

## Lead in the Modern Workplace

Occupational lead poisoning has been recognized for over 2,000 years. Its cardinal features—*anemia, colic, neuropathy, nephropathy, sterility, coma and convulsions*—were described by Hippocrates,<sup>1</sup> and Nikander<sup>2</sup> in ancient times and by Ramazzini,<sup>3</sup> Thackrah,<sup>4</sup> Hamilton,<sup>5</sup> and Lilis<sup>6</sup> in the modern era.

The single most effective approach to the prevention of industrial plumbism—control of the inhalation of airborne lead—has also been known since antiquity. Pliny, writing in the middle years of the Roman Empire, reported that miners could protect themselves against the inhalation of lead dust by wearing an animal bladder tied tightly across the face.<sup>1</sup>

The modern era of control of occupational lead poisoning began in Britain in the early years of this century with the work of Sir Thomas Legge, the first Medical Inspector of Factories.<sup>7</sup> Legge proposed four axioms for the control of occupational lead poisoning:

"1. Unless and until the employer has done everything—and everything means a good deal—the workman can do next to nothing to protect himself, although he is naturally willing enough to do his share.

"2. If you can bring an influence to bear external to the workman (i.e. one over which he can exercise no control), you will be successful; and if you cannot or do not, you will never be wholly successful.

"3. Practically all industrial lead poisoning is due to the inhalation of dust and fumes; and if you stop their inhalation you will stop the poisoning.

"4. All workmen should be told something of the danger of the material with which they come into contact and not be left to find it out for themselves—sometimes at the cost of their lives."<sup>7</sup>

Under Legge's influence, occupational lead poisoning was made a reportable disease in Britain in 1899. With the continuing surveillance and control that followed that action, the number of reported cases of industrial lead poisoning fell from 1,058 with 38 deaths in 1900, to 505 cases in 1910, and 59 in 1973.<sup>1</sup>

In the United States, the most recent effort to reduce occupational exposure to lead was the adoption in 1978 of a comprehensive lead standard by the Occupational Safety and Health Administration (OSHA).<sup>8</sup> This standard has been an enormous success, and it has been judged as among the most influential actions undertaken by OSHA. Thousands of workers have benefited, and many work places and work practices have been improved as a result of this standard.

Despite these successes, lead remains a serious problem in American work places. Two shocking articles in this issue of the *Journal* demonstrate the persistence of occupational overexposure to lead.<sup>9,10</sup> These reports show that between April and December 1987, 2,643 workers in California had blood levels of 1.21  $\mu\text{mol/L}$  (25  $\mu\text{g/dl}$ ) or above, that 649 had levels of 1.93  $\mu\text{mol/L}$  (40  $\mu\text{g/dl}$ ) or above, and that 24 had levels of 3.87  $\mu\text{mol/L}$  (80  $\mu\text{g/dl}$ ) or above. Moreover, these reported numbers, disturbing as they are, appear to represent but a fraction of the total problem, inasmuch as only 1.4 percent of lead-using industries in California have developed biological monitoring programs for their lead-exposed workers.

Why does lead remain so widespread and persistent a problem in American's workplaces?

One reason is the change in our understanding of the effects of lead. As a result of scientific advances made over

the past decade, lead is now recognized to cause toxic effects in workers at levels of exposure that only recently were thought to be safe.<sup>11</sup> The resulting "subclinical toxicity" involves inhibition of heme biosynthetic enzymes<sup>12</sup> and delayed blood regeneration,<sup>13</sup> impairment of the function of renal tubular cells,<sup>14</sup> hypertension,<sup>15</sup> inhibition of sperm formation,<sup>16</sup> slowing of motor nerve conduction velocity,<sup>17</sup> and dysfunction of the central nervous system.<sup>18,19</sup> All of these effects have been shown to occur in apparently healthy workers at levels of exposure to airborne lead that are below OSHA's currently permissible exposure limit (PEL) of 50  $\mu\text{g/m}^3$  and that also are below OSHA's biological limit value for lead in blood of 2.42  $\mu\text{mol/L}$  (50  $\mu\text{g/dl}$ ).

Additionally, there are limitations in the extent of coverage provided by the OSHA lead standard. Certain classes of workers, such as workers in the construction and agricultural industries, and workers in industries using organolead compounds, were excluded from coverage in the 1978 standard. This failure to provide protection to workers in these businesses and in construction has resulted in numerous cases of lead toxicity.<sup>20,21</sup>

A third problem is that the standard has been inadequately enforced.<sup>22</sup> The number of OSHA inspectors in the field has been reduced, and OSHA has granted industry numerous variances and exceptions to the lead standard. Between 1979 and 1985, OSHA conducted approximately 4,000 worksite inspections in which lead in air was sampled; in 32 percent of these inspections at least one air lead level was found to be above the PEL of 50  $\mu\text{g/m}^3$ .<sup>21</sup> Moreover, there was no improvement in the average air lead concentration measured over this period.<sup>21</sup> These data indicate that excessive lead exposure continues to be widespread in American industry.

"Fetal protection policies," an unforeseen consequence of the OSHA lead standard, are yet another problem. These policies exclude reproductively active women from the workplace.<sup>23</sup> They deny employment opportunities to these women on the grounds that the fetus is more sensitive to lead than either the adult male or female worker.<sup>24</sup> It is argued by industry in proposing these policies that the period of special sensitivity of the fetus begins in the early days of interuterine development, before a woman may know that she is pregnant; on this basis fetal protection policies have been extended not only to pregnant women but to all women of child-bearing capacity. The justification for these policies advanced by industry is that lead intoxication of the fetus could result in employer liability for damages expressed in the child who is not covered by workers' compensation.<sup>25</sup>

What are the solutions to these problems?<sup>2</sup>

First, it is essential that *both the environmental and biological standards regulating exposure to lead in the workplace be sharply reduced*. Present standards are not protective.<sup>11</sup> They provide no margin of safety against subclinical lead toxicity. Workers exposed to lead at levels below the current PEL are suffering toxicity. In lowering the standard, OSHA must change the philosophy that heretofore it has used in standard setting. Rather than base a new standard on issues of economic and technologic feasibility, OSHA must reset the lead standard solely on the basis of the available medical evidence. I recommend that the PEL for lead in workplace air be reduced to 20  $\mu\text{g/m}^3$ . I recommend further that the trigger blood lead level for removal of a

worker from a lead-contaminated workplace be set no higher than 0.97  $\mu\text{mol/L}$  (20  $\mu\text{g/dl}$ ) and that a worker not be allowed to return to a lead-contaminated workplace until his or her blood level has fallen to 0.48  $\mu\text{mol/L}$  (10  $\mu\text{g/dl}$ ). Such a tactic will prevent most cases of subclinical lead toxicity and, additionally, it will provide a workplace that is safe for reproductively active workers of both sexes.

If the lead standard is to be reduced to such low levels, it will be necessary to place greater reliance than heretofore on respirators. However, this step must be taken with great care and with the explicit recognition by all parties that this approach does not constitute a retreat from OSHA's long-standing commitment to a hierarchy of controls that quite properly values engineering and work practice controls above respirators. This approach would, however, recognize both the difficulty and the importance of reducing occupational lead exposures to very low levels to protect the health of workers and the fetus. It makes considerable sense to require industry to implement both kinds of controls: to implement engineering and work practice controls, and then additionally to rely on respirator programs for supplementary protection where engineering controls are incapable of achieving appropriately low levels. If this approach is adopted, close regulatory oversight of the balance between control technologies will be required, and the movement already evident within some sectors of industry to rely excessively on respirators must aggressively be checked.<sup>25</sup>

*Exclusionary policies must be eliminated.* OSHA must specifically affirm that the use of these policies to control exposure to lead is unacceptable. Exclusionary policies for lead will largely be eliminated if the triggers for medical removal protection are reduced to the low levels suggested above and if the PEL for lead in air is also sharply lowered.

*Vigorous enforcement is necessary.* The number of OSHA inspectors in the field must be increased. These inspectors must be allowed to levy severe fines for repeated or willful violations. Criminal penalties must be used much more frequently than heretofore to punish repeated and willful violators. Variances and exemptions to the standard must be eliminated.

Finally, we, as a society, must recognize that we have reached a point in history where *non-essential uses of lead can no longer be tolerated*. All non-essential uses must, therefore, be identified and eliminated. I recommend that the National Institute for Occupational Safety and Health conduct a national survey of all lead-using industries to identify those in which the use of lead is not essential and where suitable substitutes are available. Then to encourage restriction of the use of lead to essential needs, monetary incentives must be introduced either through legislation or regulation. For example, as was suggested in a proposal put forth recently by the Environmental Defense Fund,<sup>26</sup> one option would be to impose a heavy excise fee, perhaps four times the current price of lead, on all originally produced lead, i.e., on all lead produced by primary smelters as well as on all imported lead. Such a fee would provide a strong market incentive to find substitutes for lead whenever substitution is feasible and cost-effective. Such approaches are likely to result in the elimination or reduction of many occupational lead exposures, and such a fee would also encourage recycling.

The continuing overexposure of American workers to lead and the persistent occurrence of occupational lead poisoning is a national scandal. It is not necessary. It is entirely preventable. The question is not one of technology or

of feasibility, but rather of national will to act upon the abundantly available medical data.

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