Drinking Water as a Source of Lead Pollution

by A. Goldberg †

Frank lead poisoning was found in some inhabitants of houses in the Scottish Highlands, exposed to soft water and lead-lined drinking water tanks. Further investigations were carried out on the clinical and metabolic effects of lead acquired by drinking soft domestic water from lead plumbing systems in 23 Glasgow households. The lead content of water from cold taps was up to 18 times the upper acceptable limit and was proportional to the amount of lead in the plumbing system. The blood lead of 71 inhabitants of these houses showed a significant positive correlation with water lead content. Delta aminolaevulic acid dehydrase activity, an extremely sensitive indicator of lead exposure, showed a significant negative correlation with water-lead content. Atmospheric lead was within acceptable limits in all but one house and no significant correlation could be found with biochemical measurements. A small number of clinical abnormalities were found but could not be directly attributed to lead toxicity. The results of the study underline the possible danger to health of lead plumbing systems in soft-water regions.

The importance of prenatal and postnatal exposure to lead as in the possible association of low levels of lead and childhood toxicity has been emphasized in this conference. This report deals with the problem of lead-polluted water supplies in Scotland. About 90% of Scottish infants are fed with powdered milk and thus they will be exposed to a larger volume of tap water per body weight than at any other time. The consideration of lead-polluted drinking water is thus of relevance to the central theme of the conference. Our attention to this problem was drawn to us by clinical observations in the Scottish Highlands, after which further studies were carried out in the city of Glasgow.

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Lead Poisoning in Rural Scotland

The beauty of rural Scotland seems remote from environmental pollution, but lead poisoning may occur just in such surroundings (*1, 2*). Nine people from four families living in rural parts of Scotland were found to suffer from clinical or biochemical effects of lead poisoning. Four of these patients had severe clinical symptoms in the form of acute abdominal pain, anemia, arthropathy or tremor. Three patients had hematological abnormalities manifested by anemia, reticulocytosis, and basophilic stippling. Seven had hyperuricemia, including three with joint pain. The source was traced to the domestic water supply, which in all cases was grossly contaminated with lead acquired from lead plumbing systems. Water throughout this area is, of course,

soft and this is a factor which adds to its plumbosolvency. In each of the four families there was an old lead storage tank for domestic water. In one case the tank was nearly 200 years old. Clinical improvement followed the replacement of lead piping in two of the families studied. The lead content of the domestic water in some of these homes reached levels of 2000 or 3000 μg/l., which is many times the recommended upper limit (100 μg/l.) laid down by the World Health Organization (WHO). The possibility of lead poisoning as a cause of chronic ill health in areas of plumbosolvent water must be considered especially where the plumbing system contains a lead-lined tank.

Environmental Lead Pollution in an Urban Soft Water Area

Glasgow is one of the largest soft water areas in the United Kingdom, and there are a number of houses which contain lead-lined tanks for the storage of domestic water, as well as lead pipes. For this reason, the following investigation was carried out in association with Dr. A. R. Miller, former M.O.H. for Glasgow, and Mr. W. T. Devenay of the Lower Clyde Water Board. It was considered important to study the effects of different waters, containing varying amounts of lead, on the inhabitants of the respective households. For this reason three groups were studied: group 1, comprising families whose house had a lead-lined tank for storage of drinking water plus lead piping; group 2; where there was no lead tank but lead piping in excess of 60 ft; group 3; there was less than 60 ft of lead piping carrying drinking water supply.

Twenty-three households were investigated, giving a total of 71 inhabitants, of whom 21 were under 15 years of age. Results showed that the lead content of water from cold taps was up to 18 times the upper WHO limit (100 μg/l.) and was proportional to the amount of lead in the plumbing system (Fig. 1). The blood lead of 71 inhabitants of these houses showed a significant positive correlation with the water lead content (Fig. 2). There were no significant differences in blood lead levels between men and women or between adults and children, although the levels of four children were in the range 30–40 μg/100 g. The subjects who drank the first water run from the tap each morning did not have higher blood leads than the rest of the group. ALA dehydratase activity measured in the peripheral blood, an extremely sensitive indicator of lead exposure, showed a significant negative correlation with the water lead content (Fig. 3). The average water lead content of the 23 houses was 358 μg/l. In groups 1, 2, and 3 the average water leads were 934, 239, and 108 μg/l., respectively. There were significant differences in the water lead between group 1 and group 2 and between group 2 and group 3. The lead content of the water samples obtained from the main reservoir serving the area was 17.9 μg/l., and thus

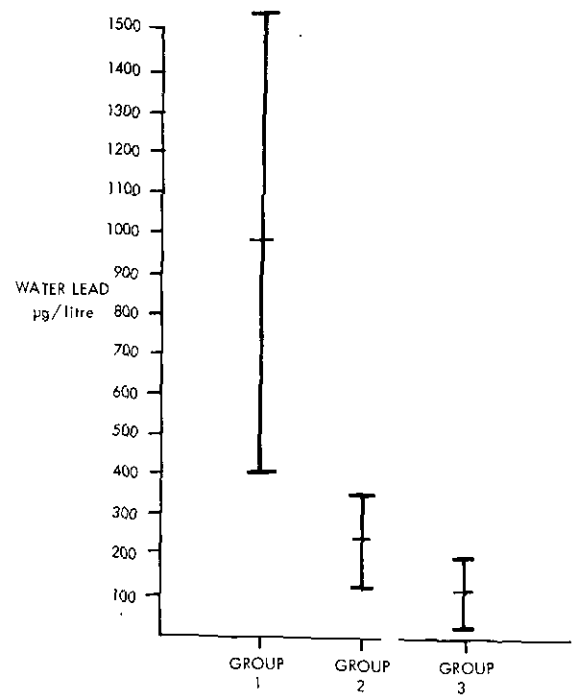

FIGURE 1. Lead content of cold tap water from houses in the three groups; mean ± 2 standard errors in each case.

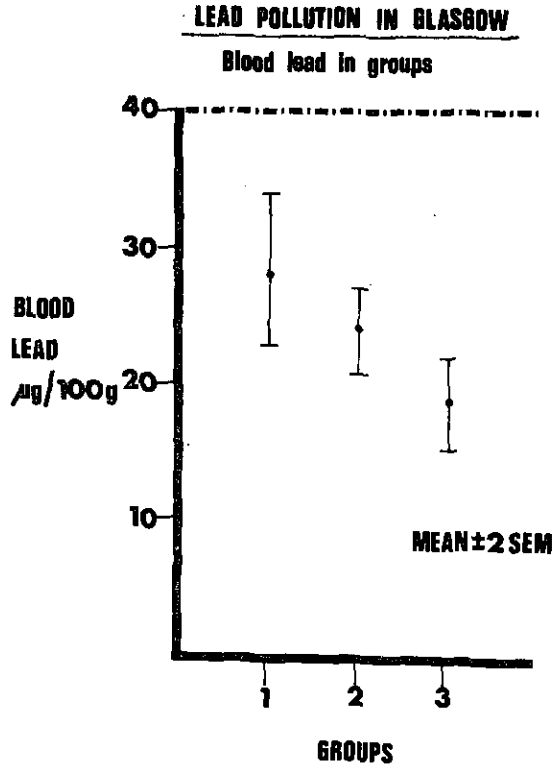

FIGURE 2. Blood lead levels in the inhabitants of houses in the three groups; mean ± 2 standard errors in each case.

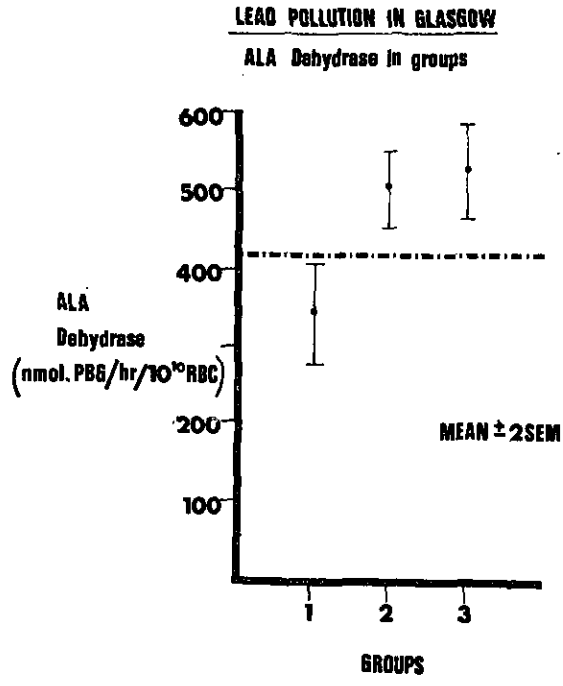

FIGURE 3. Erythrocyte ALA dehydratase levels in the inhabitants of houses in the three groups; mean ± 2 standard errors in each case.

the main cause of lead contamination was the lead plumbing system, in particular the possession of a lead-lined tank. The lead content of the atmosphere within the houses ranged from nil to 11.1 $\mu g/m^3$ with a mean of 1.46 $\mu g/m^3$. No significant correlation could be found between atmospheric lead and any of the clinical or biochemical measurements. A small number of clinical abnormalities were found but could not be directly attributed to lead toxicity. Six subjects with diastolic blood pressures of 95 mm mercury or above had a mean blood lead of 33.4 $\mu g/100$ g, which was 10.7 $\mu g/100$ g higher than that of the remaining normotensive subjects. The small number of cases of hypertension did not make this statistically significant, but clearly it is a point which is important to follow up.

REFERENCES

1. Beattie, A. D., et al. Lead poisoning in rural Scotland. Brit. Med. J. 2: 488 (1972).
2. Beattie, A. D., et al. Environmental lead pollution in an urban soft-water area. Brit. Med. J. 2: 491 (1972).