Suspected Lead Poisoning in a Public School*

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ABSTRACT

Reports of lead exposure can generate considerable public concern, particularly when children are involved. In December, 1996, a public elementary school in rural Utah was found to have elevated concentrations of lead in its drinking water. The local public health department responded by instituting remediation of the water supply and by warning parents of the possible danger to their children. Subsequent blood lead testing in 116 of the approximately 300 children involved showed an average lead concentration in the range expected for the U.S. population at large. One of the 116 specimens was marginally elevated and was probably unrelated to the school drinking water. Reducing lead exposure is an important public health concern which sometimes generates a response out of proportion to the danger involved.

Introduction

Lead poisoning in children has been declared a major health problem.1,2 In 1991, the Centers for Disease Control and Prevention (CDC) recommended that virtually every child in the United States between the ages of 6 and 72 months should be tested for lead.1 While it might seem that such a goal would be greeted with universal acclaim, the CDC recommendations have generated some controversy.3,4 Objections to the CDC goals have included concerns that lead testing is shifting resources from other areas of need, and that extensive lead testing is not needed in communities which appear to be at relatively low risk.5,6 Revised proposals from the CDC are now suggesting a more flexible approach described as targeted screening.2 One aspect of the current emphasis is that public fears of lead poisoning are often heightened. In this regard, a situation is described where an elementary school was found to have its water supply contaminated by lead, an event which caused concern in the community out of proportion to the actual danger involved.

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Case Report

In December, 1996, the Uintah Basin Public Health Department (UBPHD) in northeastern Utah received complaints about orange-colored water coming from a kitchen tap in a rural public elementary school. The school had been constructed in 1982–83 and had a population of about 300 students between the ages of 5 to 13 years old. On December 16, a water sample was collected from the kitchen tap and forwarded to the state laboratory. Analysis reported a lead content of 11 μg/dL, which is significantly higher than the maximum contaminant limit of 1.5 μg/dL set by the Environmental Protection Agency (EPA) for drinking water. Additional water samples were collected in and around the school during the following month, the results of which are summarized in table I. Based on these studies, a letter was sent to school parents on January 13, 1997, informing them of the elevated lead concentrations in the school drinking water, and recommending that children drink bottled water at school or water brought from home until the problem was resolved. Reports in the local newspapers were essentially balanced and accurate. However, other reports (personal communications with corresponding author) were indicative of considerable confusion and hostility from some parents who expressed outrage that their children were being poisoned. Subsequent modeling studies by the Utah Division of Epidemiology suggested that children drinking school water could potentially have blood lead concentrations as high as 17 to 18 μg/dL, which is above the concentration of 10 μg/dL recommended by the CDC. A voluntary program of blood lead testing was organized by the UBPHD for the involved school children. Parental approval was required for testing, and parents were also asked to complete a survey to provide additional data on other potential sources of lead exposure. On January 29, 1997, whole blood venipuncture specimens were drawn by a trained phlebotomist from a local hospital. Specimens were collected from 116 of the approximately 300 students attending the school and also from 7 adult kitchen workers. One marginally elevated blood lead was found (table II).

Materials and Methods

Whole blood venipuncture specimens were drawn into royal-blue-top evacuated collection tubes containing an EDTA anticoagulant.* Lead analysis was performed at ARUP Laboratories by inductively coupled plasma mass spectrometry (ICP-MS; Elan 6000)† as described previously. The ARUP Laboratories is a participant in good standing with the lead proficiency programs certified by the College of American Pathologists (CAP), the New York State Department of Health, the Pennsylvania Department of Health, and the Wisconsin State Laboratory of Hygiene.

The results of water lead testing summarized in table I were those reported to the UBPHD from the Utah Department of Environmental Quality, Division of Drinking Water, and were performed at the state laboratory. The lead content of water is commonly reported in units of μg/L, whereas the current report uses units of μg/dL to make them more directly comparable to those used for whole blood.

Results

Whole blood lead results for the 116 school children are summarized in table II. Since risk is higher for the younger ages, particularly six-years-old and under, the results are segregated by age. The majority of results, 115 out of 116, were below 10 μg/dL, the level recommended by the CDC for young children. The one marginally elevated lead concentration of 10.9 μg/dL was found in a 5 year-old male,
TABLE II
Whole Blood Lead Concentrations (µg/dL) of 116 School Children

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>3.6</td>
<td>3.6</td>
<td>10.9*</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>2.4</td>
<td>1.1</td>
<td>4.5</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>2.1</td>
<td>1.2</td>
<td>5.0</td>
</tr>
<tr>
<td>8</td>
<td>14</td>
<td>1.6</td>
<td>0.8</td>
<td>3.1</td>
</tr>
<tr>
<td>9</td>
<td>22</td>
<td>1.8</td>
<td>1.5</td>
<td>7.8</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>1.7</td>
<td>1.5</td>
<td>7.6</td>
</tr>
<tr>
<td>11</td>
<td>14</td>
<td>2.0</td>
<td>1.4</td>
<td>6.6</td>
</tr>
<tr>
<td>12</td>
<td>9</td>
<td>1.9</td>
<td>0.71</td>
<td>3.1</td>
</tr>
<tr>
<td>13</td>
<td>5</td>
<td>2.7</td>
<td>0.16</td>
<td>2.9</td>
</tr>
</tbody>
</table>

*One specimen of 116 with lead concentration > 10 µg/dL.

Although the remaining 4 children in the 5 year-old category had a mean lead concentration of 1.8 µg/dL (SD 0.24, maximum 2.6 µg/dL). Three of the 115 normal results were between 6 and 8 µg/dL, all of which represented the maxima for their respective age groups (table II). In the 7 adult kitchen workers, aged 24 to 61, the average blood lead was 1.9 µg/dL (SD 1.1 and maximum 4.2 µg/dL).

Discussion

The mean blood lead concentrations in table II are essentially the same as those reported in the Third National Health and Nutrition Examination Survey (NHANES III), which is a population-based survey of the health status of the civilian U.S. population during 1988 to 1994. For the US population, the NHANES III mean blood lead concentration was 2.8 µg/dL (95 percent confidence interval 2.7 to 3.0). In spite of the elevated lead content of the school water supply, it did not appear to result in a significantly elevated blood lead concentration in the children attending the school. This conclusion is consistent with the observation that, in general, lead in drinking water is not the predominant source of lead exposure for children.

One marginally elevated whole blood concentration of 10.9 µg/dL was found in a 5-year-old student. Since this was the only elevation found, it was probably not due primarily to school drinking water. To put the degree of elevation in context, prior to 1991 the value of 10.9 µg/dL would have been well below the level of concern of 25 µg/dL and would have been classified as normal. Since 1991, the actions advocated by the CDC for concentrations ≤10 µg/dL consist of monitoring and educational measures. The current recommendations from the CDC for blood lead in the range of 10 to 14 µg/dL is to: (1) provide education; (2) provide follow-up testing within 3 months, and (3) provide social services, if necessary. Medical treatment, such as chelation therapy, is not recommended until much higher concentrations, specifically ≥45 µg/dL. Although it is prudent to be concerned about reducing this child's lead exposure, identifying the child as "lead poisoned" seems unwarranted and exaggerated. It is our suggestion that the goal of reducing lead exposure would be better served by a more balanced classification which puts such low level exposures in a more reasonable context and one which generates a less emotional response from parents.

There is an additional reason to be less stringent about identifying marginal elevations as "lead poisoned," namely that there is a significant degree of analytic uncertainty in the measurement of very low lead concentrations. The degree of uncertainty can be seen in the results of proficiency surveys, such as those published by the CAP. For example, the 1996 CAP proficiency specimen BL-14 was reported to have a mean blood lead concentration of 13.21 µg/dL with standard deviation of 1.90 µg/dL; the range of values reported by the 364 participating laboratories covered from 7.5 to 19.5 µg/dL, and the 95 percent confidence interval (±2 SD) was 9.41 to 17.0 µg/dL. Measuring very low concentrations of blood lead is analytically challenging and subject to significant imprecision, and the CDC defined cutoff of 10 µg/dL should be interpreted with this imprecision in mind.
One confounding factor in the present study is that, of necessity, remedial efforts were instituted at the school before blood specimens were collected. Parents were cautioned to have children use bottled water or water from home, whereas blood lead specimens were collected 16 days later. The half-life of blood lead is about 35 days. Assuming a first order rate of elimination, a child with a blood lead of 15 μg/dL would be expected to drop to an estimated 10.9 μg/dL in 16 days if all lead was completely removed from the environment. Since the lead in school water represented only a portion of the total environmental lead, it was concluded that the 16-day-delay in specimen collection would be unlikely to have significantly altered the results seen in table II.

Owing to the high risk of contamination with exogenous lead, blood specimens collected by venipuncture are superior to capillary fingerstick collections. Likewise, whenever possible, blood specimens for lead analysis should be collected into tubes such as royal-blue-top vacuutainers designed for trace element collection. Given the degree of community concern, falsely elevated results would not have been well tolerated, and the use of venipuncture specimens collected into trace element tubes was highly desirable. Fingerstick specimens can be sanctioned for screening purposes, particularly when follow-up venipuncture specimens can be collected. However, it should be emphasized that follow-up specimens are notoriously difficult to obtain, and that treatment decisions should only be based on venipuncture results. The conclusion of more than one study has been called into question by the use of fingerstick specimens.

Based on the results of the water testing summarized in table I, the Division of Epidemiology at the Utah Department of Health used modeling software from the Environmental Protection Agency (EPA) to estimate the exposure of the school children involved. Modeling predicted that a child 5 to 7 years of age could potentially have blood lead concentrations up to 17 to 18 μg/dL (data not shown). Since it is important for modeling studies to estimate the maximum potential impact of lead in the water system, it is not surprising that modeling also overestimated the actual degree of exposure. Given the complexities of lead absorption, the only way to assess accurately the lead exposure is to measure it. In partial defense of modeling, specimens are often difficult to collect, and even in a small rural community such as the one described here, specimens were collected from less than 40 percent of the children involved.

Although the children in this particular case were not significantly impacted by the elevated lead content of the school water, the lead content of drinking water remains an important issue. As a matter of public health, drinking water is required to comply with EPA regulations, and the school has made changes to its plumbing system to reduce the lead content of its water. In addition, the local water district has instituted changes designed to reduce the acidity of the water released from its processing plant. While slightly acidic water facilitates the leaching of lead from pipes and joints, less lead is mobilized when water is on the alkaline side. Acid water also encourages corrosion, and the orange-colored water in the school kitchen which first drew the attention of the school staff and students was most likely due to an increased iron content secondary to corrosion in the water system.

One fact emphasized by the data in table I is that the drinking water which has been standing in pipes for several hours often contains higher lead concentrations. This is a common phenomena caused by the leaching of lead from the pipes, joints, and plumbing fixtures. Running a water tap briefly before using the water has been suggested as a simple way to lower potential lead exposure.

Conclusions

Reports of lead exposure can be expected to generate concern in communities, sometimes out of proportion to the danger involved. When lead poisoning is suspected, confirmation of lead exposure can be accurately assessed by testing specimens from the individuals involved.
Children in rural Utah, specifically in the Uintah Basin in northeastern Utah, have average blood lead concentrations in the range expected for the U.S. population at large, although sporadic elevations can also be found. Reducing lead exposure in the environment is an important public health issue which would be aided by policies which discourage an exaggerated public response. The use of the term “lead poisoned” for slightly elevated blood lead concentrations should be avoided.

References