

CATHARINE M. TUMPOWSKY, MPH ■ LETITIA K. DAVIS, SCD
RICHARD RABIN, MSPH

Elevated Blood Lead Levels Among Adults in Massachusetts, 1991–1995

Ms. Tumpowsky and Dr. Davis are with the Occupational Health Surveillance Program, Massachusetts Department of Public Health, Boston. Ms. Tumpowsky is the Research Coordinator, and Dr. Davis is the Director. Mr. Rabin is the Coordinator of the Massachusetts Occupational Lead Registry, Division of Occupational Safety, Massachusetts Department of Labor and Workforce Development, West Newton.

S Y N O P S I S

Objective. Lead poisoning, the oldest recognized occupational disease, remains a danger for children and adults. Data collected for 664 cases reported to the Massachusetts Occupational Lead Registry in 1991–1995 were summarized in a 1998 state report. Here, the authors present some of the key findings from that report for a wider audience.

Methods. The authors summarize key findings of the 1998 state report.

Findings. Construction workers, in particular licensed deleaders and house painters, accounted for almost 70% of occupational cases involving blood lead levels ≥ 40 micrograms of lead per deciliter (mcg/dl) of blood. Among 100 workers with the highest blood lead levels (≥ 60 mcg/dl), 29% were house painters. Hispanic workers were over-represented in the Registry. A small proportion of cases were non-occupational, typically associated with recreational use of firing ranges or do-it-yourself home renovations.

Conclusion. Lead poisoning is a preventable disease, yet these data indicate that additional prevention efforts are warranted.

Address correspondence to:

Ms. Tumpowsky, OHSP, 6th Fl., MDPH, 250 Washington St., Boston MA 02108; tel. 617-624-5637; fax 617-624-5696; e-mail <catharine.tumpowsky@state.ma.us>.

Inhaled or ingested lead can cause both acute and chronic health problems in children and adults. Workers in many industries may be exposed to dangerous levels of lead. Lead is used in the manufacturing of many products, such as batteries, bullets, and plastic goods. Lead paint is found in many older residences, where it poses a health hazard not only for the children and adults who live in these homes but for adults removing paint or renovating. Lead has also been used extensively on exterior surfaces, placing bridge painters and other heavy construction workers at risk of lead poisoning.

In the occupational setting, lead may be absorbed into the body by inhalation of lead dust or fumes. Lead can also be ingested—for example, when workers eat their lunches in contaminated workplaces.

Massachusetts is one of more than 25 states with occupational lead registries that participate in the Adult Blood Lead Epidemiology and Surveillance (ABLES) program funded by the National Institute for Occupational Safety and Health (NIOSH). The goal of the Massachusetts Occupational Lead Registry is to reduce the incidence of lead poisoning among the state's workers and their families by identifying overexposure to lead in workers and workplaces. The Registry is located within the Division of Occupational Safety at the Massachusetts Department of Labor and Workforce Development.

Data collected by the Registry from April 1991 to December 1995 were summarized in a state-issued report titled *Lead at Work: Elevated Blood Lead Levels in Massachusetts Workers*, released in 1998.¹ In what follows, we present some key findings from that report. (A detailed analysis of elevated blood levels among construction workers was published in 1994.²)

DATA COLLECTION METHODS

The lead standard of the US Occupational Safety and Health Administration (OSHA) requires control of exposure to ambient lead dust and medical monitoring of all workers exposed to lead.³ The standard calls for engineering controls to reduce airborne lead concentrations, personal protective equipment, and hygiene facilities including clean lunch rooms and showers. Massachusetts lead registry staff have observed that compliance with the medical monitoring provision is far from complete.

Since April 1991, clinical laboratories in Massachusetts have been required to report blood lead concentrations ≥ 15 micrograms of lead per deciliter (mcg/dl) of blood in people ages 15 and older to the Massachusetts

Occupational Lead Registry.⁴ Laboratories are required to submit reports to the Registry weekly. Registry staff believe that laboratory reporting of elevated blood lead levels is nearly complete.

At the Registry, reports of people with blood lead levels ≥ 25 mcg/dl or greater are entered into a computerized database. (During the study period, reports of levels ≥ 15 mcg/dl but < 25 mcg/dl were filed but not entered into the database.) Because of resource limitations, the Registry follows up only on people with blood lead levels ≥ 40 mcg/dl; OSHA requires increased medical surveillance at this level. Using a structured questionnaire, a trained, bilingual (English-Spanish) interviewer obtains information over the telephone about a variety of topics including source of lead exposure (for example, occupation, hobby, home renovation), working conditions, and demographics including racial and ethnic self-identification. Respondents are asked to choose their answers from a predetermined list of responses. For example, seven choices are provided for "race" (white, black, Hispanic, Asian/Pacific Islander, American Indian/Alaskan, other, unknown), and 18 choices are provided for "ethnicity" (including Puerto Rican, Dominican, Brazilian, Cape Verdean, Eastern European, African, Chinese, Cambodian, and so on). If occupation is the reported source of over-exposure, individuals are asked additional questions about their employer's efforts to control lead in the workplace. Health care providers are also contacted by telephone to confirm or provide information, including industry and occupation.

Case definition. The Registry uses the NIOSH definition of a case of lead poisoning: a reported blood lead level ≥ 25 mcg/dl in a person for whom there were no reports of blood lead levels exceeding this threshold during the previous calendar year. This case definition is used in an attempt to measure the *incidence* of lead poisoning; thus, the same person might be counted more than once over the study period. For the analyses reported here, we used the highest blood lead level reported for a case to determine the distribution of cases by blood lead level.

FINDINGS

From April 1991 through December 1995, the Registry received 5993 reports of blood lead levels ≥ 25 mcg/dl for 2457 separate individuals, with 2584 cases meeting the NIOSH case definition. Of cases meeting the NIOSH definition, 664 (26%) involved people with at least one

blood lead level ≥ 40 mcg/dl, the level at which OSHA requires increased medical surveillance. (Duplicate reports were filed for 10 individuals.) Ten percent of cases (266) involved people who had a blood lead of at least 50 mcg/dl, a level that should trigger immediate removal from exposure under both the OSHA construction lead standard and Massachusetts regulations for residential lead paint workers (“deleaders”).

Information about source of exposure was obtained from either individuals with elevated blood lead levels or their physicians for 646 (97%) of the 664 cases involving people with blood lead levels ≥ 40 mcg/dl. Ninety-nine (15%) of the 646 cases were attributed to non-occupational exposures. The two most common sources of lead exposure for the non-occupational cases were home renovation, which accounted for 38% of the 99 non-occupational cases, and shooting range use, which accounted for 36% of these non-occupational cases.

The industry was known for 546 of the 547 occupational cases involving blood lead levels ≥ 40 mcg/dl (Figure 1). The majority (69%) of the 546 cases involved people employed in construction, predominantly the deleading and painting industries. Of 161 painters, 60 were bridge painters and 101 were house painters. Blood lead levels ≥ 60 mcg/dl were reported for 100 of these 546 occupational cases, 80% of which involved construction

workers. This high blood lead group included 46 painters and 21 deleaders. Three of the house painters had lead levels in the range of 130 mcg/dl – 135 mcg/dl, the highest occupational exposures identified by the Registry during the study period.

Interviews were completed for 320 (59%) of the 546 cases involving people with blood lead levels ≥ 40 mcg/dl attributed to occupational exposures. Information on industry and occupation was not collected from one respondent. Twenty-seven (9%) of interview respondents described themselves as Hispanic; this proportion was approximately four times the Hispanic proportion of the employed population of Massachusetts.⁵

Among the 87 deleaders interviewed, 84 (97%) reported being tested as part of an employer-sponsored medical screening program, while among the 233 respondents who worked in other industries, the figure was 50% (Figure 2). Among the 103 house painters interviewed, only 35% said they had been tested as part of a medical monitoring program. Almost all deleaders (95%) also indicated that they had received training about lead hazards, compared with 48% of respondents employed in other industries. Only 38% of house painters reported having received training about lead hazards. Of the 36 people interviewed who had blood lead levels ≥ 60 mcg/dl, a level at which medical removal from further exposure is

Figure 1. Distribution by industry of cases involving blood lead levels ≥ 40 mcg/dl (N = 546 cases for which industry was known)

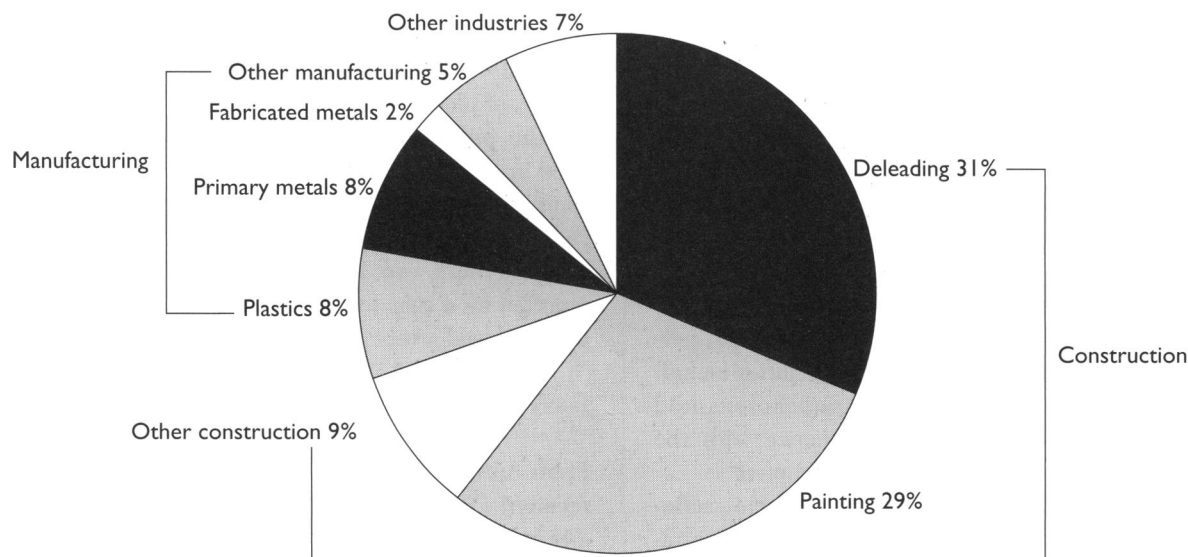
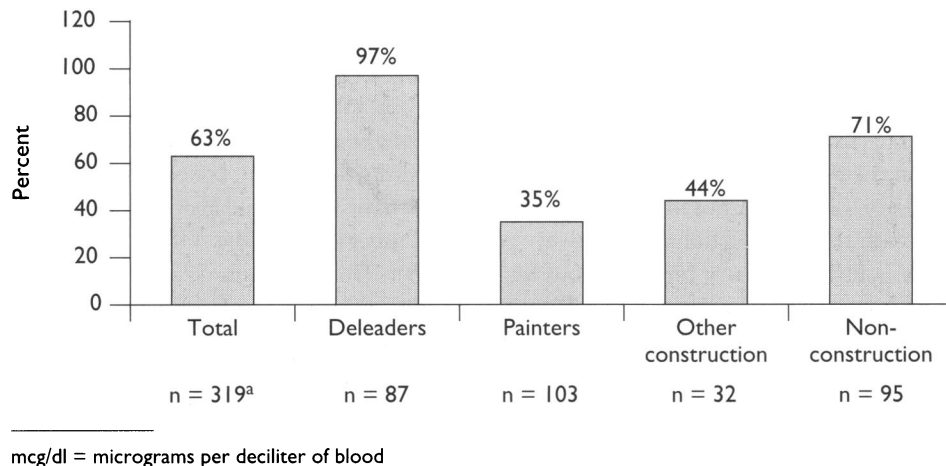


Figure 2. Self-reported participation in medical screening among 319 workers with blood lead levels ≥ 40 mcg/dl



required by OSHA, 21 (58%) said that they were still working in conditions that exposed them to lead at the time of the interview.

DISCUSSION

Surveillance of elevated blood lead levels in adults through the collection of clinical laboratory reports allows identification of industries and populations for which intervention efforts are needed. The above data suggest that workers in a variety of industries, most notably the construction industry, may still be over-exposed to lead in Massachusetts. These findings also suggest that Hispanic workers are overrepresented in the population of workers with elevated blood lead levels, and that non-occupational exposures to lead in firing ranges and home renovation are causes of concern.

Construction workers. The proportion of cases involving people who worked in construction (69%) is substantially higher than reported by lead registries in other states, as summarized in an earlier report.² The extent of residential deleading and state requirements for licensing deleaders likely account in part for this difference. In Massachusetts, lead paint abatement (deleading) is required whenever a child younger than age 6 lives in a residence that has lead paint. This requirement is virtually unique in the United States, and, while compliance is not complete, several thousand housing units are deleaded each year (Unpublished data, Asbestos and Lead Program, Massachusetts Department of Labor and Workforce

Development, 1996–1999). Deleaders must be licensed, and in order to obtain and keep their licenses, they must take an initial training course and a yearly refresher course. In addition, they must have a blood lead test every two to three months and report those results to the licensing office. Case ascertainment is therefore likely to be higher for deleaders than workers in other industries with fewer regulations.

Nearly 100% of the deleaders interviewed reported that they had been tested as part of a medical monitoring program and that they had received training in the hazards of lead. Findings from the first two years of a mandatory blood testing program in Taiwan show an apparent reduction in blood lead levels among lead-exposed workers.⁶ The licensing requirements for deleaders in Massachusetts appear to promote medical monitoring in this industry, yet despite strict licensing requirements, many deleaders continued to have high blood lead levels during the study period. Deleading is a hazardous occupation, and increased efforts to prevent overexposure to lead in this industry are warranted.

Among the 100 cases with the highest blood lead levels, 29% involved house painters. Surveillance systems in other states have reported similar findings⁷ (Personal communication, Milinda Daye, MPH, Occupational Health Surveillance Program, Connecticut Department of Public Health, May 1999). We have found no published studies on airborne lead concentrations associated with house painting. However, the common use of power sanders, dry scraping, and other abrasive methods of paint removal suggests that lead exposures in this industry can be quite high. Worksite investigations conducted by the Division of Occupational Safety of the Massachusetts Department of Labor and Workforce Development reveal that protective measures such as the use of dust-suppressing controls and appropriate respirators are often lacking. The California Department of Health Services found average eight-hour exposures of 420 mcg/m³ of air from dry scraping, more than eight times the eight-hour

exposure limit set by OSHA.⁸ NIOSH has reported that the use of power tools and torch burning can create occupational exposures to airborne lead of more than 200 times the OSHA Permissible Exposure Limit (PEL).⁹

As further discussed in the following section, the number of house painters reported to the Registry is likely a substantial undercount of the true number of house painters with elevated blood lead levels. Federal regulations requiring construction workers, including house painters, to have blood lead monitoring were not in place until 1993, and compliance with these regulations is likely to be limited in the house painting industry for several reasons. The house painting industry is difficult to regulate given the informal nature and small scale of many businesses. Workers often move from one job site to another. As a result, it is sometimes difficult to establish responsibility for medical monitoring. Because of these practical difficulties, it is important to direct education and prevention efforts to small businesses and temporary workers through trade unions, trade associations, building and paint supply stores, and other venues.

Hispanic workers. The finding that Hispanic workers are over-represented in the Registry is consistent with earlier reports from several other states, including New Jersey,¹⁰ California,¹¹ and Texas.¹² Workers from minority ethnic groups, especially black and Latina(o) workers, have been shown to be over-represented in many of the more hazardous industries and occupations, including jobs with greater potential for lead exposure.¹³⁻¹⁶ A number of studies conducted in New Jersey during the mid-1980s and early 1990s found that minority workers' rates of occupational lead poisoning, fatal construction injuries, work-related finger amputations, and chemical poisonings leading to hospitalization (most of which occurred at work) all exceeded the rates for white workers.¹⁰ Lead poisoning prevention efforts should be directed at high risk industries in which minority workers are disproportionately represented. Furthermore, there is clearly a need to develop linguistically and culturally appropriate educational programs to educate minority workers on the hazards of lead.

Non-occupational exposure. Although the majority of cases of elevated blood lead levels in adults were found to be due to occupational exposures, a small but significant proportion of cases involved non-occupational sources. There have been numerous reports from both Massachusetts and elsewhere of lead absorption from recreational use of firing ranges. These reports are not surprising,

since airborne lead concentrations at firing ranges can be high (often 500 mcg/m³–1000 mcg/m³ or higher¹⁷). The number of shooters with elevated blood lead levels is not known; however, since there are more than 800,000 competitive pistol shooters in the United States and an unknown number of recreational shooters,¹⁷ the public health significance is substantial.

Non-occupational exposure to lead during home renovation is likewise an important concern. Most homes built before 1978 have lead-based paint. According to a survey published in 1990 by the US Department of Housing and Urban Development, 57 million of the 77 million privately owned and occupied homes built before 1980 contained lead paint.¹⁸ Painting and renovating by scraping, sanding, or burning lead paint can generate dangerous levels of airborne lead. Children who live in older residences that are undergoing renovation activities are also at risk.¹⁹ Elevated blood lead levels due to home renovation underscore the widespread extent of lead in homes and the potential for exposure even in projects not specifically undertaken for the purpose of deleading. The US Environmental Protection Agency and several state health departments have in recent years published educational materials on this subject, which should be widely distributed.

Limitations. The findings in this report are subject to several limitations. Although OSHA standards require employers to conduct periodic blood lead testing of lead-exposed employees, studies have shown that a large proportion of these workers are not provided with medical monitoring for lead. In the late 1980s, a California study found that only 1.4% of lead-using companies had medical surveillance programs.²⁰ A similar study in Washington state found that only 17% of lead-using employers routinely tested their employees.²¹ Also indicative of the lack of blood lead testing is the fact that while the 27 adult lead registries in the country reported about 12,000 cases of blood lead levels ≥ 25 mcg/dl in 1997,²² the Third National Health and Nutrition Examination Survey (NHANES) estimated a total of 700,000 adults nationwide with blood lead levels ≥ 25 mcg/dl.²³ Therefore, the Massachusetts findings, like findings from other states, must be considered a conservative estimate of the true extent of elevated blood lead levels among workers.

In addition, because employers in some industries are more likely to conduct medical monitoring and identify cases of elevated blood lead, the distribution of cases in the Registry by industry does not necessarily reflect the underlying distribution of elevated blood lead levels by

industry in the population. Workers in industries that are less likely to offer blood lead testing, such as house painting, may not be tested until they become symptomatic and seek medical care.

Furthermore, use of NIOSH's case definition presents a limitation. The use of this definition is an attempt to measure the *incidence* of occupational lead poisoning year by year, not the *prevalence* in the population. Thus the data reported here under-represent the true extent of the problem. In addition, while the focus on new cases is important, it should not obscure the existence of some individuals who remain in the Registry with elevated blood levels year after year.

Finally, it should be noted that the findings in this paper are based on data collected more than five years

ago. However, the data collected by the lead registry have remained remarkably stable over the past 10 years, as evidenced by analyses conducted on 1991–1993 data and preliminary analyses conducted in 1998. The authors have no reason to believe that the findings reported here are no longer relevant.

Conclusion. Lead poisoning is a wholly preventable disease. In *Healthy People 2010: National Health Promotion and Disease Prevention Objectives*, the federal government set as a goal the elimination of exposures that result in workers having blood lead levels >25 mcg/dl.²⁴ The information collected by the Massachusetts Occupational Lead Registry indicates that significant steps remain to be taken to achieve this goal.

References

1. Massachusetts Department of Public Health and Massachusetts Department of Labor and Workforce Development. Lead at work: elevated blood lead levels in Massachusetts workers, April 1991–December 1995. Boston: MDPH and MDLW; 1998 Apr.
2. Rabin R, Brooks DR, Davis LK. Elevated blood lead levels among construction workers in the Massachusetts Occupational Lead Registry. *Am J Public Health* 1994;84:1483-5.
3. Department of Labor (US). Occupational Safety and Health Administration. Lead standard. 29 CFR 1910.1025, 1926.62.
4. Massachusetts Department of Labor and Workforce Development. Code of Massachusetts Regulations: Occupational Lead Registry, Boston, Mass. 454 CFR 23.00, 1991.
5. Department of Labor (US). Geographic profile of employment and unemployment. Washington: DOL; 1993.
6. Wu T-N, Shen C-Y, Liou S-H, Chao S-L, Hsu C-C, Lin F-T, et al. Reducing lead exposure by surveillance system: the Taiwan experience. *Arch Environ Health* 1998;53:75-8.
7. New York State Department of Health. Info for consumers. Section II-lead tests by blood lead level. Available from: URL: <http://www.health.state.ny.us/nysdoh/environ/hmr/section2.htm>
8. California Department of Health Services, Occupational Lead Poisoning Prevention Program. California Painters Project: helping small business work safely with lead. Berkeley: California Department of Health Services; 1998 Feb.
9. National Institute for Occupational Safety and Health (US). Protecting workers exposed to lead-based paint hazards: a NIOSH report to Congress. Washington: NIOSH; 1997. Pub. No. 98-1122.
10. New Jersey Department of Health. Occupational health surveillance update. Trenton: New Jersey Department of Health; 1993 Winter.
11. Maizlish NA, Rudolph LA, Royce S, Agello E, Rosenberg J, Tabb K. Elevated blood lead in California adults, 1987–1990. Berkeley (CA): California Department of Health Services, California Occupational Health Program; 1991. Pub. No.: CDHS (COHP) SR90-001.
12. Texas Department of Health, Epidemiology Division. Epidemiology in Texas: annual report. Austin: Texas Department of Health; 1989.
13. Environmental Protection Agency (EPA). Environmental equity: reducing risk for all communities. Washington: EPA; 1992.
14. Friedman-jimenez G. Occupational disease among minority workers: a common and preventable public health problem. *AAOHN J* 1989;37(2):64-70.
15. Redmond CK, Ciocco A, Lloyd JW, Rush HW. Long-term mortality study of steelworkers. VI. Mortality from malignant neoplasms among coke oven workers. *J Occup Med* 1972;14:621-9.
16. Alexander DL. Chronic lead exposure: a problem for minority workers. *AAOHN J* 1989;37:105-8.
17. Ozonoff D. Lead on the range. *Lancet* 1994;343:6-7.
18. Department of Housing and Urban Development (US). Comprehensive and workable plan for the abatement of lead-based paint in privately owned housing. Washington: HUD; 1990.
19. Children with elevated blood lead levels attributed to home renovation and remodeling activities—New York, 1993–1994. *MMWR Morb Mortal Wkly Rep* 1997;45:1120-3.
20. Rudolph L, Sharp DS, Samuels S, Perkins C, Rosenberg J. Environmental and biological monitoring for lead exposure in California workplaces. *Am J Public Health* 1990;80:921-5.
21. Nelson NA, Kaufman JD. Employees exposed to lead in Washington state non-construction workplaces: a starting point for hazard surveillance. *Am Ind Hyg Assoc J* 1998;59:269-77.
22. Adult Blood Lead Epidemiology and Surveillance—United States, first quarter 1998, and Annual 1994–1997. *MMWR Morb Mortal Wkly Rep* 1998; 47: 907-911.
23. Pirke JL, Brody DJ, Gunter EW, Kramer RA, Paschal DC, Flegal KM, et al. The decline in blood lead levels in the United States: the National Health and Nutrition Examination Surveys (NHANES). *JAMA* 1994;272:2884-91.
24. Department of Health and Human Services (US). Healthy People 2010. Reduce the number of persons who have blood lead concentrations from work exposures. Vol. 2, Section 20-7. Available from: URL: <http://www.health.gov/healthypeople/document/tableofcontents.htm#volume2> ■