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Mercury Exposure from Exterior Latex Paint

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In the United States, mercury has been routinely used as a biocide to preserve exterior latex paint. Although the concentration of mercury in exterior latex paints can be up to 1500 mg/L, mercury exposure from these paints has never been studied. We performed this investigation to determine the extent of mercury exposure from the outdoor application of exterior latex paints. To assess mercury exposure we compared air and urinary mercury concentrations of 13 professional male painters with those of 29 men having other occupations (non-painters). The painters used two brands of exterior latex paint that contained mercury. The median concentration for the four paint samples obtained was 570 mg/L. The median air mercury concentration was higher for painters (1.0 $\mu\text{g}/\text{m}^3$; range, nondetectable [ND], 4 $\mu\text{g}/\text{m}^3$) than for nonpainters (ND; range, ND, 3 $\mu\text{g}/\text{m}^3$); $p = 0.0004$. The median urinary mercury concentration was nearly twice as high for painters (9.7 $\mu\text{g}/\text{L}$; range, 5.9–20.4 $\mu\text{g}/\text{L}$) than for nonpainters (5.0 $\mu\text{g}/\text{L}$; range, 2.6–11.6 $\mu\text{g}/\text{L}$); $p = 0.0001$ (normal range $< 20 \mu\text{g}/\text{L}$). Among painters, urinary mercury concentrations increased with the percentage of time spent applying exterior paint (Pearson $r = 0.6$). These data suggest increased mercury exposure among professional painters who use mercury-containing exterior latex paint outdoors. Hefflin, B.J.; Etzel, R.A.; Agocs, M.M.; Stratton, J.W.; Ikawa, G.K.; Barsan, M.E.; Schutte, G.R.; Paschal, D.C.; Kozman, A.R.: Mercury Exposure from Exterior Latex Paint. *Appl. Occup. Environ. Hyg.* 8(10):866–870; 1993.

Introduction

Phenylmercuric acetate (PMA) has, for many years, been used in latex paint as a fungicidal and bactericidal agent to prolong the paint's shelf life. In 1990 about a third of the exterior latex paint used in the United States contained mercury compounds.⁽¹⁾ Until recently, mercury compounds were added to about a third of interior latex paints as well;

this use was discontinued when a child developed acrodynia shortly after his home was painted and a subsequent study showed that persons living in recently painted homes had higher than normal urinary mercury concentrations.⁽²⁾ Mercury is often added at much higher concentrations to exterior latex paint (up to 1500 mg/L) than was recommended for interior latex paint (up to 300 mg/L), though mercury exposure from exterior latex paint has never been studied. Specifically, we do not know how effective outdoor ventilation is in preventing exposure to the mercury in these paints. The purpose of this investigation was to compare mercury exposure among persons who routinely used mercury-containing exterior latex paint outdoors with persons who did not.

Methods

In March 1991, the California Department of Health Services (CDHS) analyzed 10 brands of exterior latex paint, using a cold vapor technique, to determine which brands contained mercury.⁽³⁾ Of the brands tested, Brand A and Brand B had the highest concentrations of mercury (627 mg/L and 141 mg/L compared with $< 0.05 \text{ mg}/\text{L}$, the detection limit, in most of the other brands). Thus, for this study, we recruited painters who routinely use Brand A and Brand B exterior latex paints from the Joint Committee of the East Bay Painters and Decorators and from members of an independent painting company.

In August 1991, we performed a cross-sectional study in the San Francisco Bay area and in Sacramento County, California. We compared urinary mercury concentrations and air mercury levels of professional male painters with those of a comparison group consisting of men having occupations other than painting (nonpainters). Nonpainters included various CDHS employees, park rangers, and fire fighters.

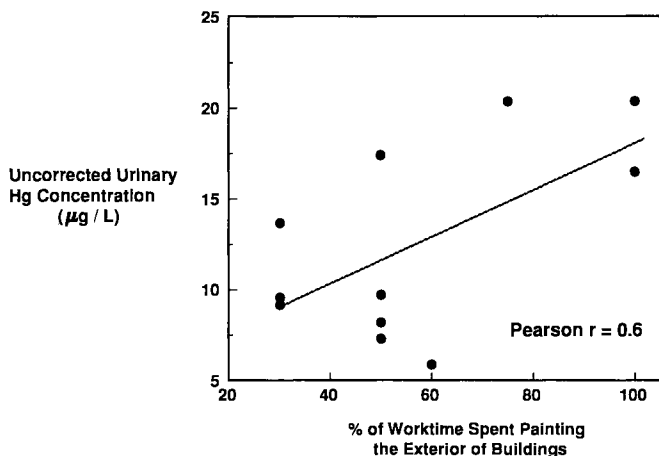


FIGURE 2. Relationship between the time spent painting the exterior of buildings and urinary mercury concentration in 11 painters.

higher for painters ($1.0 \mu\text{g}/\text{m}^3$; range, nondetectable [ND], $4 \mu\text{g}/\text{m}^3$) than for nonpainters (ND; range, ND, $3 \mu\text{g}/\text{m}^3$); $p = 0.0004$.

We collected first-void urine samples from 11 (85%) painters and 27 (94%) nonpainters. The median urinary mercury concentration was higher for the painters ($9.7 \mu\text{g}/\text{L}$; range, 5.9 to $20.4 \mu\text{g}/\text{L}$) than for the nonpainters ($5.0 \mu\text{g}/\text{L}$; range, 2.6 to $11.6 \mu\text{g}/\text{L}$); $p = 0.0001$ (Figure 1). The median urinary mercury:creatinine ratio was also higher for painters ($10.2 \mu\text{g}/\text{Hg}/\text{g}$ creatinine; range, 4.8 to $27.9 \mu\text{g}/\text{Hg}/\text{g}$ creatinine) than for nonpainters ($4.9 \mu\text{g}/\text{Hg}/\text{g}$ creatinine; range, 1.8 to $14.7 \mu\text{g}/\text{Hg}/\text{g}$ creatinine); $p = 0.0007$. Among painters, urinary mercury concentrations increased with the percentage of time spent applying exterior paint (Pearson $r = 0.6$) (Figure 2).

Air mercury concentration was a strong predictor for urinary mercury concentration ($p = 0.006$), though the two measurements did not correlate well (Spearman $r = 0.3$). The air mercury concentrations among painters did not correlate well with the levels of mercury in the paint (Spearman $r = 0.5$).

Overall factors such as recent domestic painting (< 5 months), fish consumption, and recent placement of silver amalgam fillings were not significantly related to urinary mercury concentration ($p > 0.1$). In addition, some of these factors affected both groups in small numbers (Table I). Among painters, gallons of paint applied per day, method of paint application, the use of protective clothing while painting, and smoking or eating while painting were not significantly related to urinary mercury concentration ($p > 0.1$).

Painters were more likely than nonpainters to paint both the interior and exterior of their homes. Among both groups most home interior painting had been done more than 6 months before, most home exterior painting had been done more than a year before, and no participant had used exterior paints indoors (Table I). Stratification of median urinary mercury concentrations by the time since the home was painted did not show higher levels, in most cases,

for those who most recently engaged in home painting (Table I).

Discussion

During this investigation, we determined that professional painters who routinely use mercury-containing exterior latex paint outdoors had significantly higher urinary mercury concentrations than a comparison group of nonpainters. This difference appears to be attributable to occupational exposure to mercury-containing paint because factors such as recent nonoccupational residence painting, fish consumption, and recent dental work were not associated with urinary mercury concentration.

PMA, a form of organic mercury used in paint, can enter the body through cutaneous or gastrointestinal absorption; in the body it is rapidly broken down to form inorganic mercury. Additionally, mercury vapor from paint containing mercury is well absorbed through the lungs.⁽²⁾ The source of the mercury vapor may be inorganic metallic mercury formed during the manufacture of PMA or produced during the decomposition of PMA after paint application.^(2,9) Inorganic mercury accumulates in the brain and kidney, and is excreted in the urine.⁽⁶⁾ Signs of mercury toxicity include tremor, delays in motor-nerve and sensory-nerve conduction, short-term memory loss, insomnia, and emotional instability, as documented by occupational

TABLE I. Characteristics of Painters and Nonpainters*

Characteristic	Painters (N = 13)	Nonpainters (N = 29)
Race/ethnic group		
White (non-Hispanic)	11(85)	26(90)
White (Hispanic)	2(15)	2(7)
Other	0(0)	1(3)
Age (years)		
25-30	5(38)	4(14)
31-40	6(46)	7(24)
41-50	1(8)	15(52)
51-60	1(8)	3(10)
Exterior painting at home		
During previous 1-5 months	0(0)	1(3)
During previous 6-12 months	2(15)	1(3)
More than 12 months previously	11(85)	27(94)
Interior painting at home		
During previous 1-5 months	3(23)	4(14)
During previous 6-12 months	8(62)	5(17)
More than 12 months previously	2(15)	20(69)
Exterior paint used indoors at home during previous 2 years		
Yes	0(0)	0(0)
No	13(100)	29(100)
Fish consumed at least once per week		
Yes	3(23)	12(41)
No	10(77)	17(59)
Amalgam filling placed during previous 3 months		
Yes	2(15)	2(7)
No	11(85)	27(93)

*Numbers in parentheses indicate percentages.

TABLE II. Median Urinary Mercury Concentrations for Painters and Nonpainters by Amount of Time Elapsed Since the Most Recent Application of Paint to Their Residences

	Median Urinary Hg Concentrations ($\mu\text{g/L}$)*	
	Painters (N = 11)	Nonpainters (N = 27)
Interior painting at home		
During previous 1–5 months	9.7 (3)	4.7 (4)
During previous 6–12 months	13.7 (7)	5.2 (5)
More than 12 months previously	7.3 (1)	4.9 (18)
Exterior painting at home		
During previous 1–5 months	—	5.0 (1)
During previous 6–12 months	9.9 (2)	6.4 (1)
More than 12 months previously	9.5 (9)	4.3 (25)

*Numbers in parentheses indicate number of subjects.
Hg = mercury.

studies.^(7–10) Since PMA was routinely added to about one third of the exterior latex paint used in the United States, frequent handlers have been placed at risk of increased mercury exposure which can result in increased body levels of mercury.

In our study, air mercury concentration was a strong predictor for urinary mercury concentration. Therefore, we conclude that the significantly higher urinary mercury concentrations we found in painters were attributable mostly to their exposure to mercury vapors from exterior paint, which occurred despite outdoor ventilation.

The urinary mercury concentrations did not correlate well with the levels of mercury in the air because mercury has a 40- to 60-day half-life in the body; thus it was not surprising that the urinary mercury concentrations did not reflect the current air mercury concentrations.⁽²⁾ The air mercury concentrations did not correlate well with the levels of mercury in the paint possibly because the air measurements, taken outside, were subject to varying winds. Our conclusions are limited by the small number of samples that were obtained.

Painters had urinary mercury concentrations almost twice those of nonpainters, although they were all below or not far above the accepted upper limit of normal (20 $\mu\text{g/L}$). This limit is based on an international survey performed by the World Health Organization in 1961.⁽²⁾ However, there is now some speculation regarding the validity of this value for the 1990s, since environmental mercury exposure in the United States is possibly different than it was 30 years ago. No upper limit of normal has been developed for urinary mercury:creatinine ratios.

The American Conference of Governmental Industrial Hygienists proposes a reference value of 35 $\mu\text{g Hg/g creatinine}$ for the evaluation of potential health hazards in occupationally exposed persons.⁽³⁾ This value, however, is for total inorganic mercury that represents only part of the total mercury measurements we performed in this study. The urinary mercury:creatinine ratios we found in painters (range, 4.8 to 27.9 $\mu\text{g Hg/g creatinine}$), if they were expressed as total inorganic mercury concentrations, would be even

further below the proposed 35- $\mu\text{g Hg/g creatinine}$ reference value.

In addition, health effects from mercury exposure are reported at urinary mercury concentrations higher than those we found in painters. Proteinuria has been associated with urinary total mercury:creatinine ratios as low as 50 $\mu\text{g Hg/g creatinine}$, and objective tremors have been associated with urinary total mercury:creatinine ratios as low as 100 $\mu\text{g Hg/g creatinine}$.⁽⁶⁾

We found varying concentrations of mercury in different paint containers of the same brand (from 466 to 679 mg/L for Brand A paint) suggesting that the amount of mercury from one container of paint to the next is inconsistent and unpredictable, producing haphazard exposure.

Interior latex paints containing mercury have previously been shown to be hazardous. In August 1989, a child exposed to paint vapors in his newly-painted home developed acrodynia. That case prompted an investigation of mercury exposure from one brand of mercury-containing interior latex paint. The investigation showed that persons living in homes which were recently painted had been exposed to potentially toxic amounts of mercury.⁽²⁾ Another investigation showed that potentially hazardous mercury exposure may occur even in homes recently painted with interior latex paint that contains mercury concentrations less than 200 mg/L .⁽⁹⁾ In 1990, the U.S. Environmental Protection Agency (EPA) reached a voluntary agreement with the National Paint and Coatings Association and PMA manufacturers to cease adding mercury containing compounds to interior latex paint after August 20, 1990.

In 1991, another voluntary agreement was reached between these groups to cease the sale of PMA to paint companies for use in exterior latex paint as of September 1991. Mercury-containing exterior latex paint, however, can be produced and sold by paint companies until they exhaust their existing PMA stocks. However, as of June 1990, the EPA required that exterior latex paints containing mercury compounds be so labeled.⁽⁴⁾

The results of this study indicate increased mercury exposure from exterior latex paint for persons in an occupational setting. However, in the United States about 66 percent of the homes painted each year are painted by their owners.⁽¹⁾ We recommend that consumers carefully examine paint can labels to determine the presence of mercury. Mercury-containing exterior paints are sometimes misused—for example, consumers mistakenly use these paints indoors, which may produce higher exposures to mercury than when they are used outdoors. Therefore, consumers should be warned not to use mercury-containing exterior paints indoors. Further investigation is necessary to determine the extent of mercury exposure for home owners who paint their own homes.

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Disclaimer

The use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

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