



UK Aluminium Industry Fact Sheet 13

Aluminium and Health

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Introduction

Do some aluminium products and compounds pose a risk to human health through inhalation ingestion or skin contact? In recent years this question has received widespread public attention. There are several reasons for this. A small number of doctors and scientists have claimed that there may be a link between aluminium and Alzheimer's disease, the commonest cause of senile dementia. Incidents such as the accidental pollution of drinking water with aluminium sulphate which occurred in North Cornwall in 1988, have also heightened media and public interest in this issue. In some medical situations, such as kidney failure, there are adverse effects associated with abnormal exposure to aluminium and although such findings are irrelevant as far as normal healthy adults are concerned, their reporting out of context has sometimes helped to fuel public anxiety. This Fact Sheet aims to clarify the confusion surrounding aluminium and health and makes reference to independent sources of medical and scientific information on the matter.

Aluminium in the Environment

Aluminium is the third most common element and the most common metal in the earth's crust. In nature it is almost always found combined with other elements and there are many, different compounds which contain aluminium. The richest source is aluminium trihydrate or bauxite, the ore from which aluminium is produced. Aluminium also combines readily with silicon to form aluminosilicates, the major constituent of many rocks, clays and soils.

While aluminium is abundant in the environment, the naturally occurring forms are stable and do not interact with the biological processes which go on in living organisms. Under very acidic conditions, however, aluminium can be released from rocks and soils in a soluble form which can be absorbed by plants and animals. Some plants naturally accumulate relatively high amounts of aluminium compounds in their leaves, from the soil in which they grow. Tea, for example, has a high aluminium content.

There are many useful man-made compounds which contain aluminium. High levels of aluminium hydroxide are present in some antacid preparations used to treat indigestion, and in buffered aspirin

tablets which are designed to reduce irritation of the stomach. Other types of aluminium compounds are used as food additives; for example, as colorants or to prevent the caking of powdered foods such as milk substitutes.

Aluminium sulphate is widely used around the world in the treatment of water supplies. It is added as a flocculating agent to remove suspended particles, including the spores of some infectious organisms which are difficult to remove by other means. Most of the aluminium is removed in the later stages of treatment and the final concentration is usually much less than two hundred parts per billion. Thus, drinking water contributes only a very small fraction, less than 1%, of the aluminium which we take in each day. Aluminium cookware and foil are also relatively insignificant sources of dietary aluminium, compared to food additives or pharmaceutical preparations such as antacids. Aluminium drink cans are internally lacquered, so there is no contact between the metal and the drink.

From these natural and man-made sources of aluminium, it is estimated that the average person has a dietary intake of around 10mg (thousandths of a gramme) of aluminium each day, although this will vary widely depending upon dietary habits. This aluminium intake is excreted normally in urine and faeces.



Aluminium in the Body

It has been estimated that the human body contains around 35 mg of aluminium, of which approximately 25% is in the soft tissues, 25% in bone and the rest in the lungs, probably as inhaled dust particles. There is no known biological role for aluminium - it does not appear to be an essential trace element - and the body has highly effective barriers to exclude aluminium. Only a minute fraction of aluminium in the diet is taken up from the gut, and in healthy individuals, most of this absorbed aluminium is excreted by the kidneys. The brain is vulnerable to many metals, including aluminium, but there is a 'blood-brain barrier' which prevents most of the aluminium in blood from entering this organ. When blood aluminium levels are high, bone appears to act as a 'sink', taking up aluminium and releasing it slowly over a long period.

Medical Problems Associated with Aluminium

When the natural barriers which limit the absorption of aluminium are bypassed, or when the ability of the kidneys to excrete aluminium is impaired, the accumulation of this metal in the body may sometimes be associated with adverse health effects. Individuals receiving regular intravenous treatment with products such as blood proteins that were contaminated with aluminium were found to be at risk, and such preparations are now produced in ways which eliminate aluminium.

Patients with kidney failure are unable to excrete aluminium. Toxicity associated with exposure to aluminium in the dialysis fluid, or with the long-term medical use of aluminium compounds in this patient group, are now recognised. Care is taken to monitor blood levels of aluminium in anyone with kidney failure. The acute 'dialysis dementia' described in the early days of renal dialysis, before aluminium was implicated, is quite unlike the slow progressive dementia resulting from Alzheimer's disease.

In a few, extremely rare cases, long-term exposure to massive levels of flake powdered aluminium in the work-place has previously been shown to cause toxic effects. Modern occupational hygiene practices, which are enforced by health and safety legislation, now prevent the occurrence of such exposures in the work-place.

Although following the North Cornwall water

pollution incident at Camelford, it was claimed by a few scientists that there would be long-term adverse health effects, two government reports by an independent team of medical and scientific experts concluded that aluminium was not the cause of symptoms reported by the local population.

Alzheimer's Disease and Aluminium

If it was not for the highly controversial claims linking aluminium with Alzheimer's disease, there would be little public interest in the health aspects of aluminium. This disorder is the most common cause of dementia, a condition which affects about 5% of the population aged over 65 years. The main symptom is the progressive loss of memory and other higher mental functions. These changes result from the destruction of brain cells and the development of plaques and tangles - two types of microscopic damage which involve the abnormal accumulation of proteins in the brain.

Recent research has established that Alzheimer's disease has various different causes. Some forms are inherited and several genetic mutations which give rise to early onset Alzheimer's disease have been identified. There is also a normal variant of the gene for a substance called apolipoprotein E, which increases the risk of developing late onset Alzheimer's disease in carriers. It is likely that environmental risk factors contribute to the development of Alzheimer's disease but much less is known about these. Epidemiological studies - that is, investigations to determine whether factors such as place of residence, lifestyle, diet, occupation, medical history etc can throw light on possible causes - have suggested that head injury is a risk factor for Alzheimer's disease. The hypothesis is supported by independent evidence showing that plaques and tangles, the hallmark pathological signs of Alzheimer's disease, occur in the brain following head injury.

The medical debate about aluminium as a risk factor for Alzheimer's disease has been set out clearly for the lay reader in an Information Sheet (No 406) published by the Alzheimer's Disease Society. Briefly, it has been claimed at various times that the aluminium content of the brain is elevated in Alzheimer's disease; that aluminium is associated with the plaques and tangles which occur in the Alzheimer brain; that people who live in areas where there is a high level of

aluminium in the drinking water are at increased risk for this disorder; and also that the brains of patients exposed to increased blood levels of aluminium because of kidney disease show changes similar to those which occur in the early stages of Alzheimer's. However, many of the studies on which these reports are based have major deficiencies, often the data are open to several interpretations and, in some cases, other scientists have been unable to replicate some of the key findings. For example, the aluminium found associated with plaques and tangles may be a secondary accumulation in damaged tissues and irrelevant to the disease process. Other substances in water, such as dissolved silicon, significantly affect the uptake of aluminium by the body and could easily explain the results of the drinking water studies. Patients with kidney failure have metabolic disorders which may be responsible for the Alzheimer-type changes in the brain. The overwhelming viewpoint of the scientific and medical community and supported by the Alzheimer's Disease Society, is that a causal link between aluminium and Alzheimer's disease has not been established and that the evidence does not warrant any public health recommendations.

The Public Health Perspective

In view of the importance of Alzheimer's disease, any claims linking this condition to an environmental risk factor - especially one which could be controlled - must be taken seriously. Health, environmental and other regulatory agencies across the world meet frequently with doctors, research workers and the aluminium industry to consider the evidence in relation to aluminium.

A comprehensive report was produced in 1995 by a Task Group of the International Programme on Chemical Safety, under the auspices of the World Health Organisation and the United Nations Environment Programme. Their report concludes '...aluminium has not been shown to pose a health risk to healthy, non-occupationally exposed humans. There is no evidence to support a primary causative role of aluminium in Alzheimer's disease and aluminium does not induce Alzheimer's disease pathology in vivo in any species, including humans. The hypothesis that exposure of the elderly population in some regions to higher levels of aluminium in drinking water may exacerbate or accelerate Alzheimer's disease is not supported by available data.'

Recent exhaustive work has been reported by the French National Institute for Health Surveillance and by Dr A Delacourt. This work concludes that the brain of an Alzheimer's disease patient shows no elevated levels of aluminium compared to the brain of a non-AD patient and that aluminium has no causative role in Alzheimer's disease.

Similar conclusions have been reached by many other specialist groups and reference can be made to some of the publications listed below for independent information on this matter.

Aluminium and Anti-Perspirants

Aluminium is not a carcinogen. Nevertheless, a claim has been made recently that aluminium compounds, used in some under-arm deodorants, are linked with the onset of breast cancer. Only one properly-conducted epidemiological study has been carried out, comparing a population of patients against an equal population of controls. The results indicate that the use of aluminium containing deodorants has no significance at all in the incidence of breast cancer.

Because aluminium is such a commonly occurring element, even in the dust in the air, accurate detection and analysis of aluminium in samples is notoriously difficult because of contamination of the samples. Claims of aluminium being associated with body tissue must be treated very carefully. The early claims of aluminium being associated with deposits in the brain sections of Alzheimer's disease victims were proved to be due to contamination of the samples during preparation, leading to an erroneous picture about the role of aluminium.

Conclusions

The overwhelming majority of medical and scientific experts in this field believe that a causal relationship between aluminium and Alzheimer's disease has not been demonstrated and that no useful medical or public health recommendations should be made at present concerning aluminium and health. Not all the questions have yet been resolved. The aluminium industry around the world is working with government research agencies and the relevant medical research organisations and charities, to ensure that high quality research is supported and that the public is provided with a fair and balanced account of this complex issue.

For Further Reference

'Aluminium and Alzheimer's disease', Alzheimer's Disease Society Fact Sheet 406, available from the ADS, Devon House, 58 St Katharine's Way, London E1W 1LB, or via www.alzheimers.org.uk

- (1) 'Alzheimer's disease and the environment'
Editor: Lord Walton of Detchant, Royal Society of Medicine, Round Table Series No 26, RSM Publications, London 1992.
- (2) 'Aluminium in biology and medicine' Editors:
DJ Chadwick and J Whelan, Ciba Foundation Symposium No 169, Wiley, Chichester, 1992.
- (3) Doll R. 'Review: Alzheimer's Disease and Environmental Aluminium' Age and Ageing, 1993, 22: 138-153.
- (4) 'Environmental Health Criteria for Aluminium'
Report of The International Programme on Chemical Safety Task Group, Brisbane 1995.
World Health Organisation and United Nations Environment Programme.
- (5) 'Living with Alzheimer's Disease' Dr Tom Smith, Sheldon Press, 2000
- (6) 'Evaluation of health risks from exposure to aluminium' French National Institute for Health Surveillance, November 2003
- (7) 'Level of aluminium salts in the normal and Alzheimer brain' Dr A Delacourt, et al, Unité Inserm, July 2003
- (8) 'Aluminium and Your Health' Dr J T Hughes, Rimes House, 1992

Further information about aluminium and aluminium alloys, their production, fabrication and end use can be obtained from:

- (1) European Aluminium Association in Brussels
www.eaa.net
- (2) International Aluminium Institute in London
www.world-aluminium.org