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Keeping Lead at Work

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Exposure to lead from construction work may not be limited to the job site. Workers can inadvertently carry lead home from work on clothes, skin, hair, and tools, and in their vehicles. These "para-occupational" or "take-home" exposures among workers' families may cause lead poisoning in family members. This type of exposure is not a new problem. Holt cited 2 early studies of families of lead workers that were published in 1860 and 1896.¹ Oliver reported in 1914 on lead poisoning in wives of house painters who washed their husbands' overalls—observations that resulted in a series of laws in Great Britain to protect workers' families from lead poisoning.²

Families of lead-exposed workers, especially young children, are of particular concern. Children are at higher risk for lead exposure because they have more hand-to-mouth activity than adults and because the efficiency of gastrointestinal absorption of lead in children exceeds that of adults.³ Lead poisoning has been shown to cause a variety of problems in children, ranging from behavioral disorders to brain damage. Elevated blood lead levels can have adverse reproductive effects in women and men and can also affect the fetus in pregnant women, causing irreversible neurological damage.

A recent report by the National Institute for Occupational Safety and Health (NIOSH) cites about 65 incidents of lead poisoning among

workers' families; about a third of these were reported in the last 10 years.⁵ Exposure of lead workers' families has been identified in nearly 30 different industries, most com-

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monly in lead smelting, battery manufacturing and recycling, radiator repair, pottery/ceramics, and stained glass crafts. However, family members' exposure to lead has rarely been reported in the construction industry, including work on steel structures. This may be partly due to the fact that, before 1993, the construction industry was exempt from the Occupational Safety and Health Administration (OSHA) lead standard and was therefore relatively under-regulated and understudied.⁵

Several factors suggest that take-home lead may be more of a problem for families of construction workers than for families of workers

in other lead industries. Because construction work is often short-term and transient and typically conducted in isolated locations, it may be more difficult to implement and practice preventive measures specifically intended to minimize the potential for lead to be taken from work sites. These measures include the use of on-site hygiene facilities for changing from contaminated work clothing and showering before leaving work each day.

To evaluate take-home lead exposures in the construction industry, NIOSH recently conducted 2 studies of bridge workers and their families. This article describes NIOSH's findings in these studies.

Study of Abrasive Blasters

In a study of abrasive blasters removing lead-based paint from a bridge in Connecticut, NIOSH investigators measured lead contamination on workers' skin and in their cars.⁶ Lead found on these surfaces is thought to be an indication of potential contamination of workers' homes. Lead was found at the end of the work shift on the hands and faces of most workers immediately upon leaving the work area. A decontamination trailer with a changing room and showers was available at this site (although its use by the workers was observed to be irregular). Additional samples collected immediately before workers left for their cars to return home indicated that significant levels of lead were found on some workers' hands. This suggests that workers were not ade-

quately removing lead by washing or that they were re-contaminating their hands through contact with contaminated clothing or surfaces before leaving the work site.

In this study, lead was present in all workers' cars that were sampled. High lead loadings were found on drivers' floors (geometric mean [GM] = 1,900 $\mu\text{g}/\text{m}^2$), armrests (GM = 1,100 $\mu\text{g}/\text{m}^2$), and steering wheels (GM = 240 $\mu\text{g}/\text{m}^2$). For comparison, OSHA recommends a level of 2,000 $\mu\text{g}/\text{m}^2$ in evaluating cleanliness of change areas, storage facilities, and lunchrooms/eating areas at construction sites.⁷ No guidelines are provided by OSHA for assessing contamination in workers' cars. Abrasive blasters, who typically have very high exposure to air-borne lead, had relatively low lead loadings in their cars (370 $\mu\text{g}/\text{m}^2$). This 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 air-borne lead did not regularly follow hygiene practices intended to prevent take-home exposures. In this study, worker exposures to air-borne lead were not predictive of lead contamination levels inside their cars. This observation demonstrates the need for all lead-exposed workers to shower and to leave their work clothing at the job site—or risk contamination of their personal automobiles and potential exposure to family members.

Study of Workers' Families

NIOSH investigators later conducted a study to assess lead exposures among 37 families of construction workers; 22 neighborhood families with no known lead exposures were included for comparison.^{8,9} The construction workers reported that

OSHA hygiene requirements (e.g., changing and shower facilities) specifically intended to prevent take-home lead exposures were infrequently followed by their employers. Blood lead testing indicated that children of construction workers were 6 times more likely than neighborhood children to have a blood lead level at or above the Centers for Disease Control and Prevention (CDC) action level of 10 $\mu\text{g}/\text{dL}$.¹⁰ Environmental measurements indicated that the hands of lead-exposed workers were 7 times more contaminated with lead compared with control workers; no difference was found between exposed and control family members' hands. Surface lead contamination was significantly higher in automobiles driven by the construction workers; some locations, such as armrests, were 10 times more contaminated for the exposed group. Elevated lead loadings in lead workers' automobiles were found on the driver's floor (GM = 1,100 $\mu\text{g}/\text{m}^2$), driver's armrest (GM = 2,000 $\mu\text{g}/\text{m}^2$), and passenger's armrest (GM = 1,200 $\mu\text{g}/\text{m}^2$). Lead loadings for these same locations in control cars were 250, 190, and 120 $\mu\text{g}/\text{m}^2$, respectively. Geometric mean surface lead concentrations were significantly higher on floors where work clothing was changed in exposed homes (370 ppm) compared to control homes (120 ppm). These results suggest that occupational exposures and poor hygiene practices are the primary causes of lead contamination in workers' cars and homes.

Preventing Take-Home Lead

These studies have therefore demonstrated that lead from construction sites can be carried on workers' skin and clothing, thereby contaminating their cars and homes and resulting in lead exposures to their families. What can be done to prevent this problem?

Current Protective Measures Required by OSHA

The OSHA lead standard for the construction industry includes several provisions specifically intended to prevent lead from leaving the work site on workers or their clothing.⁵ These provisions, listed below, are required only for those workers exposed for 1 day to air-borne lead greater than the permissible exposure limit (PEL) of 50 $\mu\text{g}/\text{m}^3$ over an eight-hour, time-weighted average.

- Employers are required to provide and assure proper use of full-body protective clothing that is laundered at least weekly (or daily for workers exposed above 200 $\mu\text{g}/\text{m}^3$). The employer is required to assure that contaminated protective clothing is removed only in designated change areas and left on-site for laundering or disposal. Workers are not permitted to wear or take home any lead-contaminated clothes, shoes, or equipment.
- Employers are required to provide clean change areas with separate storage areas for protective work clothing and for street clothes, which prevent cross-contamination.
- Employers are required to provide shower facilities, where feasible, and assure that employees shower before going home.

In addition to these provisions for workers exposed above the PEL, employers must provide hand washing facilities for all workers exposed to lead. At sites where showers are not provided, the employer must assure that employees wash their hands and face at the end of the work shift.

Additional Measures for the Prudent Employer

NIOSH has found at construction sites that clothing and skin contamination may occur in any worker exposed to lead—regardless of the air-borne level. If preventive measures are not practiced, this contamination

at the workplace may result in secondary contamination of personal automobiles and homes. Therefore, prudent employers should provide protective clothing and hygiene facilities for all employees who may enter work areas where lead is present. All employees should be informed specifically about the hazards associated with lead on skin and clothing, and should be strongly encouraged to follow guidelines for changing work clothes, showering or washing, and leaving contaminated items at work.

Employers should consider collecting samples of lead dust on workers' hands and in cars to evaluate the effectiveness of their lead prevention program. There are simple and inexpensive methods for assessing lead contamination on surfaces such as workers' hands and car interiors.¹¹ Sample results may identify problems in current hygiene procedures and demonstrate the importance of stringent personal hygiene practices. Cars requiring decontamination may also be identified. Qualified personnel, such as industrial hygienists, should conduct a lead monitoring and decontamination program.

Lead in workers' cars may also come from non-occupational sources. Contributing sources include residential lead-based paints, particulate fallout from local sources of industrial air pollution, soil contaminated from past motor vehicle emissions, and disintegration of exterior lead-based paints.^{6,8,9} Nevertheless, it is reasonable to assume that the workers' occupational exposure to lead is a primary factor. Prudent construction contractors should therefore be concerned about the presence of lead in their workers' cars.

Employers can also help in efforts to reduce lead contamination in workers' automobiles if significant lead levels are found or suspected. Employers frequently have high-effi-

ciency particulate (HEPA) vacuum cleaners at work sites for cleaning clothing, respirators, and work equipment. HEPA vacuums are specially designed to prevent the release of collected lead dust back into the environment. Employers can help workers safely maintain clean vehicles by allowing their employees access to a HEPA vacuum. Also, employee usage of lead-specific detergents for wiping their car interiors is also recommended. Employers can often provide these products to their employees or assist workers in obtaining them at minimal cost.

Currently, there are no health-based federal regulations for lead dust in automobiles. The Department of Housing and Urban Development (HUD) and the Environmental Protection Agency (EPA) have recommended "clearance levels" for surface lead levels in housing following lead hazard control work.^{12,13} The highest recommended lead level on bare or carpeted floors is 1,000 $\mu\text{g}/\text{m}^2$ (100 $\mu\text{g}/\text{ft}^2$). OSHA has adopted an earlier HUD recommendation of 200 $\mu\text{g}/\text{ft}^2$ for lead on floors in evaluating cleanliness in non-work areas at construction sites.⁷ OSHA does not expect that surfaces in change areas, lunch rooms, or storage areas be any cleaner than this level. These recommendations are not entirely health-related but are based on empirical evidence that these levels are achievable by prudent cleanup procedures. Based on previous NIOSH studies⁸, it appears feasible to maintain lead levels inside cars to at least this same level. Lead loadings measured in control cars indicate that ambient lead levels are well below the 1,000 $\mu\text{g}/\text{m}^2$ guideline and are therefore achievable. It is important to recognize that lead in cars, especially on seats, armrests, or the steering wheel, represents a potential exposure for ingestion, especially by young children.

Conclusion

A critical aspect in preventing take-home lead hazards is ensuring employee compliance with measures intended to minimize lead contamination. Owners, managers, and supervisors should be proactive in training, enforcement, and encouragement for proper hygiene practices. Education efforts should focus on the health effects of lead exposure, including effects on family members such as young children and pregnant women. Also, giving workers results of any dust sampling performed on hands or inside cars provides a visual indication of the effectiveness of the workers' efforts and any improvements needed. A concerted and mutual effort by employers and their workers is needed to be successful at keeping lead at work—and out of workers' cars and homes. **JPCL**

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