



STATE OF MICHIGAN

DEPARTMENT OF COMMUNITY HEALTH

LANSING

JENNIFER M. GRANHOLM
GOVERNOR

JANET OLSZEWSKI
DIRECTOR

December 14, 2004

Dear Healthcare Provider:

On September 28, 2004, the Department of Community Health (DCH) posted information to its website regarding evaluating aluminum exposure. The information had been compiled by DCH in response to inquiries from a pediatric clinic that tested serum aluminum levels in two pre-teen children from Lyon Township. The children's parent, concerned that her children might be exposed to excess amounts of aluminum, had her children's pediatrician test for serum aluminum levels. The results of the tests indicated that the serum aluminum levels from the children were higher than the reference range provided by the analyzing laboratory. The parent and the clinic requested information from DCH regarding the implications to health from these perceived-elevated levels and how to proceed. The purpose of this letter is to update that information and provide recommendations.

Since the release of that information, DCH has continued to confer with the federal Agency for Toxic Substances and Disease Registry (Atlanta and Chicago offices), the Michigan Poison Control Center (out of the Detroit Medical Center), and the Pediatric Environmental Health Specialty Unit (regionally based in Chicago). Our discussions have centered on:

- determining the necessity for medical testing, in regards to township residents' concerns;
- determining an appropriate reference range, if possible;
- what patients and doctors should be aware of before conducting medical testing;
- and interpreting analytical results.

The updated information sheet, "Evaluating Aluminum Exposure: Information for Healthcare Providers" is attached. The DCH prepared a similar information sheet for the public. The key points are below:

1. **Testing is rarely recommended for patients with proper kidney function.** Aluminum is commonplace in the soil and in the products we use or eat. There are two tables in the attachment showing concentrations of aluminum found in various foods and over-the-counter drugs. The information in the tables shows how common aluminum is and that we are regularly exposed to it in food and medicine. Although aluminum has no known nutritional function, a small amount is stored in our bones. Our kidneys are used to handling and getting rid of the excess. Therefore, unless your patient has kidney problems requiring dialysis, **there should be no risk of accumulating toxic amounts of aluminum.**



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2. **There is no consensus among analytical laboratories on serum (or plasma or urine) reference ranges.** “Reference ranges” are just that: they are a reference, usually specific to the analyzing laboratory. They are similar to “screening levels” used by regulatory or health agencies: a value within the range warrants no concern whereas a value higher than the range warrants further evaluation. The concentration of aluminum in the body is fluctuating continuously. Recent exposures, such as eating a baked good along with drinking an acidic juice (the acid in the juice will increase absorption) or taking an aluminum-containing antacid, will cause the amount of aluminum in the body to increase rapidly, until the kidneys eliminate it, at which point it will decrease to a steady state. Depending on when the patient took in the baked good or antacid compared to when blood is drawn, the serum aluminum level could be above a testing laboratory’s reference range or it could be at the low end of that range.
3. Although DCH does not recommend serum aluminum testing, the patient might insist on having the test anyway. As discussed in points 1 and 2, **recent exposure can affect test results.** If the patient is tested, you should discuss all potential sources of aluminum (food, medicine, water, high-aluminum soils, other sources) before taking the sample or discussing the results.
4. **If the patient chooses to be tested and the results are above the laboratory’s reference range, re-testing as verification is recommended.** Again, as discussed in the previous points, exposure to aluminum is, for all practical purposes, unavoidable. If the first test results suggest a re-test, you should first consult with the Michigan Poison Control Center, or with DCH, to discuss potential aluminum sources and to ensure that all proper steps are followed during the re-test.

If you need further assistance, please do not hesitate to contact me.

Sincerely,

Christina Bush, Toxicologist
Division of Environmental and Occupational Epidemiology
(517) 335-9717 or 1-800-648-6942
bushcr@michigan.gov

Attachments

Evaluating Aluminum Exposure: Information for Healthcare Providers

Aluminum - Key Points:

- One of the most common elements; found in food, water, drugs, cookware
- Patients with normal kidney/excretory function are not considered at risk of reaching toxic levels
- Patients with compromised kidney/excretory function may not be able to excrete aluminum efficiently
- Normal urine or blood levels – see Reference Ranges section

General Information:

Aluminum is the third most common element and the most common metal in the earth's crust. Daily exposure to aluminum is inevitable due to its abundance in nature and its diverse use by man.

Sources of Exposure:

General population -

Processed foods
Infant formula
Drinking water
Antiperspirants
Cosmetics
Analgesics
Anti-ulceratives
Antidiarrheals
Antacids
Airborne dust particulates

Worker population -

Primary aluminum smelters
(processing ore)
Secondary aluminum smelters
(recycling)
Production/use of compounds
containing aluminum
Aluminum welding

Populations who may have higher exposures:

Persons living near industrial emission sources or uncontrolled hazardous waste sites
Patients with chronic kidney failure requiring long-term dialysis or treatment with phosphate binders
Infants, especially premature infants, fed soy-based formula containing high levels of aluminum
Individuals consuming large quantities of antacids, anti-ulcerative medications, buffered analgesics, antidiarrheal medications, or vitamins and food supplements containing aluminum

Absorption/Metabolism/Excretion:

Aluminum is poorly absorbed following either oral or inhalation exposure and is essentially not absorbed dermally. The absorption of ingested aluminum is

influenced by its form and the presence of other substances in the gastrointestinal tract that may significantly enhance (e.g., citrate) or hinder (e.g., silica) absorption. Inhaled fine powders of aluminum metal may deposit in the lung. Unabsorbed aluminum is excreted in the feces. The majority of absorbed aluminum is excreted in the urine.

Laboratory Testing:

Testing is rarely indicated in patients with proper kidney function. If testing is conducted, serum tests are preferred. Withdraw a 7-ml sample (0.6 ml minimum). Use a certified trace-metal-free tube (glass can contain aluminum). Most resources say not to use a serum separator tube. Analyze via atomic absorption spectrometry (AAS).

When using urine as a biomarker for aluminum, it is recommended to obtain a 24-hour sample rather than a random sample, due to the diurnal pattern of elimination. Use an acid-washed bottle for collection. Analyze via AAS or inductively coupled plasma/mass spectrometry (ICP/MS). Results might be difficult to interpret, since a patient might consume aluminum-containing food or medicine before or during the 24 hours.

If initial sample results are of concern and retesting is considered, it is recommended to be done as soon as possible to verify the first test’s results.

Testing of hair is not recommended.

Reference Ranges:

Below are listed several national laboratories and the non-dialysis-patient reference ranges they use when analyzing for aluminum. (You may find these laboratories on the Internet by searching under “reference range aluminum.”)

Laboratory	Analysis	Reference Range
Marquette General Health System	Serum	0 - 6 µg/L
Beth Israel Deaconess Medical Center	Serum	< 7 µg/L
Medlab Analytic	Blood	< 10 µg/L
ACT Pathology	Plasma	< 11 µg/L
ARUP (University of Utah)	Serum	0 - 20 µg/L
University of Iowa, Department of Pathology	Serum	0 - 20 µg/L
University of Kentucky Hospital	Serum	0 - 20 µg/L
Specialty Laboratories Inc.	Serum	< 40 µg/L
	Whole blood	< 20 µg/L
Cleveland Clinic Reference Laboratory	Blood	< 40 µg/L
ARUP (University of Utah)	24-hr urine	0 - 20 µg/24 hr
London Laboratory Services Group	24-hr urine	0 - 25 µg/24 hr
Cleveland Clinic Reference Laboratory	24-hr urine	< 36 µg/24 hr
Specialty Laboratories Inc.	24-hr urine	< 36 µg/24 hr

As can be seen, there is no consensus on reference ranges. Laboratories provide “reference ranges” based on historical results seen in their practice using their protocol or based on information from various health studies. The majority of health studies on aluminum in which blood values were determined used patients undergoing dialysis treatment or other patients with compromised excretory function. The central nervous system and bone effects discussed below pertain to these patients and have not been seen in otherwise healthy individuals. (Lung effects are generally seen in persons who work in the aluminum industry.)

Potential Health Effects:

Central Nervous System (seen only in patients with compromised kidney/excretory function - at blood aluminum levels >50 µg/L) -

Encephalopathy (stuttering, gait disturbance, myoclonic jerks, seizures, abnormal EEG)

Bone (seen only in patients with compromised kidney/excretory function - at blood aluminum levels > 100 µg/L) -

Osteomalacia (painful spontaneous fractures, hypercalcemia, tumorous calcinosis)

Lung -

Pulmonary effects (cough, wheeze, etc.)

Suggested Treatments:

Asymptomatic patients with aluminum levels greater than the laboratory-provided reference range-

Evaluate potential recent exposures

Retest after consulting with Poison Control Center (1-800-222-1222) regarding test method

Patients with aluminum levels > 50 µg/L -

Evaluate potential exposures

Test kidney function

Consult with Poison Control Center

Aluminum-containing Non-prescription Drugs

Antacids (e.g., Gaviscon, Maalox, Mylanta, Riopan, Roloids)	
Aluminum salt used	Al content/dose (mg)
Aluminum hydroxide	35 - 208
Dihydroxyaluminum acetate	45 - 72
Aluminum carbonate	(not available)
Aluminum oxide	41
Bismuth aluminate	55
Magaldrate	51 - 61
Dihydroxyaluminum aminoacetate	100
Dihydroxyaluminum sodium carbonate	63
Analgesics (e.g., Arthritis Pain Formula, Bufferin, Vanquish)	
Aluminum salt used	Al content/dose (mg)
Aluminum hydroxide	9 - 52
Aluminum glycinate	35,717
Antidiarrheals (e.g., Kaopectate)	
Aluminum salt used	Al content/dose (mg)
Kaolin	120 - 1,450
Aluminum magnesium silicate	36
Attapulgate	500 - 600
Anti-ulcerative (e.g., Carafate)	
Aluminum salt used	Al content/dose (mg)
Aluminum sucrose sulfate	207