

## **Indecent Exposure:**

### **Lead Puts Workers and Families at Risk**

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Six weeks after Raymond began working at a large California company that manufactures industrial radiators, a blood test showed that the 37-year-old had very high levels of lead in his blood: 60 micrograms per deciliter ( $\mu\text{g}/\text{dL}$ ), versus average levels of 1–2  $\mu\text{g}/\text{dL}$  in the general population. Lead is a potent toxic substance that affects many biological systems.

An investigation by the state health department's Occupational Health Branch revealed the source of the poisoning. It found that Raymond had been assigned to cut and grind a pliable steel alloy before he could be outfitted with protective clothing and a respirator for radiator fabrication work using lead-tin solder. Despite OSHA requirements, the employer had not checked the material safety data sheet, which listed lead as a component of the alloy's coating. Raymond was therefore heavily exposed to lead. And the dust he carried home on his clothing and shoes resulted in the lead poisoning of his baby.

### **Problems Remain Despite Early Successes**

Recognition of lead as a major toxic hazard was one of the concerns that resulted in the creation of both the US Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) in 1970. The removal of lead from many commercial products—such as gasoline, ceramic glazes, house paint, and solder in plumbing pipes and food cans—dramatically reduced environmental sources of lead exposure. Average blood lead levels in adults were between 10–15  $\mu\text{g}/\text{dL}$  in the late 1970s. Now they are 1–2  $\mu\text{g}/\text{dL}$ . Despite this progress, research conducted over the past several decades emphasizes that major public health concerns persist.



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**Many family members are poisoned by “take-home” lead. Babies and young children are especially sensitive. Lead can affect their central nervous systems even before they are born—with potentially irreversible effects on their development and behavior.**

Raymond's employer had provided the test as part of the company's routine lead medical surveillance program. Raymond's high blood lead levels triggered investigations by the state and county health departments. They evaluated his workplace and home and tested the blood of family members. Raymond's 2-month-old son was found to have almost 10 times the average level of lead for a baby his age.

*The continuing overexposure of American workers to lead and the persistent occurrence of occupational lead poisoning is a national scandal.*

*—Dr. Philip Landrigan  
(Mount Sinai School of Medicine, New York)*





**Battery-production workers face high lead exposure.**

*The OSHA lead standards provide inadequate protection to lead workers; the existing evidence is compelling that we are subjecting lead workers to too large a burden of risk for both acute and chronic health effects.*

—Dr. Brian Schwartz and  
Dr. Howard Hu

- **Lead is still used in many workplaces.**

Although the use of lead in nonbattery products has declined in the US and some other parts of the industrialized world, the use of lead worldwide continues to grow, especially in battery applications.

- **Many workers have too much lead in their blood.** The US Centers for Disease Control and Prevention (CDC) reported that 37 states with reporting systems recorded 1,649 adults in 2003 and 1,425 in 2004 with blood lead levels of 40  $\mu\text{g}/\text{dL}$  or higher. “These numbers are likely to underestimate the true magnitude of the problem,” note lead experts and epidemiologists Dr. Brian Schwartz of Johns Hopkins University and Dr. Howard Hu of the University of Michigan. Many workers exposed to lead are not getting monitored.

As scientific evidence has shown more serious health effects associated with lower lead levels than previously anticipated, the number of persons who must be considered at risk increases dramatically. For example, in 2004, 43 California adults were reported with blood lead levels 40  $\mu\text{g}/\text{dL}$  or higher, while 2,930 had levels from 10 to 39  $\mu\text{g}/\text{dL}$ . This represents a fraction of the workers exposed to hazardous levels of lead.

- **Legal protections lag current knowledge about lead toxicity.** OSHA standards for permissible lead exposure limits were established in the late 1970s. At that time, the primary goal was preventing signs and symptoms of overt lead poisoning, particularly anemia, central nervous system problems, peripheral nerve damage, severe kidney damage, and reproductive

problems. To protect against overt lead poisoning, OSHA established permissible exposure limits that were intended to prevent the blood lead level of most workers from exceeding 40  $\mu\text{g}/\text{dL}$ .

Over the past three decades, extensive research has shown that lead causes significant health problems in adults at much lower levels. Cumulative exposure to low to moderate levels of lead has been associated with an increased risk of hypertension and reduced cognitive and kidney function. Low levels of lead exposure during pregnancy have been associated with an increased risk of miscarriage and impaired fetal growth and neurological development.

### **Low Lead Levels Cause Serious Health Problems**

Research on the health effects of lead has been published in *Environmental Health Perspectives*, a journal of the US National Institute of Environmental Health Sciences, as well as other peer-reviewed journals. The journal’s March 2007 issue included a mini-symposium on adult lead poisoning in which many experts reviewed recent developments in the field and offered new recommendations on medical management and prevention.

In April 2007, the Association of Occupational and Environmental Clinics—a national association of highly qualified academic and specialty clinics with expertise in environmental health—issued a guidance document that concluded, “the evidence for adverse effects [of lead] at levels of exposure far below those currently permitted by OSHA speaks forcefully for an immediate reduction in permissible exposure levels in the workplace.”

Serious health concerns include:

- **Hypertension.** Lead exposure has been consistently associated with increases in blood pressure in studies conducted in both workers

and the general population. Several studies have combined data from prior research, and many of these studies included workers whose blood lead levels were less than 20 µg/dL, which was still associated with increases in blood pressure.

Hypertension is a major public health concern because it is a leading risk factor for heart disease, stroke, and chronic kidney disease. These three diseases are among the 10 leading causes of death in the US—and heart disease is the top killer.

In a recent 12-year follow-up study of people age 40 or older enrolled in the third National Health and Nutrition Evaluation Survey (a scientific sample of the general US population), Schober and others observed that individuals with a blood lead level of 10 µg/dL or greater had a 60% higher relative risk of death from heart disease than those who had blood lead levels less than 5 µg/dL.

- **Decreased kidney function.** Low to moderate levels of lead exposure also have been associated with adverse changes in kidney function. This association may be even worse in people who have other risk factors for kidney disease, such as hypertension or diabetes.
- **Decreased brain function.** Decreased brain function in adults has been associated with blood lead concentrations of 20 to 50 µg/dL. Shih and Weisskopf and colleagues recently studied older adults who were children and young adults in the 1940s through 1970s, when blood lead levels in the general population were usually between 10 to 25 µg/dL. The researchers found that their cumulative lead exposure, measured by lead levels in bone, was associated with decreased performance on tests of hand-eye coordination and perception. (Lead can be stored in bone for

## Primary Sources of Occupational Lead Exposure

### Manufacturing

- Batteries
- Radiators
- Steelworks, blast furnaces
- Iron foundries
- Smelting and casting of brass, copper, and lead (including ammunition, solder, weights)
- Paint for industrial use
- Ceramics, tile, glass
- Machining and grinding lead alloys
- Plastics

### Mining

- Lead
- Copper

### Construction

- Bridges and tunnels
- Welding and cutting painted steel
- Paint removal and sanding
- Lead abatement
- Renovation/remodeling
- Wrecking and demolition

### Other

- Recycling (batteries, scrap metal, cable, electronics)
- Radiator repair
- Cutting and soldering wire cable; cable splicing
- Indoor firing ranges
- Stained glass

decades, so measuring lead levels in bone is one way to assess a person's past lead exposure.)

- **Reproductive problems.** Low to moderate levels of lead exposure during pregnancy have been associated with an increased risk of spontaneous abortion and with harmful effects on fetal physical growth and brain development. Two prominent studies in which the average maternal blood lead level during pregnancy was approximately 10 µg/dL or less found that prenatal lead exposure was associated with decreased childhood IQ.

### Current Lead Standards Do Not Protect Workers

Public health advocates have applauded US successes in reducing environmental levels of lead and protecting children from lead exposure. However, many assert that we are not protecting workers—and their children.

Occupational health experts agree that OSHA's lead standards have serious limitations:

- **The standards are based on outdated toxicity information.** Current standards require removing workers from lead exposure when their blood lead level exceeds 50 or 60 µg/dL. However, a number of studies show that harmful effects can occur at much lower levels.

### Chronic Effects of Lead in Adults

- High blood pressure
- Cardiovascular disease (heart attacks, strokes)
- Kidney disease
- Reduced fertility
- Depression, impaired thinking and reasoning
- Anemia

### Effects of Fetal or Childhood Exposure to Lead

- Miscarriage
- Reduced birth weight
- Delayed or impaired intellectual development
- Learning disabilities, behavioral problems

*A leading group of experts has recommended that the goal should be to keep workers' blood lead levels under 10 µg/dL.*

—Environmental Health Perspectives, March 2007

A group of experts (including co-author Kosnett) recently recommended removing workers from exposure “if a single blood lead concentration exceeds 30 µg/dL . . . [and] if exposure control measures over an extended period do not decrease blood lead concentrations to less than 10 µg/dL.”

Women who are or may become pregnant are advised to reduce lead exposure if their blood lead levels (BLLs) exceed 5 µg/dL.

- **The limit on lead in workplace air is not protective.** OSHA’s permissible exposure limit was set so that blood lead levels for most workers would not exceed 40 µg/dL. Most experts now think this level is far too high.

To prevent workers from having a blood lead level greater than 10 µg/dL over an extended period, the limit must be reduced.

In addition, unlike most environmental standards, the OSHA standards do not incorporate a margin of safety between the permissible exposure limit and the level associated with harmful effects on health.



**Protective gear and HEPA vacuums can reduce worker exposure.**

- **The air monitoring trigger for blood lead testing is inadequate.** Current standards require blood testing of exposed workers only if the lead measured in the workplace air exceeds a certain level. Because few workplaces conduct the required air monitoring, many workers never receive a blood test for lead. In addition, dangerous exposures can occur through incidental hand-to-mouth ingestion, despite relatively low air levels.

To protect workers, all individuals who work with lead should have periodic, employer-sponsored testing of blood lead levels.

- **OSHA is not required to update standards.** Environmental health scientists Drs. Ellen Silbergeld and Virginia Weaver of Johns Hopkins University note that environmental

### Health-based Management Recommendations for Lead-exposed Adults

< 5 µg/dL	No action
5–9 µg/dL	Discuss health risks Reduce lead exposure for women who are or may become pregnant
10–19 µg/dL	As above for BLL 5–9 µg/dL, plus: Decrease lead exposure Increase biological monitoring Consider removal from lead exposure to avoid long-term risks if exposure control over an extended period does not decrease BLL < 10 µg/dL, or if medical condition present that increases risk with continued exposure (e.g., chronic renal dysfunction, hypertension, neurologic disorders, and cognitive dysfunction)
20–29 µg/dL	Remove from lead exposure if repeat BLL measured in 4 weeks remains ≥ 20 µg/dL
30–39 µg/dL	Remove from lead exposure
40–79 µg/dL	Remove from lead exposure Refer for prompt medical evaluation Consider chelation therapy for BLL > 50 µg/dL with significant symptoms or signs of lead toxicity
≥ 80 µg/dL	Remove from lead exposure Refer for immediate/urgent medical evaluation Probable chelation therapy

Source: Kosnett et al., 2007, Table 1.

protection law requires periodic review of new data “to determine whether existing standards should be revised.” OSHA has no such requirement.

OSHA’s failure to update its lead standards ignores medical evidence of harm from lower-level, long-term exposures and has likely resulted in preventable disease in many lead-exposed workers.

In the mid-1970s, when OSHA established a permissible exposure limit and a medical removal requirement, adult blood lead levels from background environmental exposures were considered to be 19 µg/dL. Today it is more feasible to maintain workers’ blood lead levels below 10 µg/dL, in part because current background lead exposures contribute significantly less to their overall blood lead levels.

### Emerging Challenges and Promising Solutions

Throughout the world, there is a growing mountain of lead-containing “e-waste” created by discarded electronic products, such as computers containing lead solder and obsolete televisions containing lead-filled tubes. In addition, despite the move toward production of some hybrid and plug-in electric cars that use different battery technologies, the use of lead acid storage batteries in the automotive industry is likely to continue for some time. Although much of the lead in these batteries and consumer products can be recycled, the process of recycling itself can expose more workers to lead. This provides another reason to revise lead standards.

Because of lead’s hazards, some industries have successfully substituted safer compounds or changed their production practices to protect workers from exposure.

*Some substitutes were developed by companies that found it less expensive to use lead-free formulations than to continue practices that carried high health and economic risks.*

*Manufacturers may be able to learn about substitutes from their state health departments and trade industry associations.*

For example, lead-free solders are now used widely in products that are sold in Europe, such as computers and other electronic devices. Lead-free industrial paints and glazes are available, as are lead-free stabilizers for manufacturing insulated electrical wiring and other plastics. One battery manufacturer reduced employee exposures by developing a dye-transfer method to apply lead sulfate, replacing a more dangerous spray-on method.

Other promising solutions are emerging from collaborative efforts to safeguard health and support economic sustainability. For example, the Massachusetts Toxics Use Reduction Act of 1989 led to the creation of the Toxics Use Reduction Institute (TURI), a successful program at the University of Massachusetts Lowell that is promoting the development and use of safer materials through cooperation between industry, labor, and academia.

The goal of California’s “Green Chemistry” initiative is to develop products and manufacturing processes that are economically viable and safe for workers, communities, and the environment. Applied to lead, this initiative has the potential to promote policy changes and cooperative strategies that will protect the health of workers and their families, while creating new economic opportunities. (The importance of transforming workplaces to realize the promise of green chemistry will be the subject of *Perspectives* in spring 2009.)



Photo courtesy of [Silicon Valley Toxics Coalition](#) (2001)

**Used electronics should be recycled, with protections for workers exposed to lead and other toxic materials.**

## Prescription for Change

Workers who handle lead are at high risk for chronic health problems that exact a toll in increased costs of care, reduced productivity, and premature illness and death. The risks from lead also affect many workers in lower-wage jobs with no health benefits, whose care must be covered by publicly funded programs. This burden of disease results in substantial societal costs that can be avoided by preventing harmful lead exposures.

Actions that have been recommended to reduce workplace health hazards from lead exposure include:

### 1. Eliminate all unnecessary uses of lead.

Eliminate the use of lead in workplaces when safer alternative materials exist. Examples include lead in ammunition, paint-coated steel, and consumer products. Where elimination is not feasible, require manufacturing processes that minimize lead exposure.

Offer economic incentives for changing manufacturing processes or adopting safer substitutes for lead.

Emulate policies enacted in other countries that minimize or eliminate the use of lead and other hazardous substances. Currently, some products are formulated differently

for the European Union and US markets; less stringent US standards subject American workers and consumers to unnecessary lead exposures.

**2. Revise OSHA standards.** Update standards to reflect current scientific knowledge about the health effects of long-term, low-level lead exposure.

Needed changes include: a) lowering the threshold for removing a worker from exposure; b) lowering the permissible exposure limit; and c) eliminating air monitoring as the trigger for testing blood lead levels and preventing take-home lead. Workers with potential lead exposure by any route, not just inhalation, should receive periodic blood tests. The tests will let them and their employers know whether medical attention is needed and how well their lead safety program is working. Over time, revised standards that reduce lead exposure may save employers money by eliminating the need for some components of medical monitoring.

Some aspects of the revised policies may have to be phased in over time to address feasibility concerns, particularly as they relate to workers with a history of high exposure to lead. In such workers, lead accumulated in bone may result in the persistence of high blood lead levels that are difficult to reduce through temporary removal from work using lead.

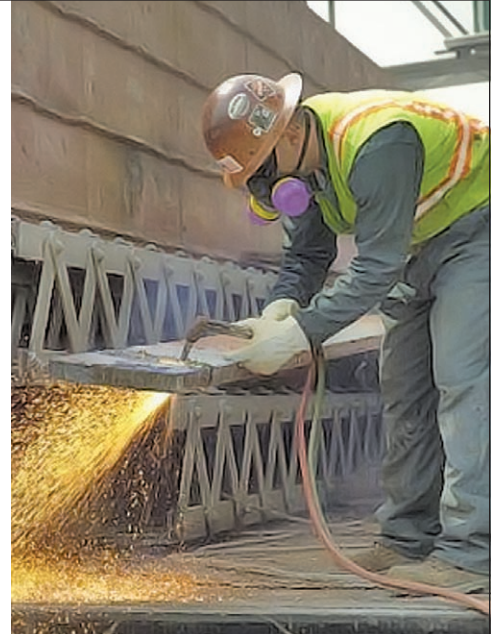
Increased enforcement of revised standards should be targeted to workplaces identified by public health departments based on results of blood lead testing or known lead risks.

**3. Reward compliance.** Create a system of incentives and rewards for investing in workplace health and safety. For example, employers with a proven health and safety track record might be granted favored status for public works contracts and projects. Track records can be determined through health department lead registries, along with OSHA compliance and Workers' Compensation records.

**4. Expand employer education and consultation.** Currently, there is no mechanism for ensuring that businesses know about the dangers of



Regular blood tests can identify the need for additional worker protection.



**Construction work carries high lead exposure risks.**

lead and other workplace hazards—and their requirements to mitigate them—prior to starting operations. Nor is there a central clearinghouse of information to help them choose safer substitutes for lead and other toxic materials.

Industrywide education on risk reduction and product substitution, coupled with on-site consultation and supervisor training in high-hazard industries, should be provided. Training supervisors is just as important as training workers in reinforcing the importance of jobsite health and safety.

#### **5. Expand worker education and outreach.**

Workers need effective health and safety training and educational materials to help them identify and take action on lead and other workplace hazards and solutions. Materials are needed in multiple languages and at appropriate literacy levels. In addition, active health and safety committees can increase worker participation in the creation of safer workplaces.

Although employers are responsible for educating workers about health and safety, government should take the lead in developing effective educational resources and establishing links with community-based organizations that can help reach underserved workers.

#### **6. Set enforceable reporting standards for clinical laboratories that perform blood lead tests.**

It has taken a major investment to develop the current systems under which laboratories report blood lead test results to 40 state public health departments that forward summary data to the CDC. Reporting requirements should be implemented in the remaining states, creating a nationwide system for tracking blood lead levels. In order to have a comprehensive and effective reporting system, clinical laboratories

must be required to collect and report critical information, such as the identity of the patient's employer (or the parent's employer when children are screened).

To enforce compliance, health departments should be able to assess and collect penalties for failure to provide timely and complete information. Compliance could be linked to laboratory certification. Enforceable compliance will facilitate tracking of which industries conduct testing and have higher exposures. It will also help ensure interventions for those overexposed to lead.

### **Conclusion**

Much more is known today about the health effects of lead than was known when OSHA enacted its lead standards in 1978 (for general industry) and 1993 (for the construction industry). Research has identified significant health risks at low to moderate levels of lead exposure that were formerly without recognized harm. Because lead can seriously impair cardiovascular health, cognition, reproduction, and kidney function, the persistence of elevated blood lead levels in workers may be a significant contributor to chronic illness and societal health care costs.

Clearly, current workplace standards are not protecting workers and their families from unsafe lead exposures. Action is needed to strengthen the lead standards and increase enforcement.

Employers and workers need support for introducing safer substitutes and work processes. In the short term, more education is needed to expand awareness about lead's dangers. These steps will ensure that workers like Raymond, and his children, do not suffer illnesses associated with exposure to lead at work or at home. Health problems caused by lead can, and must, be prevented.

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## To Learn More

California Department of Public Health, Occupational Health Branch, Occupational Lead Poisoning Prevention Program:

[www.cdph.ca.gov/programs/olppp](http://www.cdph.ca.gov/programs/olppp)

*Environmental Health Perspectives* special issue: Lead Exposure and Health Effects in Adults: Evidence, Management, and Implications for Policy (Vol. 115, No. 3, March 2007):

[www.ehponline.org/docs/2007/115-3/toc.html](http://www.ehponline.org/docs/2007/115-3/toc.html)

CDC/NIOSH Adult Blood Lead Epidemiology and Surveillance (ABLES) Program:

[www.cdc.gov/niosh/topics/ABLES/ables.html](http://www.cdc.gov/niosh/topics/ABLES/ables.html)

Online tools to find safe substitutes are available at the Toxics Use Reduction Institute, University of Massachusetts Lowell:

[www.turi.org](http://www.turi.org)

Center for Occupational and Environmental Health, University of California, Berkeley (see "About Us" for links to Irvine and Los Angeles locations):

<http://coeh.berkeley.edu>

California Department of Toxic Substances Control, Green Chemistry Initiative:

[www.dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative](http://www.dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative)

References for this article are available on p. 9 of the online version posted at:

<http://healthresearchforaction.org/perspectives/occupational-lead-exposure.pdf>

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