

HAIR ELEMENTS



LAB#:
 PATIENT:
 SEX: Male
 AGE: 3
 CLIENT#:

POTENTIALLY TOXIC ELEMENTS				
TOXIC ELEMENTS	RESULT µg/g	REFERENCE RANGE	PERCENTILE	
			68 th	95 th
Aluminum	9.9	< 8.0		
Antimony	0.065	< 0.066		
Arsenic	0.14	< 0.080		
Beryllium	< 0.01	< 0.020		
Bismuth	0.013	< 0.13		
Cadmium	0.099	< 0.15		
Lead	1.6	< 1.0		
Mercury	1.0	< 0.40		
Platinum	< 0.003	< 0.005		
Thallium	< 0.001	< 0.010		
Thorium	0.001	< 0.005		
Uranium	0.003	< 0.060		
Nickel	0.12	< 0.40		
Silver	0.15	< 0.20		
Tin	0.34	< 0.30		
Titanium	1.7	< 1.0		
Total Toxic Representation				

ESSENTIAL AND OTHER ELEMENTS							
ELEMENTS	RESULT µg/g	REFERENCE RANGE	PERCENTILE				
			2.5 th	16 th	50 th	84 th	97.5 th
Calcium	326	125- 370					
Magnesium	23	12- 30					
Sodium	140	12- 90					
Potassium	230	12- 40					
Copper	8.8	8.0- 16					
Zinc	75	100- 190					
Manganese	0.22	0.20- 0.55					
Chromium	0.28	0.26- 0.50					
Vanadium	0.058	0.030- 0.10					
Molybdenum	0.091	0.050- 0.13					
Boron	1.1	0.60- 4.0					
Iodine	0.61	0.25- 1.3					
Lithium	0.005	0.007- 0.023					
Phosphorus	169	160- 250					
Selenium	0.89	0.95- 1.7					
Strontium	0.80	0.16- 1.0					
Sulfur	43700	45500- 53000					
Barium	0.56	0.16- 0.80					
Cobalt	0.011	0.013- 0.035					
Iron	12	8.0- 19					
Germanium	0.030	0.045- 0.065					
Rubidium	0.25	0.016- 0.18					
Zirconium	0.010	0.040- 1.0					

SPECIMEN DATA			RATIOS		
COMMENTS: 0100829					
Date Collected: 9/1/2006	Sample Size: 0.202 g		ELEMENTS	RATIOS	EXPECTED RANGE
Date Received: 9/13/2006	Sample Type: Head		Ca/Mg	14.2	4- 30
Date Completed: 9/16/2006	Hair Color:		Ca/P	1.93	0.8- 8
Methodology: ICP-MS	Treatment:		Na/K	0.609	0.5- 10
	Shampoo:		Zn/Cu	8.52	4- 20
			Zn/Cd	758	> 800

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HAIR ELEMENTS REPORT INTRODUCTION

Hair is an excretory tissue for essential, nonessential and potentially toxic elements. In general, the amount of an element that is irreversibly incorporated into growing hair is proportional to the level of the element in other body tissues. Therefore, hair elements analysis provides an indirect screening test for physiological excess, deficiency or maldistribution of elements in the body. Clinical research indicates that hair levels of specific elements, particularly potentially toxic elements such as cadmium, mercury, lead and arsenic, are highly correlated with pathological disorders. For such elements, levels in hair may be more indicative of body stores than the levels in blood and urine.

All screening tests have limitations that must be taken into consideration. The correlation between hair element levels and physiological disorders is determined by numerous factors. Individual variability and compensatory mechanisms are major factors that affect the relationship between the distribution of elements in hair and symptoms and pathological conditions. It is also very important to keep in mind that scalp hair is vulnerable to external contamination of elements by exposure to hair treatments and products. Likewise, some hair treatments (e.g. permanent solutions, dyes, and bleach) can strip hair of endogenously acquired elements and result in false low values. Careful consideration of the limitations must be made in the interpretation of results of hair analysis. The data provided should be considered in conjunction with symptomology, diet analysis, occupation and lifestyle, physical examination and the results of other analytical laboratory tests.

Caution: The contents of this report are not intended to be diagnostic and the physician using this information is cautioned against treatment based solely on the results of this screening test. For example, copper supplementation based upon a result of low hair copper is contraindicated in patients afflicted with Wilson's Disease.

Aluminum High

The Aluminum (Al) level in hair is a reliable indicator of assimilation of this element, provided that hair preparations have not added exogenous Al. Al is a nonessential element that can be toxic if excessively assimilated into cells.

Excess Al can inhibit the formation of alpha-keto glutarate and result in toxic levels of ammonia in tissues. Al can bond to phosphorylated bases on DNA and disrupt protein synthesis and catabolism. Al excess should be considered when symptoms of presenile dementia or Alzheimer's disease are observed. Hair Al is commonly elevated in children and adults with low zinc and behavioral/learning disorders such as ADD, ADHD and autism. Individuals with renal problems or on renal dialysis may have elevated Al.

Possible sources of Al include some antacid medications, Al cookware, baking powder, processed cheese, drinking water, and antiperspirant components that may be absorbed. Analyses performed at DDI indicate extremely high levels of Al are in many colloidal mineral products.

Al has neurotoxic effects at high levels, but low levels of accumulation may not elicit immediate symptoms. Early symptoms of Al burden may include: fatigue, headache, and symptoms of phosphate depletion.

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A urine elements test can be used to corroborate Al exposure. Al can be effectively complexed and excreted with silicon (J. Environ. Pathol. Toxicol. Oncol., 13(3): 205-7, 1994). A complex of malic acid and Mg has been reported to be quite effective in lowering Al levels (DDI clients).

Arsenic High

In general, hair provides a rough estimate of exposure to Arsenic (As) absorbed from food and water. However, hair can be contaminated externally with As from air, water, dust, shampoos and soap. Inorganic As, and some organic As compounds, can cause toxicity. Some research suggests that As may be essential at extremely low levels but its function is not understood. Inorganic As accumulates in hair, nails, skin, thyroid gland, bone and the gastrointestinal tract. Organic As is rapidly excreted in the urine.

As can cause malaise, muscle weakness, vomiting, diarrhea, dermatitis, and skin cancer. Long-term exposure may affect the peripheral nervous, cardiovascular and hematopoietic systems. As is a major biological antagonist to selenium.

Common sources of As are insecticides (calcium and lead arsenate), well water, smog, shellfish (arsenobetaine), and industrial exposure, particularly in the manufacture of electronic components (gallium arsenide).

As burden can be confirmed by urine elements analysis. Comparison of urine As levels pre and post provocation (DMPS, DMSA, D-penicillamine) permit differentiation between recent uptake and body stores.

Lead High

This individual's hair Lead (Pb) level is considered to be moderately elevated but below the levels consistent with Pb poisoning. Generally, hair is an excellent indicator of the body burden of Pb. However, elevated levels of Pb in head hair can be an artifact of hair darkening agents, or dyes, e.g. lead acetate. Although these agents can cause exogenous contamination, some transdermal absorption can contribute to body burden. Hair levels of iron, boron, calcium, and zinc are often concomitantly elevated with Pb burden.

Pb has neurotoxic and nephrotoxic effects in humans as well as interfering with heme biosynthesis. Pb may also affect the body's ability to utilize the essential elements calcium, magnesium, and zinc. At moderate levels of body burden, Pb may have adverse effects on memory, cognitive function, nerve conduction, and metabolism of vitamin D. Children with hair Pb levels greater than 1 µg/g have been reported to have a higher incidence of hyperactivity than those with less than 1 µg/g. Children with hair Pb levels above 3 µg/g have been reported to have more learning problems than those with less than 3 µg/g. Detoxification therapy by means of chelation results in transient increases in hair lead. Eventually, the hair Pb level will normalize after detoxification is complete.

Symptoms associated with excess Pb are somewhat nonspecific, but include: anemia, headaches, fatigue, weight loss, cognitive dysfunction and decreased coordination.

Sources of exposure to Pb include: welding, old leaded paint (chips/dust), drinking water, some

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fertilizers, industrial pollution, lead-glazed pottery, and newsprint.

Confirmatory tests for Pb excess are: urine elements analysis following provocation with intravenous EDTA, DMPS, or oral DMSA. Whole blood analysis for Pb only reflects recent or ongoing exposures and may not correlate with total body burden. Increased blood or urine protoporphyrins is a finding consistent with Pb excess, but may occur with other toxic elements as well.

Mercury High

Mercury (Hg) is toxic to humans and animals. The accumulation of Hg in the body is generally reflected by the hair Hg levels, but hair Hg levels can be artifactually high in association with the use of certain hair dyes. Individuals vary greatly in sensitivity and tolerance to Hg burden.

At hair levels below 3 µg/g, Hg can suppress biological selenium function and may cause or contribute to immune dysregulation in sensitive individuals. Hallmark symptoms of excess Hg include: loss of appetite, decreased senses of touch, hearing, and vision, fatigue, depression, emotional instability, peripheral numbness and tremors, poor memory and cognitive dysfunction, and neuromuscular disorders. Hair Hg has been reported to correlate with acute myocardial infarction and on average each 1 µg/g of hair Hg was found to correlate with a 9% increase in AMI risk (Circulation 1995; 91:645-655).

Sources of Hg include dental amalgams, contaminated seafood, water supplies, some hemorrhoidal preparations, skin lightening agents, instruments (thermometers, electrodes, batteries), and combustion of fossil fuels, some fertilizers, and the paper/pulp and gold industries. After dental amalgams are installed or removed a transient (several months) increase in hair Hg is observed. Also, "baseline" hair Hg levels for individuals with dental amalgams are higher (about 1 to 2 µg/g) than are baseline levels for those without (below 1 µg/g).

Confirmatory tests for elevated Hg are measurement of whole blood as an indication of recent/ongoing exposure (does not correlate with whole body accumulation) and measurement of urine Hg following use of a dithiol chelating or mobilizing agent such as DMSA or DMPS (an indication of total body burden).

Tin High

Hair Tin (Sn) levels have been found to correlate with environmental exposure. Depending on chemical form, Sn is a potentially toxic element. Inorganic Sn has a low degree of toxicity, while organic Sn has appreciable toxicity.

The main source of Sn is food. Other possible sources are: dental amalgams, cosmetics, preservatives, food and beverage containers, pewter, bronze, and anticorrosive platings. Symptoms of excess Sn include: skin, eye, and GI tract irritation, muscle weakness, anemia, and testicular degeneration.

A confirmatory test for excessive accumulation of Sn is the measurement of Sn in urine before and after provocation with a chelation/complexing agent.

Sodium High

Sodium (Na) is an essential element with extracellular electrolyte functions. However, these functions do not occur in hair. Hair Na measurement should be considered a screening test only; blood testing for Na and electrolyte levels is much more diagnostic and indicative of status. High hair Na may have no clinical significance or it may be the result of an electrolyte imbalance. A possible imbalance for which high hair Na is a consistent finding is adrenocortical hyperactivity. In this condition, blood Na is elevated while potassium is low. Potassium is elevated (wasted) in the urine. Observations at DDI indicate that Na and potassium levels in hair are commonly high in association with elevated levels of potentially toxic elements. The elevated Na and potassium levels are frequently concomitant with low levels of calcium and magnesium in hair. This apparent phenomenon requires further investigation.

Appropriate tests for Na status as an electrolyte are measurements of Na in whole blood and urine, and measurements of adrenocortical function.

Potassium High

High hair Potassium (K) is not necessarily reflective of dietary intake or nutrient status. However, elevated K may be reflective of metabolic disorders associated with exposure to potentially toxic elements.

K is an electrolyte and a potentiator of enzyme functions, but neither of these functions take place in hair. Elevated K in hair may reflect overall retention of K by the body or maldistribution of this element. In adrenocortical insufficiency, K is increased in blood, while it is decreased in urine; cellular K may or may not be increased. Also, hair is occasionally contaminated with K from some shampoos. Observations at DDI indicate that K and sodium levels in hair are commonly high in association with toxic element burden. The elevated K and sodium levels are often concomitant with low levels of calcium and magnesium in hair. This apparent phenomena requires further investigation.

Elevated hair potassium should be viewed as a screening test. Appropriate tests for excess body K include measurements of packed red blood cell K; serum or whole blood K and sodium/K ratio, measurement of urine K and sodium/K ratio; and an assessment of adrenocortical function.

Copper Normal

Hair Copper (Cu) levels are usually indicative of body status, except that exogenous contamination may occur giving a false normal (or false high). Common sources of contamination include: permanent solutions, dyes, bleaches, and swimming pools/hot tubs in which Cu compounds have been used as algacides.

Cu is an essential element that activates specific enzymes. Erythrocyte superoxide dismutase (SOD) is a Cu (and zinc) dependent enzyme; lysyl oxidase which catalyzes crosslinking of collagen is another Cu dependent enzyme. Adrenal catecholamine synthesis is Cu dependent, because the enzyme dopamine beta-hydroxylase, which catalyzes formation of norepinephrine from dopamine, requires Cu.

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If hair Cu is in the normal range, this usually means tissue levels are in the normal range. However, under circumstances of contamination, a real Cu deficit could appear as a (false) normal. If symptoms of Cu deficiency are present, a whole blood or red blood cell elements analysis can be performed for confirmation of Cu status.

Zinc Low

A result of low hair Zinc (Zn) is very likely to be indicative of low Zn in whole blood, red blood cells, and other tissues. Hair analysis is a good screen for Zn deficiency provided that the hair sample has not been chemically treated (permanent solutions, dyes, and bleaches); such hair treatments can significantly lower the level of Zn in hair.

Zn is an essential element that is required in numerous biochemical processes including protein, nucleic acid and energy metabolism. Zn is an obligatory co-factor for numerous enzymes including alcohol dehydrogenase, carbonic anhydrase, and superoxide dismutase.

Zn competes for absorption with copper and iron. Cadmium, lead and mercury are potent Zn antagonists. Zn deficiency can be caused by malabsorption, chelating agents, poor diet, excessive use of alcohol or diuretics, metabolic disorder of metallothionein metabolism, surgery, and burns. Hair levels of Zn (copper and selenium) were decreased in human subjects after switching from a mixed to a lactovegetarian diet (Am. J. Clin. Nutr.; 55:885-90,1992).

Hair Zn is commonly low in diabetics, and in association with ADD/ADHD and autism (DDI observation). Reported symptoms of Zn deficiency include: fatigue, apathy, hypochlorhydria, decreased vision and dysgeusia, anorexia, anemia, dermatitis, weak/brittle nails and hair, white spots on nails, alopecia, impaired wound healing, sexual dysfunction (males), and hypogonadism.

Other laboratory tests to confirm Zn status are whole blood or packed red blood cell elements analysis, and urine amino acid analysis (Zn dependent peptidase activity).

Selenium Low

Selenium (Se) is normally found in hair at very low levels, and several studies provide evidence that low hair Se is reflective of dietary intake and associated with cardiovascular disorders. Utilization of hair Se levels to assess nutritional status, however, is complicated by the fact that use of Se- or sulfur-containing shampoo markedly increases hair Se (externally) and can give a false high value.

Se is an extremely important essential element due to its antioxidative function as an obligatory component of the enzyme glutathione peroxidase. Se is also protective in its capacity to bind and "inactivate" mercury, and Se is an essential cofactor in the deiodination of T-4 to active T-3 (thyroid hormone). Some conditions of functional hypothyroidism therefore may be due to Se deficiency (Nature; 349:438-440, 1991); this is of particular concern with mercury exposure. Studies have also indicated significant inverse correlations between Se and heart disease, cancer, and asthma.

Selenium deficiency is common and can result from low dietary intake of Se or vitamin E, and exposure to toxic metals, pesticides/herbicides and chemical solvents.

Symptoms of Se deficiency are similar to that of vitamin E deficiency and include muscle aches,

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increased inflammatory response, loss of body weight, alopecia, listlessness, skeletal and muscular degeneration, growth stunting, and depressed immune function.

Confirmatory tests for Se deficiency are Se content of packed red blood cells, and activity of glutathione peroxidase in red blood cells.

Sulfur Low

Sulfur (S) in hair is covalently bound within the cysteinyl residues of hair protein. On average, cysteine constitutes about sixteen percent of the total amino acid content of hair. Although not well documented, hair S levels may vary with S-containing amino acid status in the body. Interpretation of hair S levels is confounded by the fact some hair conditioners and permanent treatments increase hair S while straighteners can significantly lower hair S levels.

Observations at DDI indicate that hair S and urine sulfhydryl amino acid levels are often low in Hg burdened patients.

Appropriate tests to determine sulfhydryl amino acid status are plasma or urine amino acid analyses.

Total Toxic Element Indication

The potentially toxic elements vary considerably with respect to their relative toxicities. The accumulation of more than one of the most toxic elements may have synergistic adverse effects, even if the level of each individual element is not strikingly high. Therefore, we present a total toxic element "score" which is estimated using a weighted average based upon relative toxicity. For example, the combined presence of lead and mercury will give a higher total score than that of the combination of silver and beryllium.