Lead Exposure in a Firing Range

THOMAS NOVOTNY, MD, MAGDALENA COOK, MS, JOHN HUGHES, MD, AND STEVEN A. LEE, MS, CIH

Abstract: We report lead exposure in four employees of a privately owned shooting range, one of whom had neurological toxicity due to lead. Increasing time worked at the range was associated with elevation of blood lead. This incident emphasizes the risk of airborne lead exposure to employees of firing ranges. (Am J Public Health 1987; 77:1225–1226.)

Introduction

Exposure to lead in indoor firing ranges is a documented occupational hazard. 1–3 Airborne lead is generated by the action of hot propellant gases against the base of the bullet, by the friction of bullets against the gun barrel, when leaded bullets strike the target area, and by the combustion of lead in priming compounds. 4 Inadequate ventilation at a firing range and lack of personal protective equipment use by employees may result in lead poisoning of exposed employees.

In April 1985, the Colorado Department of Health (CDH) received a report from the director of a local health department concerning two persons with blood lead levels of 88 and 69 μg/dl. These persons were employed at a privately owned indoor firing range, and their lead levels were reported as part of routine medical monitoring by a physician. They had normal baseline blood levels reported in August 1983, when the range had opened (these results were unavailable to the investigators); the elevated blood lead levels were found in follow-up in April 1985.

Methods

In April 1985, each of the four employees at the firing range and three of their spouses agreed to have their blood sample drawn. A blood lead ≥30 μg/dl was considered evidence of recent lead exposure; an erythrocyte protoporphyrin (EP) of ≥50 μg/dl was considered evidence of exposure to lead in the last three months. Each person was administered a questionnaire to identify possible additional sources of lead exposure, including hobbies such as painting with lead-based paint, and food storage in lead-glazed pottery.

Blood lead by anodic stripping voltammetry and EP analyses by extraction were performed by Environmental Sciences Associates, a reference laboratory used by the National Institute for Occupational Safety and Health (NIOSH). Follow-up blood samples for lead and EP were obtained on the exposed workers again in July 1985.

Air sampling was performed in the range using MSA Model G vacuum pumps* operating at 1.5 l/min with AA (37 mm) filters. Air samples were taken in the showroom, at the firing line, midway between the target and firing line, and as close to the target as possible. The air lead analysis was performed by the CDH laboratory using atomic absorption spectrophotometry.

Results

Blood lead levels and EP values for all persons are shown in Table 1. Case 1, the range manager, had the highest lead and EP levels, indicating both chronic and acute exposure. This person smoked more than one pack of cigarettes per day, often while cleaning lead dust and bullets out of the traps down range. Evaluation by an occupational medicine physician disclosed symptoms of intermittent headaches and right leg numbness and weakness. The physical examination demonstrated fasciculations and motor weakness in the right calf. This deficit was verified with nerve conduction velocity testing showing motor latency delay of the posterior tibial nerve. Neuropsychological testing was remarkable only for a mild learning disability, felt to be a pre-existing condition. On the basis of these findings, a diagnosis of neurological lead toxicity was made. The employee was advised not to clean the range and to avoid exposure to the range during use. Three months after diagnosis, the only residual symptom was a mild tremor of the calf; nerve conduction studies were normal. After six months, the patient’s blood lead level had fallen to 43 μg/dl.

The blood lead and EP level of case 2 also indicated chronic and acute exposure, but this person declined to see a physician. The part-time employees had only slightly elevated blood leads and normal EP levels. None of the spouses had elevated blood lead or EP levels. Risk factors for exposure included increasing hours worked per week {p = 0.008, Linear regression} and increasing months worked at the range {p = 0.02, Linear regression}. Smoking at work, eating at work, hours using the range for target practice, and other potential exposures were not associated with elevated blood lead levels. Use of protective clothing, showering on arrival home, and respirator use were not shown to affect the degree of lead absorption.

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Blood Lead (μg/dl)</th>
<th>Erythrocyte Protoporphyrin (μg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>April</td>
<td>July</td>
</tr>
<tr>
<td>1(FT)</td>
<td>77</td>
<td>43</td>
</tr>
<tr>
<td>2(FT)</td>
<td>59</td>
<td>30</td>
</tr>
<tr>
<td>3(PT)</td>
<td>49</td>
<td>36</td>
</tr>
<tr>
<td>4(FT)</td>
<td>41</td>
<td>17</td>
</tr>
<tr>
<td>5(S)</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>6(S)</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>7(S)</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

*Trade name is used for identification only and does not imply endorsement by the US Department of Health and Human Services or the US Public Health Service.
Table 2 lists the airborne lead concentrations at the range. The highest, 90.5 μg/m3 lead was found closest to the target. Technical difficulties in measuring air flow rates precluded adequate assessment of the ventilation system, but the flow rate recorded at installation was approximately 17,000 ft³/minute; this is below NIOSH recommended guidelines of 20,000 ft³/minute based on the dimension of this shooting range.5

Discussion

This incident emphasizes the risk of exposure to lead for employees in an indoor firing range. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Level for lead in workplace air is 50 μg/m³/8-hr working day. Air lead levels on the range suggest that the workers may have been exposed to potentially toxic lead levels while working in the contaminated down-range areas. Inadequate ventilation may also have contributed to the elevated blood lead levels found in the employees. An additional source of exposure to the two part-time employees, who recycled bullets at their homes, might have been lead suboxide particles thrown off during molten lead agitation in the bullet molding process.2 The failure to find an association between behaviors known to increase lead absorption (such as smoking and eating in the shooting area) may be due to the small number of subjects.

The ventilation at the firing line was not measured or examined for turbulence. Patrons and employees alike could have been exposed to lead even with the low air levels measured in this investigation. Air lead sampling of exposed persons would have provided a better measure of exposure during maximum firing conditions.5 Because the range had ceased operations due to unrelated reasons, further investigation regarding exposure to patrons was not possible.

Periodic lead and EP levels should be used to monitor exposed shooting range workers. Public health officials as well as range proprietors should be aware of design problems and work habits in ranges which allow exposure of employees and patrons. NIOSH has published guidelines for the construction, maintenance, and monitoring of firing ranges.5

ACKNOWLEDGMENTS

We wish to thank Dr. Robert Sherwood and James Cassiano for their assistance in this investigation; Bobby Gunter, NIOSH Region VIII, and Dr. Philip Landrigan for valuable suggestions.

REFERENCES


Fellowships in Applied Gerontology

Applications are being accepted from organizations wishing to host a fellow as part of the 1988 Fellowship Program in Applied Gerontology sponsored by the Gerontological Society of America. Now in its 15th year, the program places academic researchers in public and private organizations for three summer months to provide technical assistance is such disparate areas as discharge planning, curriculum development, program evaluation, case management, planning and evaluation of geriatric assessment units, and housing issues.

Agencies will be selected on the basis of: (1) degree to which proposed project will advance the state-of-the-art in gerontological research and be applicable to other settings; (2) appropriateness of the proposed project approach or design to the stated problem; (3) degree to which the proposal is realistic in terms of time and effort, and specific in anticipated products; (4) ability of the host agency to provide adequate supervision and support to the proposed project; (5) national geographic distribution and diversity of type of selected agencies; and (6) level of in-kind and stipend support committed (a minimum of $2,500 cash contribution toward the program’s costs).

This program is supported by grants from the Administration on Aging, the Retirement Research Foundation of Chicago, the Illinois Department on Aging, the Fred Meyer Charitable Trust of Portland, Oregon, the Cleveland Foundation, and the General Board of Global Ministries of The United Methodist Church. Application deadline is October 2, 1987. For application forms and further information, contact: Program Director, Fellowship Program in Applied Gerontology; 1411 K Street, NW, Suite 300; Washington, DC 20005. Telephone: (202) 393-1411