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Effect of Personal Hygiene on Blood Lead Levels of Workers at a Lead Processing Facility

The relationship between personal hygiene and blood lead levels was tested at a lead processing facility. During the workers' semiannual respirator fit test, when they were confident their hands were clean, the amount of lead on their right hands was measured. Samples were obtained by cleaning one entire hand with a wiping towel treated with a proprietary mixture of alcohol, surfactants, and ethylenediaminetetraacetic acid. Wipe samples were analyzed for total lead and then compared with the worker's blood lead level. Each worker's personal habits at rest were also observed. Workers with more than 1 year's experience had a significantly positive correlation between lead on the hand tested and their blood level. The study strongly suggests that lead on the skin ultimately enters the bloodstream. The route of entry was not investigated. Personal habits of the workers with high blood lead levels were observed to include actions that would quickly contaminate their hands shortly after washing.

Keywords: blood lead, dermal exposure, personal hygiene, skin wipe sample

An investigation of the relationship between personal hygiene and blood lead levels was conducted at a lead processing facility. During semiannual respirator fit-testing, the amount of lead on each worker's right hand was measured with a wipe sample. Previous testing by the author on the effectiveness of the skin cleansers used at this facility established variability of the available soaps to remove lead oxide.

MATERIALS AND METHODS

Samples were obtained by wiping each worker's right hand with a moist towelette that had been treated with a proprietary mixture of alcohol, cleaner, and ethylenediaminetetraacetic acid (EDTA; ESCA Tech, Inc., Milwaukee, Wis.). The sample technician wore a clean pair of disposable plastic gloves (Lab Safety Supply, Janesville, Wis., Part 7A-1358 DP) for each test to avoid any contamination from the technician's hands.

Both sides of the right hand up to the wrist, both sides of each finger, and the top of each fingernail were wiped with a single towelette, using a back-and-forth motion. No attempt was made to clean under the fingernails.

The towelette was folded and placed in a 120-mL, sterile specimen container, sealed, and shipped to the laboratory for analysis. An unused towelette (control blank) was treated in the same manner as the test samples. Employee t was used as an additional control. This individual was an office worker who did not work in the plant. This person is not included in the data averages.

During the fit-test, each worker's personal habits were observed and noted for later comparison with blood lead levels and hand lead levels.

RESULTS

After the results were analyzed, the amount of lead on each worker's right hand was compared with his or her blood lead level. These results are shown in Table I.

Subjectively, it was observed that low blood lead workers had cleaner work clothes and shoes than high blood lead workers. With the one exception noted, all of the other workers said they had washed their hands after leaving the factory and before coming for their fit-test.

Individuals with low and high blood leads were observed to differ in their personal habits

TABLE I. Blood Lead and Right-Hand Lead Levels, by Employee

Employee	Blood Lead µg/dL	Micrograms Pb/Hand	Blood Lead Range	Average Pb/Hand
Blank	0	0		
t	6	75		
d	20	312		
i	22	230		
m	24	97	20-25	213
h	26	94		
r	29	229		
y	29	388	26-29	237
l	30	511		
p	32	656		
b	33	365		
s	34	431		
x	34	534	30-34	499
n	35	470		
u	35	1650		
z	36	542		
o	36	608		
e	37	535		
q	37	1275		
k	38	1146		
g	38	656		
c	39	1018	35-39	878
f	42	4410		
w	42	2166		
a	45	2,440	40-45	3005

Note: Average blood lead level = 31 µg/dL

when they were relaxed. For the quantitative fit test, they sat in a chair while they did the required exercises. Persons with high blood leads shared one or more of the following habits while sitting relaxed in the chair.

(1) They rested their hands in their laps or on their legs, where their hands could pick up lead from their dirty coveralls.

(2) They put their hands in their pockets and played with change or keys.

(3) One or more of their fingernails had been bitten off.

(4) They had visible dirt under their fingernails.

Individuals with low blood lead levels shared the following habits while sitting relaxed in a chair.

(1) They rested their forearms or elbows on their legs, with their hands hanging clear of their coveralls.

(2) None were observed putting their hands in their pockets.

(3) None of their fingernails had been bitten off.

(4) Little or no dirt was visible under any of their fingernails.

DISCUSSION

Every worker had been properly trained on respirators and received a quantitative respirator fit-test twice a year. Workers also received personal hygiene training at the same time. The facility met all relevant aspects of the Occupational Safety and Health Administration lead standard. All workers wore leather-palm gloves with gauntlet cuffs while working. All but two of the workers tested had worked in the facility for 1 or more years—long enough for their blood lead levels to stabilize. Workers reported for their fit-test after they had started a shift and within 15 minutes of the last time they had reportedly washed their hands, with one exception. Workers spent this 15 minutes in the break areas and did not enter the plant.

Three individuals are not included in the data presented here. Two persons with high lead levels on their hands and low blood leads were new to the plant, having worked there 2 months or less. This was too soon for their blood leads to stabilize. The third person who was not included had a blood lead of 22 and a hand lead of 3776 µg/hand. He stated that before the test he had not stopped to wash his hands. He was in a hurry to get back to his job and was tested without having washed his hands. Since the objective was to test people as they were, he was not instructed to go and wash. Under normal circumstances, he would have been directed to wash prior to the respirator fit-test.

Questions for Further Testing

(1) Did all workers really wash their hands as they said they did?

(2) The available hand soaps differ in their ability to remove lead. Did an employee's soap selection affect the lead level on the hand and consequently the blood lead level?

(3) Do the workers know how to wash their hands? This aspect of training had not yet been addressed.

(4) Where did the lead come from? The high lead workers frequently touched their clothes or rested their hands in their laps or pockets. Do the coveralls really have that much lead on them?

(5) Does the amount of lead on the work clothes differ between workers with high and low lead levels? How does the lead level on their coveralls compare with their blood lead levels?

CONCLUSIONS

There was a significant association between the lead levels in blood and on the hand surface of these workers. The positive correlation coefficient was 0.61 and has a highly significant association ($p < 0.002$).

Workers with higher levels of surface lead on their hands had higher blood lead levels. Lead on the surface of the hands could enter the body in three ways. Since the workers with high hand surface lead levels demonstrated poorer personal hygiene practices, it is possible the higher blood lead levels resulted partially if not entirely from ingestion, by hand-to-mouth transfers. If the skin had cracks or cuts, it is possible that some lead entered the bloodstream directly, since the integrity of the skin as a barrier isolating the blood from the environment had been compromised.

Long-term exposure to lead on the skin may result in a larger contribution to blood lead levels than currently believed via percutaneous absorption of the inorganic lead through the skin, or via sweat glands and hair follicles. Lead on hands appears to ultimately result in higher blood lead levels. Investigation of the routes lead takes into the bloodstream is needed. Workers who keep their hands continuously clean should be able to maintain lower blood lead levels.

REFERENCES

- Viverette, L., H.W. Mielke, M. Brisco, A. Dixon, et al.: Environmental health in minority and other underserved populations: benign methods for identifying lead hazards at day care centers of New Orleans. *Environ. Geochem. Health* 18:41-45 (1996).
- Mielke, H.W., L. Viverette, M. Brisco, L. Scott, et al.: Surface dust on hands as a method for assessing and preventing childhood lead exposure. In *Hazardous Waste: Impacts on Humans and Ecological Health*, B.J. Johnson, C. Xintaras, and J.S. Andrews Jr. (eds.). Atlanta, GA: Agency for Toxic Substances and Disease Registry, 1996.
- Stauber, J.L., T.M. Florence, B.L. Gulson, and L.S. Dale: Percutaneous absorption of inorganic lead compounds. *Sci. Total Environ.* 145(1-2):55-70 (1994).