Survey of Lead Levels in Patients Presenting to Child and Adolescent Psychiatry

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The role of lead as an environmental toxin is well documented; symptoms frequently include anemia, abdominal pain, paralysis, and encephalopathy. Recently lead has been cited as a possible etiologic factor in learning disabilities, attention problems, and symptoms of conduct disorder. Questions about the level at which threshold effects surface are difficult to answer because of the inconsistent findings in the literature. Ernhart critically reviewed 9 prospective studies which looked for behavioral effects of prenatal lead exposure and concluded that there was little consistency in studies.[1] Numerous other investigators did find evidence of neurobehavioral effects at low lead levels,[2-5] however, the effect of low lead levels on cognition, learning disabilities, and behavior remains unclear. Several studies have shown a subtle effect of asymptomatic lead exposure on cognitive ability. The Port Pirie prospective study, which compared lead levels in infant cord blood with IQ at 4 years, found an average decrease in IQ of 4.5% as the concentration of lead increased from 10 µg/dl to 30 µg/dl.[6] A second prospective study by Bellinger found lower levels of performance on the mental development index (MDI) of the Bayley Scales of Infant Development.[4] They compared umbilical cord lead levels at birth with capillary lead levels and MDI scores semiannually and up to 2 years. At all ages infants with a birth lead level >10 µg scored lower on the MDI than infants whose levels were <3 µg (low risk group) or 6 to 7 µg (median risk group). Dietrich found that the association between prenatal lead levels and performance on the Bayley Mental Development Index was mediated by birth weight and gestational age.[7] A cross-sectional study by Winneke sought to combine 8 individual studies within a single analysis to increase sample size and broaden the range of exposure in order to establish dose response contingencies. He found only a weak association between lead and IQ. The strongest, most consistent effect occurred for the Bender Gestalt Test and a test of serial reaction performance. However, the observed variance never exceeded 0.8% of the total variance.[4] Another cross-sectional study in Britain studied inspection time and reaction time and found both measures were worse at higher lead levels, but only inspection time was still significant after controlling for social and family background.[8] These same authors found a positive relationship between lead levels and teacher ratings on the Rutter behavior scale, especially the aggressive/antisocial and hyperactive subscores.[9]

Evidence against the effects of lead on cognition comes from 2 prospective studies, and criticism of the above studies. An Australian prospective study found no correlation between pre- or postnatal lead exposure in infancy and neurobehavioral development at 4 years of age.[10] In addition, a prospective study by Ernhart did not find pre- or postnatal lead exposure to be related to Bayley Mental Development Index or development in the preschool period.[11] Lastly, the criticism of the studies, which shows a positive association between lead and cognitive development, looks at small effects, and lack of control for certain confounds (especially maternal IQ) as problems interfering with strong conclusions. Despite the controversy, the Centers for Disease Control and the American Academy of Pediatrics have recommended universal screening of children. In addition, the American Academy of Child and Adolescent Psychiatry has recommended including lead toxicity in the differential diagnosis of children with symptoms of conduct disorder, behavior problems, learning disabilities, and attention problems.

A California study found 14% to 67% of all 1 to 5 year olds have blood lead levels >10 µg/dl.[12] The Agency for Toxic Substances and Disease Registry estimated 17% of preschool children have levels >15 µg/dl.[13] In Hawaii, there is evidence of elevated lead levels in the water system at Schofield Barracks and on the Big Island which makes screening all the more timely.[14] However a recent study in Hawaii by the Department of Health found a mean level of 4.5 µg/dl in 389 child participants.[15] These authors, therefore, did not recommend screening all children in Hawaii.

This study includes lead toxicity in the differential diagnosis of children presenting to Child and Adolescent Psychiatry and compares their lead levels to all lead levels drawn for military children on Oahu. The study assesses whether there is a relationship between behavioral, attentional, and learning problems and venous lead levels; it also looks for a difference between these children and a population sample of military children. This study

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adds to existing data by surveying lead levels in children from a specific population, namely those in Hawaii who are dependents of active duty military and are known to have neurobehavioral problems.

Table 1.—Mean Lead Levels by Age Group (μg/dl)

Age	Experimental (n=53)		Population Sample (n=440)	
	n	mean	n	mean
0 to 5	24	1.4	415	1.7
6 to 11	22	1.0	25	0.1

Methods

All parents of children and adolescents presenting to Child and Adolescent Psychiatry with symptoms of conduct disorder (lying, stealing, truancy, running away, property destruction, cruelty to animals, fighting), behavioral disorders, learning disabilities and attentional problems were given a Volunteer Agreement Affidavit and questionnaire summarizing the reasons for the venous blood test. Lead levels were tested at Pearl Harbor Industrial Hygiene Lab and used atomic absorption mass spectroscopy. Levels were reported with a 4% to 6% variance. Using Tripler's computer-automated lab retrieval method, 2 consecutive months of lead levels for military children were obtained as a comparison group. Parents were notified for any lead level above 5 μg/ml and screening of siblings was recommended in accordance with the recommendations from the American Academy of Child and Adolescent Psychiatry. A system was set up to monitor lead levels >10 μg/dl and provide chelation for children whose lead level exceeded 35 μg/dl. The 2 groups were compared using mean values for each group. A level reported as <5 μg/dl was calculated as 0 μg/dl. Chi squared analysis was used for the values >5 μg/dl in the experiential group, compared to the population sample.

Results

Overall, adolescents were difficult to obtain for the experimental group, and no adolescents were sampled in the population of military children whose blood was drawn during the months of December and January. Some parents declined the procedure and a few did not follow through even after being called and reminded. No values were greater than 7 μg/dl in the experimental group and only 4 were >10 μg/dl in the population sample. There were 53 samples in the experimental and 440 in the population sample with mean levels for both groups of less than 5 μg/dl even when broken down into age groups (Table 1). The incidence of values >5 μg/dl in the experimental group was 0.2 and 0.3 for the population sample. Chi-squared analysis comparing the number of values >5 μg/dl in the experimental group with the population sample revealed that the probability of the experimental group being different from the population sample was less than 0.2, but greater than 0.1. So the null hypothesis was accepted.

Discussion

The mean lead levels in this study are very similar to the mean levels obtained by the Hawaii Department of Health. This illustrates that military children in Hawaii who have different housing and are more transient do not have lead levels comparable to the California Survey and the data from the Toxic Disease Registry. There appears to be no relationship between behavioral, attentional, and learning problems and venous lead levels in the children tested. Lastly there is not a significant difference in lead levels in the children with known neurobehavioral problems and the population of military children screened between December 1993 and January 1994. These results add further to the data from the Department of Health and suggest that routine screening of children in Hawaii is not indicated. Although the number of children tested for lead in the Department of Child Psychiatry was not high, the fact that no level was >7 μg/dl is very significant and indicates that routine screening of all children with attention, behavioral, conduct, and learning problems is not indicated and, at $20 to $30 a test, is not cost-effective. We recommend screening only those children with *refractory* problems, those with severe difficulties, and those with known risk factors such as pica, dwelling in homes built before 1950, and those whose parents have an occupational exposure to lead.

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