Aluminum and Health

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Introduction

Aluminum is the most abundant metal in the earth's crust and, as a result, it commonly enters the food chain. The average person, therefore, ingests between 10 and 100 mg each day. Normally little of this metal enters the body because aluminum salts tend to combine with phosphate in the gastrointestinal tract and are excreted. However, some aluminum is absorbed and, as a consequence, most soft tissues contain between 0.2 and 0.6 ppm. In total, the human body burden of this metal is usually between 50 to 150 mg (Beliles, 1979). Levels tend to be greatest in the elderly and, therefore, aluminum is included amongst the age elements (Keller, 1991).

Standard academic texts on metal toxicity tend to largely ignore aluminum (Oehme, 1979; Adriano, 1986). This is because the conventional wisdom holds that, except at extremely high levels of intake, aluminum is relatively harmless (Beliles, 1979). However, evidence is accumulating rapidly, from a variety of sources, which tends to suggest that this viewpoint is incorrect. In particular, it seems possible that elevated aluminum in drinking water may be a major health hazard (Foster, 1992).

Natural water sources vary considerably in their aluminum content; fast flowing rivers with pebble beds tending to contain less than slower streams draining boggy areas (Fuge and Perkins, 1991). In the industrialized world, however, aluminum concentrations in rivers and lakes appear to be rising, reflecting the negative impact of acid rain, which increases the solubility of this metal. Considerable aluminum also enters drinking water during treatment, since many plants use aluminum sulphate as a primary flocculent to remove suspended silts, clays and viruses (Safe Drinking Water Committee, 1977). Unfortunately, however, this process also adds aluminum to drinking water and its level may be increased in this way by a factor of five (Barnett et al., 1969; Fuge and Perkins, 1991).

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Health Effects

The zoologists Erik Nyholm and Harry Myhrberg (1977) have shown that black and white fly-catchers, nesting near a polluted lake, laid eggs with very fragile shells. The calcium metabolism of these birds had been adversely affected by eating insects containing elevated aluminum. During the 1970's, a number of patients undergoing dialysis treatment, with tap water containing aluminum from treatment plants, developed osteomalacia, a disorder involving a softening of the bones resulting from impaired mineralization. This problem was recorded in Europe, North America and Australia. In Great Britain, a survey of 1293 patients in 18 centers established a very strong statistical relationship between bone softening and the aluminum content of the water supply used in dialysis (Parkinson et al., 1979). This disorder was particularly common in Glasgow, Leeds, Newcastle, Plymouth and Oxford where drinking water aluminum levels were elevated.

To explore the relationship between bone strength and aluminum content further, Mjoberg (1988) carried out 20 bone biopsies on patients who had not experienced dialysis, but who had suffered hip fractures. The aluminum and calcium content of sampled materials established that there was no significant relationship between bone aluminum and sex or fracture type, but there was a statistically significant tendency towards higher aluminum levels in the bones of younger hip fracture patients. In general, therefore, while more research is necessary, Mjoberg's (1988) results tend to support the hypothesis that aluminum impairs bone mineralization and increases fracture rates in the general population.

The use of water containing high levels of aluminum in the treatment of kidney patients was also associated with significant increases in dialysis encephalopathy, a degenerative disorder of the brain that showed some similarities with Alzheimer's disease. Parkinson and colleagues (1979) demonstrated that in Newcastle, for example, of the ten patients in their twenties on home dialysis, none survived for two years; all dying of dialysis encephalopathy, osteomalacia or unexplained cardiorespiratory failure.

It is certainly possible that aluminum may be a key risk factor in Alzheimer's disease, since patients' brains appear to contain slightly less than double the aluminum found in similarly aged controls, roughly 3.8 mg per kg (dry weight). This may be significant since Sohler and coworkers (1981) have shown that, in a sample of 400 psychiatric outpatients in New Jersey, memory loss increased as blood aluminum levels rose. There are at least three geographical studies that also tend to support a role for aluminum in the etiology of Alzheimer's disease. In England and Wales, for example, Martyn and colleagues (1989) conducted a survey of 88 county districts to establish the rate of Alzheimer's disease in people under age 70. These rates were estimated using records of computerized tomographic scanning units. It was concluded that the risk of developing Alzheimer's disease was 1.5 times higher in districts where the mean water aluminum concentrations exceeded 0.11 mg per litre than it was where they were less than 0.01 mg per litre.

In 1986, Vogt conducted a study in Norway which involved comparing the aluminum content of drinking water with mortality from both senile and presenile dementia, approximately 50 to 70 per cent of which was related to Alzheimer's disease. Death from these causes was found to be most common in regions which were experiencing both elevated aluminum levels in lakes and highly acid rain. Since aluminum solubility increases as pH declines these two variables were closely related. In 1990, Flaten conducted a similar Norwegian study, using correlation and regression analysis. His results confirmed those of Vogt (1986), showing greater mortality from Alzheimer's disease in regions where water aluminum levels were elevated.

Conclusion

While the evidence is not yet conclusive that fractures associated with osteoporosis, and Alzheimer's disease are promoted by drinking water containing elevated aluminum, it is growing more convincing. Recently, for example, McLachlan and colleagues (1991) have shown that the use of the aluminum chelator desferoxamine slowed down the decline of living skills in patients with probable Alzheimer's disease. It would appear, therefore, that the removal of aluminum from the body can at least retard the development of this form of dementia. However, it also may be possible to achieve this goal through the use of calcium and magnesium mineral supplements. Campbell (1991), who specializes in hair analysis and dietary counselling, has noted that a daily calcium supplement of 500 mg and a similar additional intake of magnesium appears capable of lowering elevated hair aluminum levels back to normal in approximately one year. Similarly, Bland (1979) recommended the daily use of 600 mg of calcium and 300 mg of magnesium to reduce body burdens of aluminum.

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