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Letter to the Editor

## DIETARY ALUMINUM AND ALZHEIMER'S DISEASE

Dear Sir:

The recent article by W. O. Caster and M. Wang (Sci. Total Environ., 17 (1981) 31—36) unfortunately is largely based on incomplete and outdated literature references. Uncorrected, it might lead to erroneous assessments of the biology and chemistry of Alzheimer's disease and senile dementia.

*Nutrition*

Caster and Wang refer to the aluminium in human nutrition as "only trace amounts". Actually we ingest 30—50 milligrams of aluminum daily in our food. This amount comes from aluminum naturally present in our foods, from aluminum cookware, and even from our eating containers. Analysis of 200 dishes, for example, showed much more than trace amounts [1].

*Dialysis encephalopathy*

The literature cited by Caster and Wang has been outdated by the wide and expanding research of 1976—1981. The finding of Alfrey et al. that aluminum is the critical causative factor in the dialysis syndrome has been confirmed more than 100 times in unintended human experiments, which have cost thousands their sanity and lives [2].

The dialysis syndrome is not identical with Alzheimer's disease — for example, histochemical investigations have shown, that in the dialysis syndrome the aluminum is mainly concentrated in the cytoplasm of the neurons, while in Alzheimer's disease and senile dementia it is firmly bonded to the chromatin *within the nuclei* of neurons.

The difference might be due to the resistance of the membrane of the cell nucleus to aluminum passage. Even this last defense can apparently be bridged by a very slow penetration, a matter of decades. This would require more time than is available in dialysis treatments.

*Induced animal Alzheimer type syndrome*

Caster and Wang mention briefly a preliminary early paper by Crapper et al. but ignore the subsequent highly important work of Crapper-McLachlan and co-workers [3] who showed that a *single* injection of about a milligram of aluminum chloride invariably led to a sequence closely resembling human Alzheimer's disease (forgetfulness, motoric disturbance, seizures, death in 3 months) [4].

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*Relevant fundamental properties of aluminum*

Caster and Wang do not take notice of the basic characteristics of aluminum which predestine the biologic dysfunction of this metal:

1. Its extreme energy concentration (3 valence electrons and atomic weight 27). This makes for very strong bonding [5].

2. Aluminum is always tri-valent, thus cannot be removed or manipulated by oxido—reductive processes, as can almost all other biologically useful polyvalent metals (ferric to ferrous, etc.).

3. The small diameter of the atom helps this metal penetrate, and fit into critical receptor sites with minimal possibility of removal.

*Presence of aluminum*

Aluminum in the dialysis water is the principal cause of dialysis encephalopathy [6]. On the other hand, aluminum is so widely spread that pinpointing particular sources for senile dementia seems futile. The body's defenses are excellent and make it possible for us to live healthy lives long enough to have our children and help them get a start in life. After that, evolution has no reason to further extend protection. So it is that the accumulation of aluminum that takes many decades, continues and becomes more critical as years advance.

*The broad picture*

Alzheimer's syndrome is characterized by the development of neurofibrillary tangles in pyramidal neurons of the brain. Wisniewski [7] has observed that such tangles can be formed without the presence of exceptionally high concentrations of aluminum. For this reason he expressed doubts about the central role of aluminum in the Alzheimer syndrome. Alfrey also points out that in a few instances the dialysis encephalopathy occurs in the absence of aluminum.

The answer becomes obvious when we compare for example Wisniewski's photographs of Alzheimer tangles with the postulated picture of the tangles caused by crosslinkage of macromolecules [13]. The common denominator is crosslinkages. Tangles can form whenever flexible, highly elongated molecules are tied together by one or a few covalent crosslinkages, so as to hold them together, while leaving them otherwise free to move.

Aluminum is an excellent crosslinker and is used as such in the tanning industry [8,9] but in addition numerous organic molecules are also excellent crosslinkers [10—12] and so are also capable of causing Alzheimer tangles [13]. Aluminum is easy to follow analytically in metabolism. Organic crosslinkages are much more difficult to distinguish, particularly when any aggregate may contain many different crosslinkers.

The problem can be visualized if we imagine 1,000 persons moving around on different tasks in a large hall. If more and more of these people are randomly shackled together by an increasing number of hand, foot and neck cuffs, they would ultimately form an enormous tangle [14]. The essential hindrance would be the linking itself. It would make no difference where

the individual links would connect, nor whether they were made of aluminum, steel, polyester or nylon, etc.

So it is that aluminum is only a part of the total picture. It is an important noxious agent because once lodged it is a substance which cannot yet be removed. Since aluminum deposition occurs through life, in advanced years it becomes an increasingly serious health hazard.

Yours very sincerely,

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