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Lead Contamination in Automobiles of Lead-Exposed Bridgeworkers

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Occupational exposure to lead at construction sites during lead-based paint abatement has become a widely recognized problem in recent years. However, these exposures to lead may not be limited to the workplace. Lead may be carried away from work sites on workers' skin and clothing, resulting in para-occupational or "take-home" exposure to workers' families. An indicator of potential take-home exposure is the level of contamination in workers' automobiles. In a recent study of lead exposures during lead-based paint abatement at a bridge renovation site, dust samples were collected from the interiors of workers' automobiles using wipe and vacuum collection methods. Lead was present in each of the 27 automobiles that were sampled. High lead loadings were found on driver's side floors (geometric mean = 1900 $\mu\text{g}/\text{m}^2$), armrests (1100 $\mu\text{g}/\text{m}^2$), and steering wheels (240 $\mu\text{g}/\text{m}^2$). Lead contamination inside automobiles did not appear to be associated with personal exposures to airborne lead in the work environment. For example, lead loadings on the floor and seat area were highest in cars of those workers with low airborne lead exposure, such as industrial hygiene/safety and security personnel (1000 $\mu\text{g}/\text{m}^2$). Abrasive blasters, who typically have high exposures to airborne lead, had low lead loadings in their cars (370 $\mu\text{g}/\text{m}^2$). These findings may be explained by the observation that workers considered to be highly exposed to lead, such as blasters, regularly changed out of work clothing and showered before entering their cars. Other workers who were thought to be only minimally exposed to lead did not regularly follow hygiene practices intended to prevent take-home exposures. Personal hygiene practices such as leaving work clothes and shoes at the job site, washing hands and face, and changing into clean clothes before leaving work are recommended for all workers at lead abatement sites to prevent lead from being carried into cars and homes and potentially exposing family members and others. PIACITELLI, G.M.; WHELAN, E.A.; EWERS, L.M.; SIEBER, W.K.: LEAD CONTAMINATION IN AUTOMOBILES OF LEAD-EXPOSED BRIDGEWORKERS. *APPL. OCCUP. ENVIRON. HYG.* 10(10):849-855; 1995.

Exposure to lead during paint removal from steel structures is recognized as a serious health concern among construction workers. Abrasive blasting, a common paint removal technique, may produce lead dust concentrations as high as tens of thousands of micrograms per cubic meter of air, which greatly exceeds the current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 50 $\mu\text{g}/\text{m}^3$.⁽¹⁾ Measures to protect the environment from dust emissions, such as fully enclosed dust containment structures,

have actually increased worker exposures to lead-based paint (LBP) during abatement activities. Occupational exposures to lead in construction were specifically addressed in the 1993 OSHA Lead in Construction Standard⁽¹⁾ and the 1992 NIOSH Alert: Preventing Lead Poisoning in Construction Workers.⁽²⁾ Both have increased awareness of the need to control workplace exposures during LBP removal. This article will present evidence that exposures to lead from bridge painting activities may, in fact, go beyond the workplace.

Para-occupational or "take-home" exposures may occur when workers are occupationally exposed to a contaminant and then carry it from the work site, generally on their skin, hair, clothing, or shoes. Previous studies have shown that several workplace contaminants, including lead,⁽³⁻¹⁰⁾ asbestos,⁽¹¹⁾ beryllium,⁽¹²⁾ and polycyclic compounds⁽¹³⁾ have adversely affected the health of workers' families. For example, increased lead absorption has been documented in families of workers at lead smelters,^(3,4) battery factories,⁽⁵⁻⁸⁾ radiator shops,⁽⁹⁾ and electronics plants.⁽¹⁰⁾ In some cases, environmental sampling documented lead contamination (other than from lead paint) in the workers' homes, particularly in areas where dirty work clothes were stored and laundered.^(3,4,6,7,8,10) Ingestion of the contaminant through hand-to-mouth activities, especially in young children, is felt to be the primary mechanism of exposure. Investigators have suggested or shown that the workers' contaminated clothing, skin, and automobiles are generally the sources of exposures among family members.

Work practices such as using protective clothing and shower facilities are thought to greatly reduce the potential for workers to inadvertently carry contaminants home on their skin or clothing. Such practices may not be closely followed or enforced at construction sites due to the temporary and changing nature of the work environment. For example, access to potable water and/or electricity is often difficult in remote locations. Also, many employers have undoubtedly failed to obtain the necessary resources, such as training materials, protective clothing, and hygiene facilities, since the OSHA Lead in Construction Standard only became effective in May 1993.

The National Institute for Occupational Safety and Health (NIOSH) has recently conducted an exposure assessment study to characterize exposures to airborne and surface lead dust at a bridge construction site with lead paint abatement activities. In addition, to assess the potential for take-home exposures, samples were collected for determining the amount of lead on workers' skin and clothing and in their personal vehicles. This article describes the methods and results of measurements of lead in workers' vehicles.

TABLE 1. Job Descriptions and Exposure Classification

Job Category	Work Duties	Exposure Category*
Blaster/painter	Remove paint from steel by abrasive blasting. Apply paint using brush, roller, and/or spray gun. Duties may also include rigging activities when moving the containment enclosure.	High
Blaster/painter apprentice	Tend blasting equipment (such as hoses and cables) and sweep/vacuum inside and outside containment. Occasionally perform blasting and painting.	High
Abrasive equipment operator	Monitor abrasive cleaning/recycling equipment. Duties also include sweeping occasional dust leaks and spills.	Medium
Paint inspector	Inspect steel surface following paint removal and after paint application.	Medium
Security	Control vehicle and pedestrian traffic around the construction site.	Low
Industrial hygiene/safety specialist	Conduct environmental and exposure monitoring, provide necessary personal protective equipment, maintain hygiene facilities, and perform worker training.	Low

*Classification assigned *a priori* based on job duties and proximity to lead dust sources: high: regularly inside containment during blasting; wears coveralls and takes shower daily; medium: works in close proximity to containment or other lead dust sources; sometimes enters containment (usually not during blasting); usually wears coveralls and takes shower only if in containment; low: rarely/never enters containment at any time; does not normally wear coveralls or take shower.

Methods

Description of Site

The study was conducted during a 2-week period in September 1993 at a bridge over the Thames River in Connecticut which was being repainted. Work on the bridge had started 4 months earlier in the estimated 36-month-long construction project. The bridge consisted of two 1-mile-long spans which each contained approximately 3 million square feet of structural steel coated with LBP; samples of the dried paint were 6 to 15 percent lead by weight. Complete abrasive blast cleaning of the steel was performed using recycled steel grit. The new coating consisted of a zinc epoxy primer, an aluminum mastic midcoat, and an aliphatic urethane topcoat. During abrasive blasting, a fully enclosed tarpaulin containment enclosure with negative pressure ventilation was used to prevent emissions into the environment; the enclosure was moved using rollers attached to the underside of the bridge. Settled particulate was swept through the open-grated floor of the containment enclosure into an auger conveyor which carried the LBP-steel grit mixture to dust collectors/recyclers (IPEC Advanced Systems, Inc.) located below the containment enclosure.

Workers at the site were provided work clothing if they performed certain job tasks, or upon request. Mobile trailers with separate rooms for changing clothes, showering, and clothes storage were available for both men and women. Another trailer was used for respirator training, cleaning, and storage. Portable hand wash stations with running water were located near areas where employees took rest and meal breaks.

Major jobs at the site included blaster/painters, apprentices, dust collection equipment operators, paint inspectors, security personnel, and industrial hygiene/safety specialists. Typical job activities for each job are provided in Table 1. Each job title was assigned *a priori* to a lead exposure category based on the proximity to and length of time spent near lead sources. These assignments are also consistent with representative airborne

lead exposure levels for different construction activities as compiled by OSHA.⁽¹⁾

Study Participants

All workers at the site were eligible to participate in the car sampling study. In addition to having dust samples collected from their car, each participant completed a brief questionnaire (concerning information such as personal hygiene practices, frequency of car cleaning, and eating/smoking habits inside their car), and had a blood lead test. Cars were randomly sampled during the day shift (two to three cars each day) while parked in or near the employee parking area (with a dirt-gravel surface) which was located approximately 500 ft from the closest work area.

Sampling and Analytical Methods

Two types of dust collection methods were used to collect dust samples from inside each car, depending on the surface sampled. Wipe sampling was performed on hard, smooth surfaces (including vinyl floor mats, seats, and armrests; dashboard; and steering wheel) using commercial wet wipes (Wash'n Dri-Moist Towelettes) by NIOSH Method 9100.⁽¹⁴⁾ On fabric surfaces, a vacuum sampling method, originally developed by Que Hee *et al.*,⁽¹⁵⁾ was used to collect dust samples. To ensure that a detectable amount of particulate was collected in each vacuum sample, a single composite sample from both the driver's floor and seat areas was collected. Composite samples improve the analytical sensitivity and reduce the number of samples analyzed, thus reducing cost, but provide no separate information about each location included in the composite. The vacuum sampler consisted of a collection nozzle connected by Tygon[®] tubing to a closed-face cassette containing a polyvinylchloride filter (37-mm diameter, 5.0- μ m pore size) and a personal air monitoring pump operated at 2.0 L/min. The collection nozzle was a short (about 5 cm long) piece of stainless steel tubing (6 mm i.d.) with the sampling end

TABLE 2. Description of Study Participants

Number of study participants	27
Number of questionnaires completed	20
Time spent in construction industry (years)	
Median	16
Range	3-28
Have children (<6 yrs old) passengers at least once a week (%)	48
Sometimes eat, drink, or smoke in car (%)	100
Vacuumed car within last month of survey (%)	52

crimped to form an opening of approximately 10 × 4 mm. Dust from the same surfaces was not always collected for each car if not feasible (e.g., a wipe was not taken on the floor if no vinyl mat was present).

Prior to collecting either type of sample, the surface was delineated using a disposable plastic template with interior dimensions of 18 × 18 cm if the size of the surface was large enough. Otherwise, the sample area was measured using a ruler. Depending on the location, either a clean collection nozzle or a fresh wet wipe was then drawn across the sample surface using a series of horizontal strokes, followed by a series of vertical strokes, and then by another series of horizontal strokes, for a total of three passes over the same surface.⁽¹⁴⁾ The same cassette was used to sample both the floor and seat areas in each car, whereas a new wipe was used for each surface sampled.

For comparison, separate wipe samples and a composite vacuum sample were collected on the driver's floor and/or the seat in cars where a rubber floor mat and/or a nonfabric seat was present, respectively. The vacuum and wipe samples were taken adjacent to each other so that the same surface was not sampled twice.

Samples were analyzed for lead using atomic absorption spectrophotometry following NIOSH Method 7082 by a laboratory accredited by the American Industrial Hygiene Association.⁽¹⁶⁾ Sample values were corrected for laboratory and

field blanks. Sample results are reported as lead loading per surface area (in micrograms lead/square meter).

Statistical Methods

Data were analyzed using the Statistical Analysis System.⁽¹⁷⁾ Analysis of the sampling data by the Shapiro-Wilk statistic test indicated that a logarithmic transformation was appropriate; therefore, geometric means (GM) and geometric standard deviations (GSD) were calculated. Analysis of variance was used to test for differences in mean values of wipe and vacuum samples by job title, exposure category, and location (for the wipe samples). Nonparametric techniques were used for small sample sizes (n < 6). Correlations were measured using the Pearson correlation coefficients.

Results

Twenty-seven of the 50 workers (54%) at the site agreed to have their personal vehicles sampled for lead. The median length of time spent in the construction industry by study participants was 16 years (range: 3 to 28 years); all respondents had previously worked at other construction sites (Table 2). Almost half (48%) of the participants reported that young children (less than 6 years old) regularly ride in their car (i.e., at least once a week). All participants (100%) reported that eating, drinking, or smoking sometimes occurred in their cars. About one-half of the all cars sampled (38, 71, and 57% in the high, medium, and low exposure groups, respectively) had been vacuumed within the last month.

Lead loadings on interior surfaces of cars which were measured by the wipe method are presented in Figure 1. The highest loadings were found on the driver's floor and the driver's armrest (GM = 1900 and 1100 µg/m², respectively). The GM for any of the other surfaces was below 500 µg/m². A statistically significant difference (p < 0.05) between means was found only for the driver's floor (1900 µg/m²) and steering wheel (240 µg/m²). The variance in lead loading from similar locations was fairly stable between cars (GSDs from 2.3 to 2.9).

The blood lead levels of the participants ranged from 4 to 17

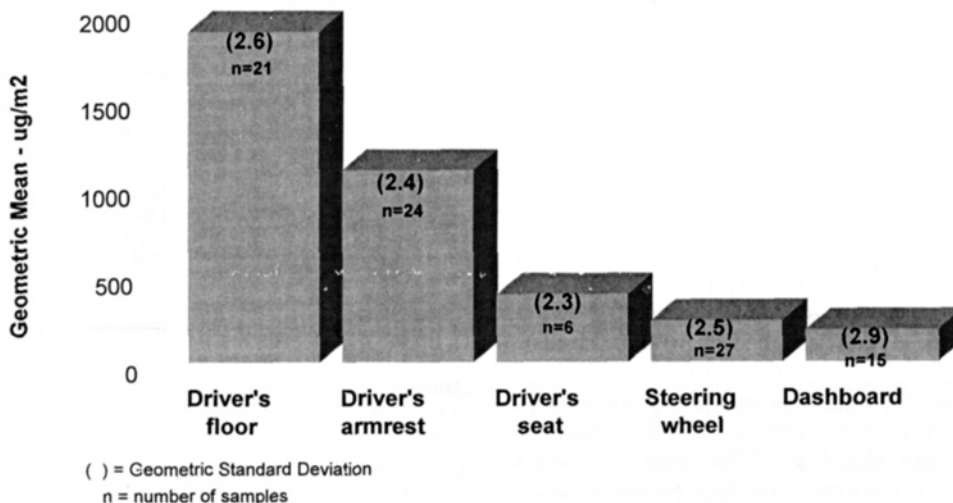


FIGURE 1. Lead concentrations inside automobiles by location (collected by wipe method).

TABLE 3. Correlation Between Blood Lead Level and Lead Contamination (Micrograms Lead/Square Meter) in Cars: Wipe Sample Results by Location

Sample Location	R	p value
Steering wheel	0.54	0.02
Driver's armrest	0.52	0.06
Driver's seat	0.68	0.20
Driver's floor	0.19	0.53
Dashboard	0.14	0.66

R = Pearson correlation coefficient.

$\mu\text{g}/\text{dl}$ (average = 8.0; standard deviation = 4.4). The correlation coefficient between the workers' blood lead levels and wipe sample results from various surfaces inside cars is presented in Table 3. A statistically significant ($p = 0.02$) correlation was found for the steering wheel ($r = 0.54$). The armrest had a similar correlation coefficient ($r = 0.52$) of borderline statistical significance ($p = 0.06$).

Lead loadings on the driver's floor and seat as determined by the vacuum method are shown for each job title in Table 4. The highest GM was for the industrial hygiene/safety specialist job ($2000 \mu\text{g}/\text{m}^2$). Blaster/painters had the lowest GM ($340 \mu\text{g}/\text{m}^2$); sampling results between blaster/painter cars were highly variable ($\text{GSD} = 9.4$) compared with results for other jobs. None of the differences between jobs were statistically significant at $p = 0.05$.

The vacuum sample results are presented by exposure category in Figure 2. The highest lead loadings were found in cars of workers in the low exposure group, although none of the groups were significantly different from the others. Similar to results for individual jobs, vacuum sampling results were highly variable within exposure groups.

The vacuum and wipe results were not highly correlated in those 21 cars in which both a floor wipe and a composite vacuum sample were taken ($r = 0.30$; $p = 0.18$); the GMs (and GSDs) for the floor wipe and the composite vacuum samples in these 21 cars are 500 (6.6) and 2000 (2.6), respectively. The correlation between vacuum results and seat wipe results was also low ($r = 0.40$; $p = 0.42$); however, seat wipes were taken in only six cars. The GM (GSD) for the seat wipe was 400 (2.3) and the vacuum composite was 100 (9.1) in these six cars. The mean of all vacuum composite samples was $630 \mu\text{g}/\text{m}^2$, which is much lower than the sum of the individual means for the floor ($2000 \mu\text{g}/\text{m}^2$) and seat ($400 \mu\text{g}/\text{m}^2$) wipe sample results.

Detailed questionnaire data (including work histories, protective clothing usage, and personal hygiene practices) were obtained for 20 of the 27 participants (74%) and are presented by exposure category in Figure 3. Twenty-five percent of the workers in the low exposure category reported that they wore company-supplied work clothes, changed from work clothes, or showered before going home; 50 percent took work shoes home. Most workers in the high exposure group wore company work clothes (100%), changed from work clothes before going home (100%), and showered (90%); none took their work shoes home. More workers in the low exposure group (75%) than in the other two groups (high = 40%; medium = 50%) thought that they usually carried lead home.

Discussion

Sampling results indicated that lead was present in all cars sampled. All cars at this construction site were driven by lead-exposed workers; therefore, it was not possible to collect control or background samples at this site. Furthermore, few data are available in the literature to quantify background lead concentrations in automobiles. However, in a study conducted by the National Center for Environmental Health of the Centers for Disease Control, lead was measured in the cars of firearms instructors and a comparison group from the Federal Bureau of Investigation training academy in Quantico, Virginia.⁽¹⁸⁾ The comparison group was composed of 37 workers at the academy who did not work in the firing range areas; their cars were sampled while parked in a paved lot at the academy. The mean lead loading on the driver's floor in the control cars was $270 \mu\text{g}/\text{m}^2$. The most probable source of the lead in these cars was soil contaminated by lead from a variety of sources, including leaded gasoline emissions, lead paint, and industrial emissions.⁽¹⁹⁾ Based on these data, the bridgeworkers' cars in our study contained lead loadings on floors at least seven times higher than levels found on floors of a group of workers without occupational exposure to lead and who lived in a different geographic region. This comparison is not ideal and there clearly is a need for data to ascertain background levels of lead in cars when assessing the relative risk of lead contamination from work sites.

The location of lead particulate measured inside cars may help to determine its source. Surfaces such as the steering wheel and armrest are most likely to be contaminated by lead from skin, particularly the hands. For example, lead particulate is likely to be deposited onto (or removed from) these surfaces whenever touched, such as when pulling the armrest to close the door. The driver's floor and seat areas are most likely to be contaminated by lead dust from clothing and shoes worn by the driver. Lead measured on the dashboard is possibly due to lead particulate which has settled from the ambient air. While none of the air samples collected in the parking lot during this survey contained detectable amounts of lead, extremely low levels of airborne lead may have accumulated over time on horizontal surfaces, such as the dashboard, which are typically left undisturbed for long periods. Although the participants were not asked if their car windows were generally left open when parked at the job site, all of the cars had their windows closed on the day of sampling despite warm and dry weather. It is also possible that any lead particulate brought inside the car

TABLE 4. Lead Loadings (Micrograms Lead/Square Meter) on Floors and Seats of Cars: Composite Vacuum Sample Results

Job	N	GM	GSD
Blaster/painter apprentice	2	560	2.2
Blaster/painter	11	340	9.4
Abrasive equipment operator	1	370	—
Paint inspector	6	920	5.5
Security	2	460	2.3
Industrial hygiene/safety specialist	5	2000	3.5
All	27	630	6.0

N = number of samples.

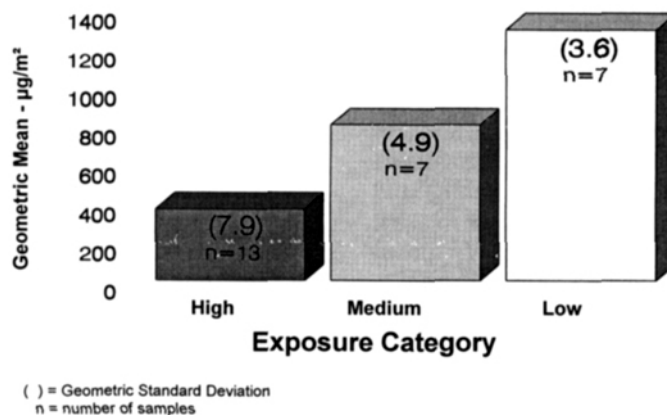


FIGURE 2. Lead concentrations inside automobiles by exposure category (collected by vacuum method).

on skin or clothing may be suspended in the air if disturbed and eventually settle randomly onto interior surfaces.

The composite samples collected by the vacuum method did not permit us to differentiate lead contamination on the floor from that on the seat. Although few samples were taken only on seats, wipe results indicate that lead levels were about five times higher on the floors than on the seats. Although these levels are not statistically different ($p < 0.05$), this finding may help to explain why the summed results from the wipe method are much higher than for the composite results from the vacuum method (in which a single sample was used for both the seat and floor). It is likely that the low lead loading from the seat diluted the higher lead loading collected from the floor, thereby resulting in a lower composite concentration. In retrospect, it is preferable to have separate results for car surfaces when trying to identify possible sources of the lead contamination (e.g., from clothes, shoes, or hands) and for recommending specific remediation efforts. The advantages of composite sampling (increased sensitivity and lower costs) are more obvious when screening for the presence of lead or determining average lead levels in the automobile, particularly if the specific location is not necessarily important (e.g., to

answer the general question, "Is lead present in the worker's car?"). Individual sampling provides more detailed information about specific sources and sites of contamination that may be useful for targeting efficient and cost-effective prevention and remediation efforts.

Questionnaire responses and observations during the survey indicated that most of the workers in the high and medium exposure groups regularly wore company work clothes and then changed from their work clothes/shoes and showered before entering their cars. However, workers in the low exposure jobs did not wear company work clothes but rather wore their street clothes into work areas and then into their cars, frequently without washing their hands and faces. In fact, many workers in the low exposure group were observed to drive their personal cars into the work areas when performing job duties, such as checking sampling equipment, monitoring workers, or maintaining hygiene facilities.

These findings were surprising considering that most workers in the low exposure group were industrial hygienists—people who had presumably received (and provided) extensive training in preventing lead exposures and who are professionally responsible for ensuring that other workers are protected

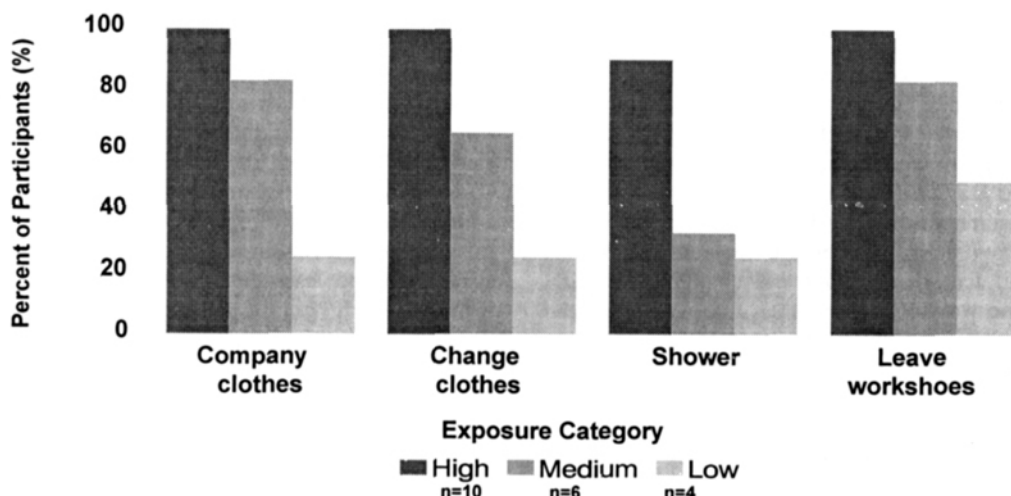


FIGURE 3. Results of worker questionnaire responses by exposure category.

from lead hazards! It is possible that the industrial hygienists at this site had underestimated the potential for contaminating their own skin and clothing, perhaps due to their minimal time spent in areas with high airborne lead concentrations. While their activities in work areas may be brief and not result in significant inhalation exposures, often they involve contact with lead-contaminated surfaces. While work clothing and hygiene facilities were made available to all workers at this site, their usage was emphasized only for workers in highly exposed jobs, that is, above the airborne lead PEL of $50 \mu\text{g}/\text{m}^3$, as minimally required by the OSHA lead standard.

In general, construction workers considered to be exposed to low levels of lead, based on their proximity to obvious lead sources and historical air monitoring data, are not always provided the same protective measures as workers exposed to higher airborne lead levels. Many of the provisions of the OSHA lead standard which are intended to prevent lead from being carried from the work site, such as protective clothing and hygiene facilities, are only required if a worker's airborne lead exposure exceeds the PEL ($50 \mu\text{g}/\text{m}^3$). However, the PEL, which is based only on air sampling, may not be predictive of exposures to surface dust contamination. The potential for such exposures needs to be more strongly considered when determining which workers should be provided protective measures intended to prevent lead from leaving the work site.

Additionally, simply making protective measures available to workers does not necessarily ensure their proper and regular usage. For example, hygiene facilities will generally be used only if they are clean and comfortable and have hot, running water. Efforts are necessary to make compliance with worker protection provisions as simple and convenient as possible. Also, all workers must be educated and motivated to take the time and effort required to minimize take-home contamination. Much of the motivation may be inherently present since we have found that most workers become highly protective of the health and safety of their families when the risks of take-home lead are explained.

Differential use of shower and changing facilities by high, medium, and low exposure groups is a logical explanation for the observed differences in lead contamination inside cars only if the measured contamination reflects primarily recent deposition. Construction work at the current bridge site had started only 2 months prior to this survey and most participants had spent over 16 years in the construction industry. While work clothing and hygiene facilities were made available to all workers at this particular survey site, such measures were generally not provided at most construction sites prior to the enactment of the OSHA lead standard in May 1993.⁽²⁾ Based on this information, we assume that prior to the work on this bridge in the fall of 1993, even highly exposed workers would generally not have had access to shower and changing facilities. Although there is no way to directly determine when the lead was deposited inside automobiles, there is some reason to believe that the contamination levels measured in this study reflect primarily exposures at the current bridge site. First, lead particulate is most likely being constantly removed from, as well as deposited onto, smooth surfaces which are frequently touched such as armrests, the steering wheel, and vinyl seats. Second, lead dust deposited onto rough surfaces such as cloth seats and carpeted floors probably gets ground in and physically

bound within the fabric fibers over time. Both the wipe and vacuum sampling methods used in this study are fairly nonaggressive (i.e., they tend to collect only loosely bound particulate from the top of most surfaces). In fact, the vacuum method was specifically designed not to collect total lead on a surface, but rather only the loose dust that would most likely stick to a person's hands.⁽¹⁵⁾ Since it is unlikely that lead which may have been deposited several months earlier was still present and loose inside automobiles, we believe that the lead collected in this study was a result of recent contamination and essentially reflects current workplace conditions and hygiene practices.

Presently, the health risks of exposure to surface lead contamination are not well understood. Although lead from surfaces has the potential to be ingested, it is unclear what levels of exposure may result in increases in blood lead levels. Since hand-to-mouth contact is probably the primary route of lead ingestion, lead contamination on the hands is more likely than lead on other surfaces, such as clothing, to affect blood lead levels. Interestingly, the highest correlations between the workers' blood lead level and surface lead contamination in this study were found for the steering wheel and the armrest—surfaces most frequently touched by the hands. Also, all study participants reported that they sometimes eat, drink, or smoke in their cars. Until more information is available to define the relationship between surface contamination and blood lead levels, it is prudent to minimize contact with lead-contaminated surfaces, thereby preventing any subsequent potential for ingestion. The most direct way to prevent ingestion which may result from take-home exposures is to ensure that lead dust from contaminated skin and clothing never gets into the workers' cars and homes. Therefore, all workers potentially exposed to lead, regardless of level, should always change out of work clothing and shoes and wash their hands and face, preferably by showering, before leaving the work site. Personal cars should never be driven into work areas. Any vehicles that are used when performing job-related duties should be properly cleaned to remove lead contamination before the vehicle is driven from the work site. Proper cleaning includes: (1) vacuuming interior surfaces with a high efficiency particulate air filter vacuum, if available; (2) washing surfaces with a high phosphate detergent solution such as trisodium phosphate; and (3) rinsing frequently with clean water.

Almost one-half of the study participants reported regularly having child passengers in their car. This indicates that a highly susceptible population is being indirectly exposed to lead because of their parent's occupation. It is thought that workers' homes can become contaminated in the same manner as their cars. The extent and the effects of any lead contamination in construction workers' homes have not yet been reported. To address these questions, NIOSH is conducting a study to measure lead levels inside construction workers' homes and also the blood lead levels of their family members. Results from this study will be presented in a future article.

Conclusion

The data presented here strongly suggest that lead may have been carried from a construction site into workers' cars. Failing to wash/shower or wearing clothes and shoes in work areas and subsequently into cars significantly increased the levels of lead carried into cars. At this site, lead contamination inside workers' cars did not appear to be associated with their per-

sonal exposures to airborne lead. Many provisions of the OSHA lead standard which are intended to prevent lead-contaminated skin and clothing from leaving the workplace are too limited in coverage. All persons at the construction site, including ancillary personnel such as industrial hygienists, security guards, and visitors who may be exposed to lead, regardless of airborne exposure level, should follow steps, such as wearing protective clothing and washing their hands and faces before going home, to keep lead from being carried on clothing and skin into their cars and homes.

Disclaimer

Mention of company or product names in this report does not constitute endorsement by NIOSH.

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