# Blood Lead Levels in Psychiatric Outpatients Reduced by Zinc andVitamin C

**Arthur Sohler, Ph.D., Marcus Kruesi, B. S., and Carl C. Pfeiffer, Ph.D., M.D.[1]**

*Blood lead levels were determined by the method of* Hesse/ *on over 1,000 psychiatric outpatients. Lead values ranged from 3.8 to 53 mcg% with a mean of 15.6 mcg%. Approximately 6 percent of the patients had lead levels above 25 mcg%. A therapeutic regimen of zinc and ascorbic acid was found to significantly decrease the blood lead level. This treatment also lowers blood copper levels. The heavy metal burden of a number of hyperactive and autistic children was alleviated resulting in clinical improvement. Vitamin C and zinc may be an attractive alternative to chelation therapy in the treatment of chronic lead intoxication. The real triad in hyperactivity may be* excess *lead and copper in zinc-deficient patients.*

## Introduction

The sensitivity of the central nervous system to heavy metal intoxication is well established. Several studies have suggested a relationship between asymptomatic lead exposure and deficits in perceptual and behavioral function (Albert et al., 1974; de la Burde and Choate, 1975; Landrigan et al., 1975; Porino and Ernhart, 1974). Lead has recently been implicated in children in cases of hyperactivity and mental retardation. David et al. (1972) reported a study in which lead excretion after the administration of penicillamine was measured. Three groups of children from an urban environment were studied. Lead excretion was highest in the group which was diagnosed as being lead poisoned, but a group of hyperactive children also excreted significantly higher amounts of lead as compared to the third normal control group. Hyperactivity has also been induced in rats by feeding lead salts (Sauerhoff and Michaelson, 1973).

Lead was implicated in mental retardation in a study by Beattie et al. (1975). A relationship was found between lead levels in the water supply and retardation. The retarded children also had higher blood lead levels than nonrelated matched controls.

**1 Brain Bio Center, 1225 State Road, Princeton, New Jersey 08540.**

Lead intoxication can produce many psychiatric symptoms. In the case of tetraethyl lead poisoning, excitement, restlessness, insomnia, nightmares, hallucinations, impairment of memory, and loss of mental concentration are reported. In inorganic lead poisoning, depression is often a symptom. Harriman and Parland (1973) have reported that lead industry workers who show no obvious signs of lead poisoning exhibit intellectual disturbances, personality changes, and an impaired performance in psychometric tests.

Vitamin C or ascorbic acid is known to have a marked effect on inorganic element metabolism, both in the case of essential trace metals and in the case of toxic heavy metals. Under physiological conditions ascorbic acid can act as a reducing agent, but it can also bind metal ions and affect their movement across biological membranes. Recently, Spivey Fox (1975) showed that the addition of ascorbic acid to the diet of the Japanese quail reduced the toxicity of a high-cadmium diet. The quail were fed 75 mg cadmium/kg of diet for four weeks, which resulted in depression of growth, anemia, and alteration in essential elements in tissue. Ascorbic acid (1 percent) added to the diet exerted a marked protective influence.

Chatterjee et al. (1975) reported on the dietary intake of metal ions and I-ascorbic acid metabolism. They found that administration of the heavy metals Cd, Pb, or Hg to rats reduced the levels of l-ascorbic acid in both liver and kidney tissue. Pb was administered in these experiments at a dose of 10 mg/100 g body weight. Daily supplementation of the diet of these animals with ascorbic acid at a dose of 10 mg/100 g body weight raised ascorbic acid in tissues to above control levels.

One can look upon lead intoxication as a stress state. Decreased blood Zn levels and increased Cu levels have been reported in several stress states such as burn cases, post surgery, infection, and leukemia. Oleske et al. (1975) has reported similar findings in asymptomatic lead-intoxicated children. He compared whole blood zinc and copper levels in a group of children with acute infection and an asymptomatic lead intoxication group with a control group which was admitted for elective surgery of minor trauma. The asymptomatic lead group was admitted for EDTA chelation therapy and had blood Pb levels greater than 60 mcg%. While the administration of zinc has been found beneficial in a number of stress states, no one has used zinc and vitamin C to reduce lead levels and symptoms.

The present report concerns itself with a survey of the psychiatric outpatient population of the Brain Bio Center and the use of vitamin C and zinc in the treatment of lead-intoxicated individuals.

## Material and Methods

The study was carried out on psychiatric outpatients of the Brain Bio Center. Blood lead levels were determined by the method of Hessel (1968). Serum copper was measured by atomic absorption spectroscopy of a trichloroacetic acid extract. Lead levels were determined on the initial visit and in high-lead patients on subsequent visits while they were on a regimen of vitamin C and Zn. Data was statistically analyzed by a paired t test.

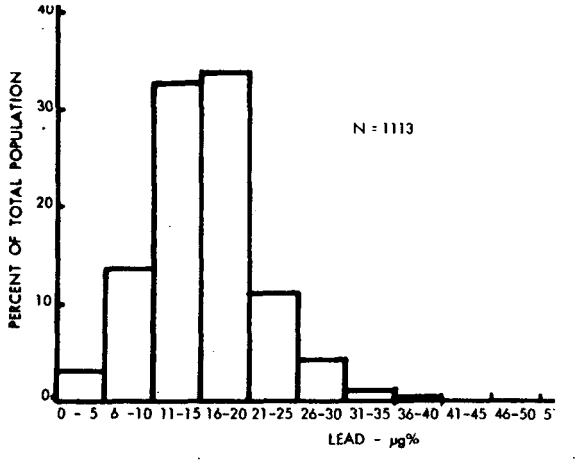
## Results

Blood lead levels were determined initially on 1,113 outpatients. The results are presented in the histogram, Figure 1. The lead levels ranged from 3.8 - 53 mcg% with a mean of 15.6 mcg%. These levels agree with means reported in the literature for general populations.

Some 5.9 percent of the patients had lead levels above 25 mcg%. We considered these patients to have high-lead values.

Although levels below 40 mcg% are generally considered normal, one must bear in mind the uniqueness of the individual resulting in the presence of susceptible and resistant individuals in a population. One must also bear in mind the greater susceptibility of children. We

FIGURE 1




**Histogram showing the distribution of blood lead levels in a psychiatric outpatient population.**

therefore took a closer look at our high-lead group, particularly cases of known lead exposure or hyperactive children. Symptoms of depression, anxiety, headache, sore joints and metallic taste were reported more frequently in the high-lead group.

Table 1 presents the results of Zn and vitamin C therapy on 47 adult patients. Blood lead levels were significantly reduced between the initial and subsequent visits. Dose levels were 2.0 g vitamin C and 30 mg zinc as the gluconate AM and PM. The difference in lead levels between the initial and third visit was significant at the .001 level when the data was analyzed with the paired t test.

TABLE 1

**Blood Lead Levels in Adult Male and Female Psychiatric Outpatients Vitamin C and Zinc Therapy**

| | Male (n = 30) | Female (n = 17) |
|---|---|---|
| | $\bar{X} \pm$ S. D. | $\bar{X} \pm$ S. D. |
| 1st visit (pretreatment) | 24.6 ± 4.6 (mcg/%) | 23.2 ± 2.8 (mcg/%) |
| 2nd visit | 21.6 ± 5.9 | 18.2 ± 3.3 |
| 3rd visit | 18.8 ± 6.8 | 18.0 ± 5.1 |

| | t* | P | t | P |
|---|---|---|---|---|
| Visit 1 vs. 2 | 2.730 | .02 | 8.009 | .001 |
| Visit 2 vs. 3 | 2.170 | .05 | .885 | N. S. |
| Visit 1 vs. 3 | 5.082 | .001 | 4.539 | .001 |

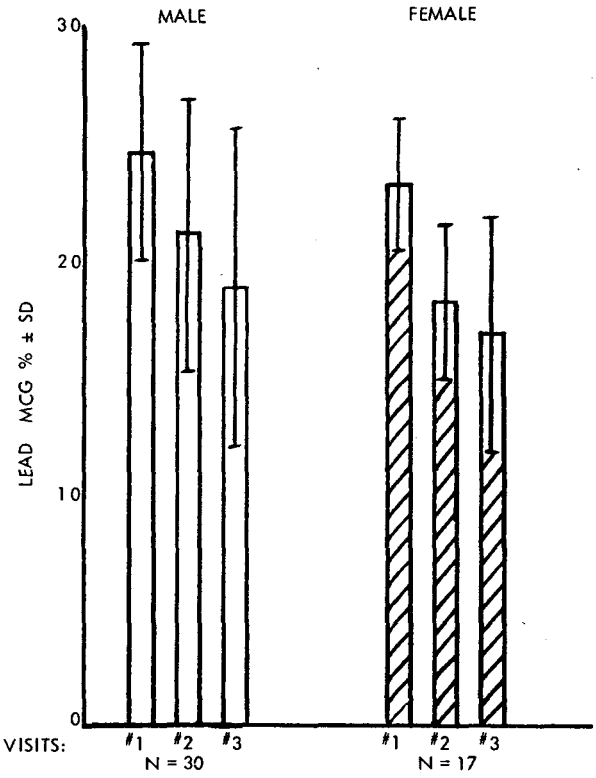
* Paired t test

The effect of the treatment regimen was similar in both male and female patients, Figure 2.

Figure 3 illustrates the decline in lead levels observed in five representative patients who were followed for a period of several months.

Table 2 illustrates the problem of heavy metal burden in children with psychiatric problems. Not only lead but also copper may burden the system of these patients. Treatment with vitamin

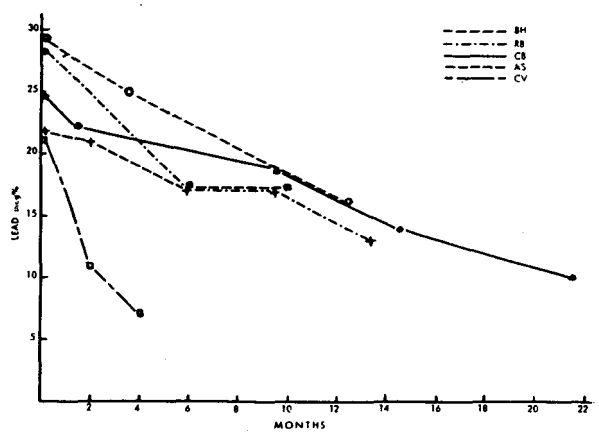
FIGURE 2




**Effect of vitamin C and Zn on blood lead levels in male and female patients.**

C and zinc is known to reduce the copper burden (Pfeiffer and Iliev, 1972). In children, lead levels greater than their chronological age may be suspect particularly in cases of known lead exposure. A decrease in the heavy metal burden by treatment with the vitamin C and zinc was followed by clinical improvement.

FIGURE 3




**Blood lead levels of representative patients on the vitamin C plus Zn regimen on initial and several subsequent visits.**

TABLE 2

**Heavy Metal Burden in Hyperactive Children**

| | Age | Pb mcg% | Cu mcg% |
|---|---|---|---|
| Male | 10.7** | 18.2 | 147 |
| n = 19 | ±2.2 | ±5.0 | ±0.29 |
| % elevated | | 100%* | 100% |
| female | 10.0 | 15.8 | 134 |
| n = 13 | ±2.4 | ±4.8 | ±0.16 |
| % elevated | | 85% | 100% |

* Refers to a blood lead level greater than chronological age.

** Values expressed as mean ± S. D.

## Discussion

Since the number of patients found in this survey to be suffering from lead intoxication was quite limited, we have recently instituted a study of 40 male lead workers with blood lead levels above 40 mcg%. We feel that efficacy of the proposed therapy can be better validated with such a group.

From a number of points of view, the therapy proposed may be advantageous. The current treatment of lead intoxication involves chelation therapy with agents such as EDTA or penicillamine, both of which are more hazardous.

A number of studies (Finkler, 1976) have shown renal damage due to prolonged use of Ca EDTA. It has been used as a prophylactic measure in a number of instances with lead workers! This practice is deplorable in that environmental conditions for the exposure are not alleviated and the worker is exposed to the possible toxic effects of the medication. The therapy proposed is simple, cheap, and relatively free of side effects.

The problem of lead exposure in children deserves some further comment. It has been well established that lead intoxication in children is quite different from that which is observed in adults. In adults the lead exposure is generally connected with known dangerous occupations; in children exposure is often due to habits such as pica where lead is ingested via foreign particles such as paint chips or living near a super highway.

Lead appears to be more easily absorbed in children, and it is retained to a greater extent. In contrast to adults where lead is stored primarily in bone, in children large amounts of lead remain in the soft tissue. From the results of the study it appears to be advisable to check most children having psychiatric problems for lead and copper intoxication. The problem of a high-lead burden in children has been extensively discussed by Bryce-Smith and Waldren (1976). They conclude that in children who are clinically asymptomatic and whose lead levels are not markedly above 40 mcg%, they have found a broad range of psychological impairment. In addition, hyperactive children with blood lead levels of the order of 25 mcg% have shown great improvement on treatment with pencillamine or calcium-EDTA. We believe that in hyperactive children lead levels of 25 mcg% may be suspect, and even lead levels above the actual age of the patient when the serum uric acid is high.

We may summarize our findings as follows: Blood levels on over 1,000 psychiatric outpatients indicate that in a small percentage of them lead exposure may cause psychiatric symptoms. This is particularly true in hyperactive children. These patients appear to benefit from a zinc, ascorbic acid supplementation which results in a decrease in their blood lead and copper levels. We are currently investigating this therapy in a group of lead workers who have lead levels over 40 mcg%.

## REFERENCES

ALBERT, R. E., SHORT, R. E., SAYERS, A. J., STREH-LOW, C, KNEIP, T. V., PASTERNACK, B. S., FRIED-HOFF, A. J., COVEN, F., and CIMINO, V. A.: Environ, Health Perspect. 7:33, 1974.

de la BURDE, 8., and CHOATE, M. S.: J. of Pediatrics 87:638, 1975.

LANDRIGAN, P. J., BALOH, R. W., BARTHEL, W. F., WHITWORTH, R. H,, STACHLING, N. W,, and ROSEN-BLUM, B. F.: Lancet 1, 1975.

PORINO, J., and ERNHART, C. B. J.: Learn. Disabilities 7:26, 1974.

DAVID, 0., CLARK, J., and VOELLER, K.: Lancet 2:900, 1972.

SAUERHOFF, M. W., and MicHAELSON, I. A.: Science 182:1022, 1973.

BEATTIE, A. D,, MOORE, M. R., GOLDBERG, A., FIN-LAYSON, M. J. W., MACKIE, E. M., MAIN, J. C, McLAREN, D. A., MURDOCK, R. M., and STEWART, G. T.: Lancet 589, 1975.

HARRIMAN and PARLAND quoted by HERNBERG, S.: Proc. Int. Symp. Environ. Health Aspects of Lead 617, 1973.

SPIVEY FOX. M. R.: N.Y. Acad. Sci. 258:144, 1975.

CHATTERJEE, G. C, MAJUMDEN, P. L, BANERJEE, S. K., ROY, R. K., and RUDRAPAL, D.: Ann. N.Y. Acad. Sci. 258-382, 1975.

OLESKE, J. M., VALENTINE, J. L, and MINNEFOR, A. B.: Health Laboratory Science 12:230, 1975.

HESSEL, D. B.: Atomic Absorption News Letter 7:55, 1968.

PFEIFFER, C. C, and ILIEV, V.: Int. Rev. Neurobiol. 15:141, 1972.

FINKLER, J. F.: JAMA 235:1553, 1976.

BRYCE-SMITH, D., and WALDRON, H. A.: The Ecologist 4, p. 202, 1976.