Elevated Blood Lead in California Adults, 1987: Results of a Statewide Surveillance Program Based on Laboratory Reports

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Abstract: California medical laboratories that test for blood lead are required to report results exceeding 1.21 μmol/L (25 μg/dl). Between April and December 1987, the California Department of Health Services received 3,077 blood lead reports from 34 laboratories for 1,293 civilian, non-institutionalized adults.

Approximately 1 percent of all reports exceeded 3.87 μmol/L (80 μg/dl), 7 percent exceeded 2.42 μmol/L (50 μg/dl), and 21 percent exceeded 1.93 μmol/L (40 μg/dl). Individuals tested were overwhelmingly male (94 percent), disproportionately Hispanic surnamed (44 percent), and most often residents of Los Angeles County (81 percent).

Workers in lead smelting, battery manufacturing, and brass foundries accounted for nearly 80 percent of reports. Construction, radiator repair, pottery and ceramics manufacturing, and gun firing ranges accounted for the remainder. All adults with reports of ≥2.90 μmol/L who were contacted reported an occupational exposure. Approximately half were not in routine medical monitoring programs. Despite OSHA standards, elevated blood lead with the potential for serious acute and chronic lead poisoning in California adults remains a significant public health and major occupational health concern. (*Am J Public Health* 1990; 80:931–934.)

Introduction

Under a state law in effect since January 1, 1987, California medical laboratories performing tests for blood lead have been required to report personal identifiers and blood lead levels of individuals with tests exceeding 1.21 μmol/L (25 μg/dl), irrespective of age. The California Department of Health Services (CDHS) was charged with notifying laboratories, establishing a proficiency program for laboratories, designing report forms, and tabulating the reports. Over 95 percent of blood lead reports received from this program in 1987 were for persons greater than 16 years of age, and are the basis of this report.

Workplace exposures to lead are regulated under a standard issued in 1978 by the federal Occupational Safety and Health Administration.[1] The standard established an exposure limit of 50 $\mu g/m^3$ for airborne lead exposures for an 8-hour work day, and required employers to provide training, respiratory protection, work clothes changes, shower facilities, and a medical surveillance program, including annual physical examinations and periodic blood lead tests to eligible employees. Workers in agriculture and construction are currently excluded. The standard requires that workers with blood lead levels exceeding 1.93 μmol/L be re-tested bimonthly and those exceeding 2.90 μg/dl (or average 2.41 μmol/L on three previous tests) be immediately transferred and placed in jobs with low or no exposure.

This article describes initial results from a pilot program for surveillance of blood lead reports from medical laboratories and from follow-up of adults with reported blood lead levels of 2.90 μmol/L.

Methods

Patient identifiers, demographics, blood lead level, and other relevant information were reported by laboratories on specially designed forms. If the gender field of the registrant was blank, one was designated on the basis of first name of the registrant. An indicator of Hispanic surname was also designated. Industry of employment was based on an assignment of the Standard Industrial Classification (SIC)[2] code for reports that included an employer identifier. Employer name and address on the report form were matched to listings in the 1987 California Manufacturers Directory.[3] The SIC code for the primary business activity was then assigned to the report. Due to a paucity of complete data, occupation was not coded.

Follow-up of Elevated Blood Lead Reports

A working draft protocol for follow-up of reports was implemented for cases exceeding 2.90 μmol/L. Individuals and their physicians and employers were traced, and structured telephone interviews were administered to determine: the level of direct medical supervision, if any; work history and source of exposure, occupational and/or non-occupational; number of household contacts less than 7 years of age; number of co-workers exposed to lead; use of personal protective equipment and hygienic practices at work; and application of medical removal requirements of the federal OSHA lead standard.

An information packet was sent to the worker, his/her physicians, and employer.[4–6] Subsequent blood lead reports were tracked until levels fell below 1.93 μmol/L; workers were re-contacted if their subsequent blood lead levels abruptly increased.

Employers were informed of free industrial hygiene services available from the state OSHA Consultation Services, or encouraged to seek private consultants for technical consultation. Apparent egregious violations of the OSHA lead standard were channeled to appropriate enforcement agencies for follow-up. A recommendation to screen children and/or household contacts for elevated blood lead was forwarded to the state and local health officials when household contacts included children at risk of parental take-home exposures or non-occupational activities, or when an adult's exposure was non-occupational.

Laboratory Certification

A proficiency program was established by CDHS, and, according to its protocol, laboratories are certified as proficient if lead concentrations are reported within 15 percent of

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target values for concentrations less than 1.93 μmol/L, or within .29 μmol/L of target values for concentrations greater than 1.93 μmol/L in 75 percent of at least nine reference samples.

Results

Blood Lead Distributions

Between April and December 1987, CDHS received 3,077 blood lead reports from 34 laboratories for 1,293 civilian, non-institutionalized adults, 16 years and older. Blood lead level was filled in on 3,024 report forms, and 2,643 reports were greater than 1.21 μmol/L (Table 1). Approximately 60 percent of individuals had only one test, 14 percent had two tests, 5 percent had three tests, and 22 percent had four or more tests in 1987.

Of reports greater than 1.21 μmol/L, approximately 1 percent (24) were equal or greater than 3.87 μmol/L, 7 percent (198) were equal or greater than 2.42 μmol/L, and 25 percent (649) were equal or greater than 1.93 μmol/L. Counting individuals once, but at their highest blood lead level in 1987, 355 individuals (31 percent) had a peak blood lead level of 1.93 μmol/L or greater; 124 (11 percent) peaked at 2.42 μmol/L or greater; 56 (5 percent) peaked at 2.90 μmol/L or greater; and 16 (1 percent) had peak levels at or above 3.87 μmol/L (Table 1).

Distribution by Age, Sex, Hispanic Surname, and Residence

The age distribution was that of a working population with 32 percent in their fourth decade (Table 2). Individuals were overwhelmingly male and disproportionately Hispanic surnamed. The blood lead distribution was similar in those with and without Hispanic surnames. Hispanics comprise approximately 24 percent of California's population. Of reports with known zip code, 81 percent were of residents of Los Angeles County (Table 2).

Distribution by Industry

Ninety-one employers were identifiable by name, and accounted for 2,521 (82 percent) reports. SIC codes were not obtainable for 1,109 (36 percent) of reports because the employer identifiers were blank or did not match entries in the California Manufacturer's Directory (Table 3). Based on the laboratory name (indicating that an employer-operated laboratory performed the blood lead analysis), three employers apparently accounted for 67 percent (2,070) of reports.

TABLE 1—Distribution of Blood Lead Reports at or Above 1.21 μmol/L, April–December 1987

Blood Lead Level	Total Reports[a]		Individuals at Peak Lead Level[b]	
μmol/L[c]	No.	%	No.	%
1.21–1.44	717	27	275	24
1.45–1.92	1277	48	508	45
1.93–2.41	451	17	231	20
2.42–2.89	98	4	68	6
2.90–3.37	52	2	26	2
3.38–3.86	24	.9	14	1
3.87–4.34	11	.4	5	.4
4.35–4.82	6	.2	6	.5
4.83–5.30	2	.1	2	.2
5.31+	5	.2	3	.3
Total	2643	100	1138	100

a) 382 reports less than 1.21 μmol/L (25 μg/dl) were received, but not included above.
b) Includes multiple reports on some individuals.
c) 1 μmol/L = 20.7 μg/dl; 10 μg/dl = .483 μmol/L.

TABLE 2—Demographic Characteristics of Individuals with a Blood Lead Report, April–December 1987

Item	No.	Percent
Age (years)[a]		
16–19	8	1
20–29	134	21
30–39	203	32
40–49	136	21
50–59	114	18
60+	45	7
Sex[b]		
Male	1059	94
Female	71	6
Surname[c]		
Non-Hispanic	687	56
Hispanic	547	44
County of Residence[d]		
Los Angeles	1092	81
Other	258	19

a) Excludes 653 reports not stating age.
b) Excludes 162 individuals for whom gender was not stated or determined.
c) Excludes 37 individuals for whom surname was not classified.
d) Excludes missing data (1457 reports) and 27 out-of-state reports.

Apparently, the reporting was done in the context of employer-based medical screening programs mandated by the OSHA lead standard. Three employers engaged in secondary lead smelting, 11 employers engaged in battery manufacture, and 12 brass, lead or copper foundries accounted for 1,656, or 55 percent of all reports. Construction, radiator repair, pottery and ceramics manufacturing, and gun firing ranges accounted for the remainder. Reports of construction workers in demolition and paint stripping represented 0.7 percent (23 of 3,077) of all reports, with 15 percent (15 of 100) of reports exceeding 2.90 μmol/L.

Follow-up of Persons with Elevated Blood Lead Levels

Of the 57 persons with blood lead levels exceeding 2.90 μmol/L, 33 (58 percent) were traced and completed telephone interviews; all persons reported occupational lead exposures. Sixteen reported that their blood lead test was part of an employer-sponsored medical monitoring program; 13 were symptomatic workers who sought medical care from a private physician. At least 10 persons had been hospitalized for treatment, including chelation. Many workers expressed deep reservations and fear of job discrimination when CDHS interviewers proposed pursuing follow-up activities with the employer (even without disclosing the name of the case).

Some individuals apparently covered by the OSHA lead standard had not been removed from their job, and some individuals who had been removed were working at other jobs within the same company at a lower pay rate in apparent violation of the OSHA lead standard. One worker alleged that employers colluded to prevent him from obtaining employment because of a history of elevated blood lead.

Because of worker concerns over potential employment discrimination, the protocol was modified and employer contact was generally limited to emergencies involving reports of blood lead exceeding 3.87 μmol/L. At levels between 2.90 and 3.87 μmol/L, follow-up with the employer was pursued if an employee did not express reservations about contact with the employer, or other workers at the worksite with elevated blood lead levels did not object to contact with the employer.

A number of physicians apparently charged with carrying out employer medical monitoring programs were unfa-

TABLE 3—Distribution of Blood Lead Reports by Industry, April–December 1987*

SIC Code	Industry	Reports**		Individuals		Facilities
		N	%	N	%	N
3341	Secondary lead smelting	1126	37	127	10	3
3691	Battery manufacturing	496	16	246	19	11
3362	Brass foundry	130	4	107	8	12
3721	Aircraft manufacturing	40	1	30	2	1
3269	Pottery products	38	1	20	2	2
9221	Firing range (police)	27	.9	13	1	6
1795	Construction, demolition	17	.6	5	.4	4
7539	Radiator repair	15	.5	8	.6	6
3674	Semi-conductors	9	.3	8	.6	1
7997	Firing ranges (sport)	8	.3	7	.5	4
2782	Printing	7	.2	5	.4	1
1721	Painting contractors	6	.2	3	.2	1
3079	Miscellaneous plastics	6	.2	5	.4	1
4811	Telephone communications	6	.2	4	.3	1
1000	Mining	5	.2	3	.2	2
3351	Copper manufacturing	5	.2	3	.2	1
3699	Electrical machinery	5	.2	5	.4	1
3714	Vehicle parts	5	.2	2	.2	2
——	Missing#	1109	36	677	52	

*Coding of the Standard Industrial Classification (SIC, 1972 Rev.) was based on matching the employer name on the lead report form to those listed in the 1987 California Manufacturer's Directory.

**Less than five reports were received in each of the SICs: inorganic pigment (2816), printing ink (2893), non-ferrous wire (3357), non-ferrous foundry (3360), fabricated metals (3499), special tool manufacturing (3544), local transportation (4111), ship manufacturing and repair (3731), and assay laboratories (7397). Table includes all reports received, including some reports below 1.21 μmol/L.

#Missing data: SIC could not be assigned either because employer identifiers were missing on report, or did not match to entries in the California Manufacturer's Directory (1987).

miliar with the OSHA lead standard. A few physicians were totally unfamiliar with normal limits of blood lead in adults.

Discussion

Before implications of these data can be discussed and conclusions drawn, limitations and potential biases of the data will be discussed. The most important potential bias is the undercounting of lead-exposed individuals with elevated blood lead levels who do not have their blood tested periodically for lead. This prevents the full estimation of the prevalence of elevated blood lead among California adults. Undercounting that differentially affects subgroups also can introduce distortions.

Certain geographic areas and certain industries were probably underrepresented. For example, data from the California Employment Development Department (CEDD) indicated that there were approximately 14,500 employees in 2,790 radiator repair establishments in 1985. However, only three employers, accounting for 15 reports were found in the lead registry in 1987. Similarly, in lead battery manufacturing, where there also is a high probability of direct lead exposure, 11 employers accounting for 496 reports were found in the lead registry, although CEDD data indicated that there were 33 employers with 2,500 workers in June 1985.

The lack of employer-based medical monitoring programs for lead-exposed workers appears to be a significant problem. A recent survey based on a probability sample of California employers indicated that only 2 percent of workers with direct exposures to lead were enrolled in an employer-sponsored, medical monitoring program.[7] Some industries, such as construction, are exempted from the lead standard and medical monitoring requirements.

Underreporting may also result when an out-of-state laboratory analyzed the blood lead of California workers, or an in-state laboratory failed to report. While some out-of-state laboratories did report on a voluntary basis, out-of-state laboratories appear to analyze 47 percent of blood tests of California employers.[7] Since virtually all California laboratories performing lead tests were contacted by CDHS, and failure to report can result in a fine, it is probable that few, if any, California laboratories did not report.

Lack of complete information on basic demographic data such as age, residence, and occupation occurred in a significant proportion of reports. This limits an accurate profile of subgroups where risk may be concentrated and surveillance needs to be expanded.

The timeliness of reporting is another concern for timely case follow-up, particularly for persons with highly elevated blood lead levels. On average, reports were received by CDHS 22 days after blood lead specimens were analyzed by the laboratory. Only 9 percent of report forms were received by CDHS within 72 hours of analysis as required by the reporting requirement. While emergency response was not initially anticipated, follow-up of highly elevated lead cases revealed situations in which imminent hazards had not been abated, and recommendations had or might have had a positive impact.

These data from California's newly implemented blood lead surveillance program indicate the need for intensified lead poisoning surveillance, education, and enforcement in California. Workers, employers, physicians and other health care personnel, laboratories, and government agencies would benefit from expanded training and education focused on lead-related health problems.

The wider implications of this finding is that without an immediate and concentrated effort to reduce occupational lead exposures, it is unlikely that the Public Health Service goal[8] of eliminating lead poisoning by 1990 will be met in California. These data also indicate that current regulations for construction workers exposed to lead do not prevent lead poisoning, and revisions need to be seriously considered. Further, these data indicate the need for occupational health and safety agencies to more vigorously and expeditiously enforce the lead standard.

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Johnson Foundation Announces $3 Million R&D Program to Improve Patient Care

An increasing amount of complex patient care in the United States is being delivered in nursing homes, in ambulatory care clinics, and at home. Yet, the tools and techniques needed to assure that patients receive high quality care in these settings have not yet been fully developed. In an effort to improve services for long-term and ambulatory care patients, the Robert Wood Johnson Foundation of Princeton, NJ, will make available up to $3 million to stimulate and support research and demonstration projects that will identify new and practical mechanisms to assure the delivery of high quality patient care.

The types of projects that will be considered for funding under the foundation's three-year initiative are: research and development of tools that assess the quality of patient care and identify patient care problems and exemplary practices: demonstrations of new approaches to improving quality of care; and evaluations of policies and of systems designed to improve quality of care.

Projects considered for funding may: develop new ways to identify problems in the quality of patient care in specific settings; test existing tools; design and demonstrate institution-wide systems to locate and solve patient care problems; or evaluate existing improvement systems or policies. Projects involving clinical interventions, treatment or drug therapies will *not* be considered under this initiative.

Institutions wishing to apply for funds are asked to submit five copies of a letter of intent of no more than four double-spaced pages, addressed to: Phyllis Kane, Program Assistant, Robert Wood Johnson Foundation, P.O. Box 2316, Route 1 and College Road East, Princeton, NJ, 08543-2316. Based on a review of the letter, the foundation may request a full proposal at a later date.

Technical assistance for the program will be provided by Jack D. McCue, MD, of Baystate Medical Center in Springfield, Mass., and Andrew Kramer, MD, of the University of Colorado Health Sciences Center in Denver.