEHHA) was tasked with addressing these questions.

A model was needed because no existing studies have examined air – blood lead relationships over a working lifetime in adults, especially at relatively low BLLs



Estimating Workplace Air and Worker Blood Lead Concentration using an Updated Physiologically-based Pharmacokinetic (PBPK) Model

October 2013

Office of Environmental Health Hazard Assessment (OEHHA)

California Environmental Protection Agency

Authors

Kathleen Vork, Ph.D., Research Scientist
Jim Carlisle, D.V.M., M.Sc., Staff Toxicologist
Joseph P. Brown, Ph.D., Staff Toxicologist

Air, Community and Environmental Research Branch

Table 2*: PbA concentrations and corresponding BLL in 95th percentile worker

8-hr TWA PbA (µg/m3)	BLL µg/dL
0.5	5
2.1	10
3.9	15
6.0	20
10.4	30

*Excerpted from Table 2 in the full OEHHA report

[OEHHA 2013]

CDPH asked Cal/OSHA to consider a revised PEL of 0.5 µg/m³ or 2 µg/m³ (as an 8 hour time-weighted average)

Cal/OSHA discussion drafts call for:

PEL of 10 µg/m^3 as 8 hr TWA, and

Action Level of 2 µg/m^3 as 8 hr TWA

Exposure at ≥ AL requires:

- Increased exposure monitoring (annually to quarterly)
- Medical surveillance program for workers exposed to ≥ AL ≥ 10 days per year
- Annual training programs

Exposure at > PEL has requirements as above plus:

- Limit exposure to ≤ PEL using hierarchy of controls
- Implement feasible exposure controls
- Appropriate PPE required
- Full hygiene requirements, including showers, change rooms and lunchrooms

Special Engineering Control Air Limits (SECAL) proposed for Lead Acid Battery Manufacturing:

- 30 to 50 µg/m^3 for certain processes
- Engineering and work practice controls required to keep exposure at or below SECAL, then ok to rely on PPE for further protection
- SECALs to exist for 5 year transition period only

Federal OSHA introduced SECAL concept in Cadmium Standard (PEL = 5 µg/m^3)

Significant exposure to lead may occur even if air monitoring does not demonstrate exposure above AL (currently 30 µg/m^3). (Examples: air testing not done or not representative; hand to mouth pathways occur without elevated air Pb)

Discussion draft of Cal/OSHA General Industry Lead Standard introduces concept of "threshold amount of lead work" to require medical surveillance independent of air monitoring results for certain employees:

- *Altering or disturbing* material that is known to contain, or reasonably anticipated to contain Pb ≥ 0.5% by weight
- Torch cutting any scrap metal

Exceptions to definition of "threshold amount of lead work"

- Combined duration fewer than 8 hours during 30 day period, *or*
- Hazard survey by IH demonstrates negative air monitoring and BLLs of employees shown to be < 10 µg/dL

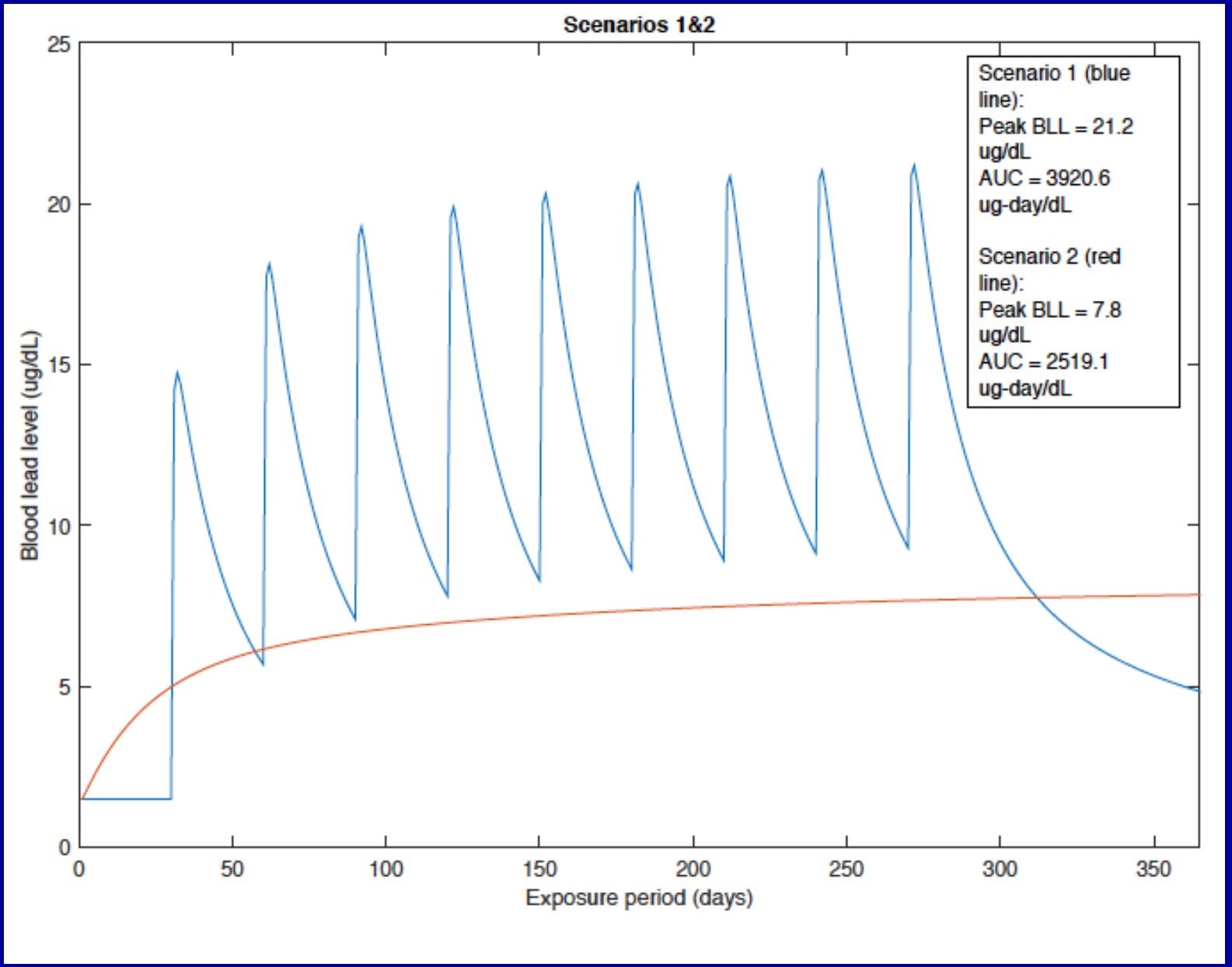
There is still some debate over proposed exceptions to definition of “threshold amount of lead work”

For example, a worker engaged in polishing lead containing metal (e.g. brass), or wet scraping lead paint, for ≤ 9 days per year, would escape medical surveillance (no BLL monitoring) if initial determination showed Pb air < Action Level (2 µg/m^3)

Demonstration of employee BLLs < 10 µg/dl on Hazard Survey may offer inadequate margin of safety. Alternative of < 5 µg/dL has been proposed

Also, the duration of low BLL needed to satisfy exception has not been specified

Infrequent Pb exposure ≠ low cumulative Pb exposure



Medical surveillance program requirements in current discussion draft – Cal/OSHA general industry lead standard

For workers exposed at Action Level ≥ 10 days/year, or those performing "threshold amount of lead work":

BLL monitoring:

- Prior to initial assignment to work or asap, then:
- Every 2 months x 3, then every 6 months.

- Resume BLL every 2 months x 3 if newly assigned to higher exposure task

- BLL monitoring every 2 mo if BLL ≥ 10 µg/dl, until two successive BLL are < 10 µg/dl

- At least monthly BLL if ≥ 20 µg/dl, including during MRP

Medical examinations and consultations

Required prior to assignment for workers initially exposed to lead ≥ action level (2 µg/m^3) or performing threshold amount of lead work (general industry standard)

At least annually if any BLL in preceding 12 month ≥ 20 µg/dl

As soon as possible if employee has signs or symptoms of Pb intoxication, or desires medical advice regarding reproduction, or has difficulty breathing while wearing a respirator

Content of medical examinations

Detailed work history and medical examination by a physician

Laboratory testing to include BLL, ZPP, CBC, BUN, Cr, ua

Pregnancy testing or evaluation of male fertility if desired by employee or physician

Retain current OSHA provisions for second opinion option, multiple physician review

All employees with “occupational lead exposure” require at a minimum:

One time training on lead (new lead standard appendices) and hazard communication standard provisions

Basic hygiene provisions:

No worksite food or beverage, smoking, cosmetic application

Adequate number of wash facilities (lavoratories)

Written program for maintaining cleanliness of wash facilities, change rooms, showers, lunch rooms

“Where applicable, each employer shall establish and implement an effective written elevated blood lead level response plan designed to reduce and maintain blood lead levels below 10 µg/dl.”

Applies to General Industry and Construction

Notable features separately applicable to discussion draft of Cal/OSHA Construction Industry lead standard

AL 2 µg/m^3 and PEL 10 µg/m^3 for all construction work *except* that for first five years PEL for abrasive blasting will be 25 µg/m^3 . (Note air-supplied respirators have assigned protection factor of 1000)

Prior to employer conducting a required exposure assessment, interim protection (PPE) is required for trigger tasks:

Level 1 tasks (assume exposure ≥ PEL but < 10x PEL)

manual demolition, scraping, heat gun of lead painted material or structures

Level 2 tasks (assume exposure ≥ 100 µg/m^3)

manual sanding; power tool cleaning, grinding, or sanding with dust collection system

Level 3 tasks *(assume exposure > 500 µg/m^3)*

Pb mortar, Pb burning, rivet busting, power tool w/o dust collection system, abrasive blasting, welding, torch cutting or burning

All trigger tasks, as well as work measured to be ≥ AL, require:
Initial or Prior BLL measurement
Medical surveillance if performed > 10 days in 12 months

Level 3 trigger tasks require shower facilities, monthly BLL, including BLL within at least 3 days after discontinuing a Level 3 task or work with exposure > 500 µg/m^3

Initially limit abrasive blasting to 5 hr/shift, changing to 2 hrs/shift after 5th year of standard implementation

Closing Comments to Consider

There is strong scientific evidence to support maintaining BLL less than 10 µg/dl; the MRP provisions that start at 20 µg/dl do not define an initial level of health concern

State of the art PBPK modeling supports a PEL of 2 µg/m^3 to keep most BLLs less than 10 µg/dL. A proposed PEL of 10 µg/m^3 provides flexibility to use a multi-modal approach to keep BLLs low.

If all medical surveillance is based on air monitoring, then inadequate air monitoring may result in lack of medical surveillance. Concepts of “threshold amount of lead work” and “trigger tasks” are prudent and protective