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Brief Report

Lead and Hypertension in a Mortality Study of Lead Smelter Workers

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Hypertension has been associated with occupational lead exposure (*1–3*), and may in part be a consequence of renal injury. Excess mortality from cerebrovascular disease (*1,4,5*) and other forms of hypertensive vasculopathy (*6*), as well as from chronic renal disease (*4–7*), have been found in previous studies of lead smelter and battery workers. To assess the epidemiology of death potentially associated with lead-induced hypertension, we have reviewed data from a larger study (*8*).

This study evaluated the mortality of a cohort of white, male, hourly workers hired at a lead smelter in Idaho between January 1, 1940, and December 31, 1965, and employed for at least 1 year. Mortality was determined as of December 1, 1977. Of the 1987 males qualifying for the study group, 1281 were known to be alive, 665 were known to be deceased (601 death certificates were obtained), and the remainder (2.1%) were lost to follow-up. The deaths in this population were compared to the U.S. white male population using a Standardized Mortality Ratio analysis (SMR).

This plant was a primary smelter. The workers were exposed to cadium, zinc, and arsenic, as well as to lead. Therefore, a scheme was developed (*8*) to categorize exposures into several groupings based on the worker's probability for high lead exposure, with or without high exposure to cadmium, zinc, and arsenic. These groups were named "high lead" (HL) and "high lead/low other" (HL/LO).

The SMR for all causes for the entire population was 98, a value close to the norm for the U.S. population. As is usually found in studies of occupational populations, there was a statistically significant decrease in mortality for circulatory system disease; this probably is the result of selection factors typically found in work forces, the so-called "healthy worker effect" (*9*). Mortality from hypertension with heart disease had an overall SMR of 61 (confidence limits, 22–133; power or ability to detect a doubling = 74%); for hypertension without heart disease, the overall SMR was 117 (confidence limits, 24–342; power = 26%). Mortality from stroke was reduced (SMR = 84; confidence limits, 61–112), but not significantly so. These findings remained unchanged when examined by duration of exposure and by latency (Table 1) and when the data were examined by HL and HL/LO subgroups.

The findings on renal disease and cancer are more suggestive of an association with lead exposure: For the total population, mortality from chronic and unspecified nephritis and other renal sclerosis [International Classification of Diseases (ICD) 591–594] was elevated but not significantly so (SMR = 192; confidence limits, 88–364); the findings for this category for the HL and HL/LO groups was similar. In addition, the SMRs for the highest exposures and latency categories for the total study group were over 300 and statistically significant (Table 1). For mortality from kidney cancer, the overall SMR was 204 (confidence limits, 75–444), which increased to 245 (confidence limits, 81–583) for the HL group and to 301 (confidence limits, 98–703; power = 28%) for the HL/LO group.

In summary, these data do not suggest an association between occupational lead exposure and mortality from hypertension. The power of the study to detect excess mortality from hypertension with heart disease was fairly high (power = 74%), but it was quite low for hypertension without heart disease (power = 26%). These data do, however, suggest an association between lead and renal disease and possibly renal cancer. Nephritis has been recognized as a component of occupational lead intoxication since the late 19th century, and although little is known about natural history and dose-response relationships for lead-related renal effects, mortality from renal disease in this population appears to be associated with long-term, high lead exposures. This finding is consistent with epidemi-

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Table 1. Mortality experience of workers at a primary lead smelter, 1940–1977.

Cause of death (ICD codes, 7th revision)	< 5 years		5–19 years		20 years	
	Observed	SMR (CL)[a]	Observed	SMR (CL)	Observed	SMR (CL)
Diseases of the circulatory system (400–468)						
Duration of exposure	91	76 (61–93)	89	75 (60–92)	66	87 (67–111)
Latency interval	2	20 (2–71)	64	66 (51–84)	180	87 (74–100)
Hypertension with heart disease (440–443)[b]						
Duration of exposure	1	—	2	52 (6–188)	3	116 (24–340)
Latency interval	0	—	0	—	6	105 (38–228)
Hypertension without heart disease (444–447)[b]						
Duration of exposure	1	—	1	—	1	—
Latency interval	0	—	1	—	2	120 (15–433)
Renal disease and cancer Kidney cancer (180)						
Duration of exposure	2	165 (20–597)	3	278 (57–812)	1	—
Latency interval	1	—	1	—	4	214 (58–548)
Renal disease (nephritis and nephrosis) (591–594)						
Duration of exposure	3	160 (33–469)	2	112 (14–404)	4	392 (107–1004)
Latency interval	0	—	2	98 (12–352)	7	315 (127–649)
Total for all causes						
Duration of exposure	265	98 (87–111)	232	92 (80–104)	168	109 (93–127)
Latency interval	19	65 (39–101)	208	94 (82–108)	438	103 (93–113)

[a]CL, confidence limits.
[b]Due to changes in ICD coding, these data refer only to deaths occurring after 1950.

ologic reports of chronic renal disease (*1,5–7*) and case reports of renal cancer (*10,11*) in workers, as well as renal cancer in rats, mice, and hamsters (*10–16*).

REFERENCES

1. Dingwall-Fordyce, I., and Lane, R. E. A follow-up study of lead workers. Br. J. Ind. Med. 20: 313–315 (1963).
2. Emmerson, B. T. Chronic lead nephropathy: The diagnostic use of calcium EDTA and the association with gout. Aust. Ann. Med. 12: 310–324 (1963).
3. Cramer, K., and Dahlberg, L. Incidence of hypertension among lead workers: A follow-up study based on regular control over 20 years. Br. J. Ind. Med. 23: 101–104 (1966).
4. Malcolm, D., and Barnett, H. A. R. A mortality study of lead workers 1925–76. Br. J. Ind. Med. 24: 375–378 (1982).
5. Davies, J. M. Long-term mortality study of chromate pigment workers who suffered lead poisoning. Br. J. Ind. Med. 41: 170–178 (1984).
6. Cooper, W. C. Mortality in employees of lead battery plants and lead-producing plants. Presented at the XXI International Congress on Occupational Health, Dublin, Republic of Ireland, September, 1984.
7. McMichael, A. J., and Johnson, H. M. Long-term mortality profile of heavily-exposed lead smelter workers. J. Occup. Med. 24: 375–378 (1982).
8. Selevan, S. G., Landrigan, P. J., Stern, F. B., and Jones, J. J. Mortality of lead smelter workers. Am. J. Epidemiol. 122: 673–683 (1985).
9. Fox, A. J., and Collier, P. F. Low mortality rates in industrial cohort studies due to selection for work and survival in the industry. Br. J. Prev. Soc. Med. 30: 224–324 (1976).
10. Baker, E. L., Goyer, R. A., Fowler, B. A., Khettry, U., Bernard, D. B., Adler, S., White, R. D., Babayan, R., and Feldman, R. G. Occupational lead exposures, nephropathy, and renal cancer. Am. J. Ind. Med. 1: 139–148 (1980).
11. Lilis, R. Long-term occupational lead exposure, chronic nephropathy, and renal cancer: A case report. Am. J. Ind. Med. 2: 293–297 (1981).
12. Boyland, E., Dukes, C. E., Grover, P. L., and Mitchley, B. C. V. The induction of renal tumors by feeding lead acetates to rats. Br. J. Cancer 16: 283–288 (1962).
13. Mao, P., and Molnar, J. J. The fine structure and histochemistry of lead-induced renal tumors in rats. Am. J. Pathol. 50: 571–603 (1967).
14. Oyasu, R., Battifora, H. A., Clasen, R. A., McDonald, J. H., and Hass, G. M. Induction of cerebral gliomas in rats with dietary lead subacetate and 2-acetylaminofluorene. Cancer Res. 30: 1248–1261 (1970).
15. Van Esch, G. J., and Kroes, R. The induction of renal tumours by feeding basic lead acetate to mice and hamsters. Br. J. Cancer 23: 765–771 (1969).
16. Van Esch, G. J., Van Genderen, H., and Vink, H. H. The induction of renal tumours by feeding of basic lead acetate to rats. Br. J. Cancer 16: 289–297 (1962).